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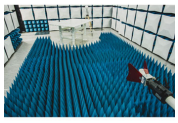

RF EXPOSURE EVALUATION Part 1
Maximum Permissible Exposure [MPE] for Frequencies < 6 GHz

Applicant Name:
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Date of Testing:
7/30/2020
Test Site/Location:
PCTEST Lab. Columbia, MD, USA
Test Report Serial No.:
1M2004140062-01.A3L

FCC ID:	**A3LSMH204V**
APPLICANT:	**Samsung Electronics Co., Ltd.**

EUT Type:	Indoor Customer Premises Equipment
FCC Classifications:	PCB, 5GT, DTS, NII, DSS
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.

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

ACCREDITED
CERT #2041.01

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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.

The limit for Maximum Permissible Exposure (MPE), specified in FCC §1.1310, is listed in Table 1-1. According to FCC §1.1310: 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 Premises Equipment FCC ID: A3LSMH204V** is a device that supports 5G NR (FR1/FR2), LTE, 2.4GHz/5GHz WiFi, and Bluetooth LE operation. The EUT uses 5G to provide coverage throughout an area indoors.

The worst case transmission scenario is determined with the following condition:

5G NR (mmWave) + LTE + 2.4GHz WiFi x 2 + 5GHz WiFi x 4 + Bluetooth LE

1.3 Time-Averaging Algorithm for RF Exposure Compliance

The equipment under test (EUT) contains:

a. Qualcomm® SDX55 modem supporting 4G/5G NR WWAN technologies

Qualcomm® SDX55 modem is enabled with Qualcomm® Smart Transmit feature. This feature performs time averaging algorithm in real time to control and manage transmitting power and ensure the time-averaged RF exposure is in compliance with FCC requirements all the time. The compliance Summary document contains a detailed description of Qualcomm® Smart Transmit feature.

Note that WLAN operations are not enabled with Smart Transmit.

The Smart Transmit algorithm maintains the time-averaged transmit power, in turn, time-averaged RF exposure of *PD_design_target* for frequencies < 6 GHz or *mmW_PD_design_target*, below the predefined time-averaged power limit (i.e., P_{limit} for sub-6 radio, and *input.power.limit* for 5G mmW NR), for each characterized technology and band.

Smart Transmit allows the device to transmit at higher power instantaneously, as high as P_{max}, when needed, but enforces power limiting to maintain time-averaged transmit power to P_{limit}. Below table shows P_{limit} EFS settings and maximum tune up output power P_{max} configured for this EUT. Note that the device uncertainty for sub-6GHz WWAN is 1.0dB for this EUT.

Mode / Band	PD Char (dBm)	
	Pmax	Plimit
LTE FDD Band 2	23.5	29.7
LTE FDD Band 4	23.5	29.8
LTE FDD Band 5	24	32.4
LTE FDD Band 13	23.95	30.7
LTE FDD Band 66	23.5	29.3
LTE TDD Band 48	22	30.3
NR FDD Band 5	23.5	32.4
NR FDD Band 2	23	29.7
NR FDD Band 66	23	29.3

*Note all P_{limit} EFS and maximum tune up output power P_{max} levels entered in above Table correspond to average power levels after accounting for duty cycle in the case of TDD modulation schemes (e.g. LTE TDD).

*Maximum tune up output power P_{max} is used to configure EUT during RF tune up procedure. The maximum allowed output power is equal to maximum Tune up output power + 1dB device design uncertainty.

The maximum time-averaged output power (dBm) for any 4G/5G Sub6 WWAN technology and band = minimum of "P_{limit} EFS" and "Maximum tune up output power P_{max}" + 1dB device uncertainty. SAR values in this report were scaled to this maximum time-averaged output power to determine compliance per KDB Publication 447498 D01v06.

The purpose of this report (Part 1 test) is to demonstrate that the EUT meets FCC Power density limits when transmitting in static transmission scenario at maximum allowable time-averaged power levels.

1.4 Test 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 each transmitter used in this product was initially measured by a spectrum analyzer or call box and the powers were recorded. Through use of the Friis transmission formula and knowledge of the maximum antenna gain to be used, the power density level is calculated at a distance of 20cm.

The power density MPE analysis of the 5G FR2 operations can be found in the MPE Power Density Part 1 Test Report for Frequencies > 6 GHz.

Friis Transmission Formula

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

Where,

P_d = Power Density (mW/cm^2) $\pi = 3.1416$
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 (Standalone) for frequencies < 6 GHz

For this device, *Plimit* > *Pmax* for all bands < 6 GHz, therefore the calculated power density corresponds to *Pmax* for those bands.

Notes:

1. For LTE operation, the highest standalone power density is recorded when operating in LTE Band 66.
2. For NR FR1 operation, the highest standalone power density is recorded when operating in NR n66.

Frequency	1710	MHz		
Limit	1.000	mW/cm^2		
Distance (cm), R =	20	cm		
Power (dBm), P =	24.5	dBm	281.84	mW
TX Ant Gain (dBi), G =	4.5	dBi		
Power Density (S) =	**0.158**	mW/cm^2	(at 20cm)	
Percent MPE Used (%)	**15.80%**			
Minimum Distance =	**8.0**	cm		

Table 1-2. Calculated MPE Data for LTE Band 66

Frequency	1710	MHz		
Limit	1.000	mW/cm^2		
Distance (cm), R =	20	cm		
Power (dBm), P =	24	dBm	251.19	mW
TX Ant Gain (dBi), G =	4.5	dBi		
Power Density (S) =	**0.141**	mW/cm^2	(at 20cm)	
Percent MPE Used (%)	**14.08%**			
Minimum Distance =	**7.5**	cm		

Table 1-3. Calculated MPE Data for NR n66

Frequency	2437	MHz		
Limit	1.000	mW/cm^2		
Distance (cm), R =	20	cm		
Power (dBm), P =	21.5	dBm	141.25	mW
TX Ant Gain (dB), G =	2.7	dBi		
Power Density (S) =	**0.052**	mW/cm^2	(at 20cm)	
Percent MPE Used (%)	**5.23%**			
Minimum Distance =	**4.6**	cm		

Table 1-4. Calculated MPE Data for 2.4GHz Band (WiFi Ant 1)

Frequency	2437	MHz		
Limit	1.000	mW/cm^2		
Distance (cm), R =	20	cm		
Power (dBm), P =	21.5	dBm	141.25	mW
TX Ant Gain (dB), G =	0.4	dBi		
Power Density (S) =	**0.031**	mW/cm^2	(at 20cm)	
Percent MPE Used (%)	**3.08%**			
Minimum Distance =	**3.5**	cm		

Table 1-5. Calculated MPE Data for 2.4GHz Band (WiFi Ant2)

Frequency	5825	MHz		
Limit	1.000	mW/cm^2		
Distance (cm), R =	20	cm		
Power (dBm), P =	22.5	dBm	177.83	mW
TX Ant Gain (dB), G =	-0.9	dBi		
Power Density (S) =	**0.029**	mW/cm^2	(at 20cm)	
Percent MPE Used (%)	**2.88%**			
Minimum Distance =	**3.4**	cm		

Table 1-6. Calculated MPE Data for 5GHz Band (WiFi Ant 3)

Frequency	5825	MHz		
Limit	1.000	mW/cm^2		
Distance (cm), R =	20	cm		
Power (dBm), P =	22.5	dBm	177.83	mW
TX Ant Gain (dB), G =	1.5	dBi		
Power Density (S) =	**0.050**	mW/cm^2	(at 20cm)	
Percent MPE Used (%)	**5.00%**			
Minimum Distance =	**4.5**	cm		

Table 1-7. Calculated MPE Data for 5GHz Band (WiFi Ant 4)

Frequency	5825	MHz		
Limit	1.000	mW/cm^2		
Distance (cm), R =	20	cm		
Power (dBm), P =	22.5	dBm	177.83	mW
TX Ant Gain (dB), G =	2.1	dBi		
Power Density (S) =	**0.057**	mW/cm^2	(at 20cm)	
Percent MPE Used (%)	**5.74%**			
Minimum Distance =	**4.8**	cm		

Table 1-8. Calculated MPE Data for 5GHz Band (WiFi Ant 5)

Frequency	5825	MHz		
Limit	1.000	mW/cm^2		
Distance (cm), R =	20	cm		
Power (dBm), P =	22.5	dBm	177.83	mW
TX Ant Gain (dB), G =	2.6	dBi		
Power Density (S) =	**0.064**	mW/cm^2	(at 20cm)	
Percent MPE Used (%)	**6.44%**			
Minimum Distance =	**5.1**	cm		

Table 1-9. Calculated MPE Data for 5GHz Band (WiFi Ant 6)

Frequency	2480	MHz		
Limit	1.000	mW/cm^2		
Distance (cm), R =	20	cm		
Power (dBm), P =	5.5	dBm	3.55	mW
TX Ant Gain (dB), G =	2.7	dBi		
Power Density (S) =	**0.001**	mW/cm^2	(at 20cm)	
Percent MPE Used (%)	**0.13%**			
Minimum Distance =	**0.7**	cm		

Table 1-10. Calculated MPE Data for 2.4GHz Band (Bluetooth LE)

Simultaneous Transmission Analysis

Due to the co-location of all of the antennas within the EUT, a simultaneous transmission analysis is also provided to assess compliance with the power density requirement when all radios are on and transmitting at the maximum allowed power. This analysis is shown in the table below.

For this device, in 5G NR + LTE + WLAN + BT simultaneous transmission, 5G NR and LTE transmission are managed and controlled by Qualcomm® Smart Transmit, while the RF exposure from WLAN and BT radios is managed using legacy approach. Since WLAN and BT do not employ time-averaging, PD assessment for WLAN and BT need to be conducted at their corresponding rated power following current FCC test procedures to determine reported PD values.

For 5G NR and LTE operation, Smart Transmit limits the maximum power density such that the overall contributions from 5G NR and LTE transmitting simultaneously is less than 60% of the power density limit, based on the following equation:

5G NR + LTE MPE Smart Tx Contribution = $minimum[norm.\boldsymbol{A}', (100-y)\% * norm.\boldsymbol{A}] + y\% * norm.\boldsymbol{B}) = 60\%$

Where for this device
norm.A' is the normalized LTE Exposure corresponding to Pmax + Device Uncertainty = 15.8%
norm.A is the normalized LTE Exposure corresponding to Plimit + Device Uncertainty = 60%
norm.B is the normalized 5G FR2 Exposure corresponding to Plimit + Device Uncertainty = 60%
y= 85% based on the EFS Entries in this device

	Percent MPE Used (%)
Transmitter #1+#2 LTE + 5G NR	60.00
Transmitter #3 - 2.4GHz WiFi (Ant1)	5.23
Transmitter #4 - 2.4GHz WiFi (Ant2)	3.08
Transmitter #5 - 5GHz UNII (Ant1)	2.88
Transmitter #6 - 5GHz UNII (Ant2)	5.00
Transmitter #7 - 5GHz UNII (Ant3)	5.74
Transmitter #8 - 5GHz UNII (Ant4)	6.44
Transmitter #9 - BLE	0.13
Total	88.49

Table 1-11. Co-location MPE Data for Simultaneous Transmission

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.