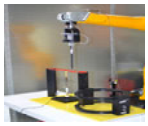
PCTEST
7185 Oakland Mills Road, Columbia, MD 21046 USA
Tel. 410.290.6652 / Fax 410.290.6654
http://www.pctest.com



HEARING AID COMPATIBILITY

Applicant Name:
Samsung Electronics Co., Ltd.
129, Samsung-ro, Maetan dong,
Yeongtong-gu, Suwon-si
Gyeonggi-do 16677, Korea

Date of Testing:
01/23/2020
Test Site/Location:
PCTEST, Columbia, MD, USA
Test Report Serial No.:
1M2001240011-16.A3L
Date of Issue:
02/04/2020

FCC ID:	**A3LSMF700U**
APPLICANT:	**SAMSUNG ELECTRONICS CO., LTD.**

Scope of Test:	RF Emissions Testing
Application Type:	Class II Permissive Change
FCC Rule Part(s):	CFR §20.19(b)
HAC Standard:	ANSI C63.19-2011 285076 D01 HAC Guidance v05 285076 D02 T-Coil testing for CMRS IP v03
DUT Type:	Portable Handset
Model:	SM-F700U/DS
Additional Model(s):	SM-F700U1/DS, SM-F700W/DS
Test Device Serial No.:	*Pre-Production Sample* [S/N: 0278M]
Class II Permissive Change(s):	See FCC Change Document

C63.19-2011 HAC Category:	**M4 (RF EMISSIONS CATEGORY, LTE ULCA Only)**

This report and category pertain only to LTE ULCA configurations supported by this wireless device. The overall category rating of the device is determined by the lowest rating obtained over all air interfaces supported by the device. This wireless portable device has been shown to be hearing-aid compatible for LTE ULCA configurations, under the above rated category, specified in ANSI/IEEE Std. C63.19-2011 and has been tested in accordance with the specified measurement procedures. Hearing-Aid Compatibility is based on the assumption that all production units will be designed electrically identical to the device tested in this report. Test results reported herein relate only to the item(s) tested. North America bands only.

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

REV 3.5.M
1/16/2020

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1. INTRODUCTION

On July 10, 2003, the Federal Communications Commission (FCC) adopted new rules requiring wireless manufacturers and service providers to provide digital wireless phones that are compatible with hearing aids. The FCC has modified the exemption for wireless phones under the Hearing Aid Compatibility Act of 1998 (HAC Act) in WT Docket 01-309 RM-8658[1] to extend the benefits of wireless telecommunications to individuals with hearing disabilities. These benefits encompass business, social and emergency communications, which increase the value of the wireless network for everyone. An estimated more than 10% of the population in the United States show signs of hearing impairment and of that fraction, almost 80% use hearing aids. Approximately 500 million people worldwide suffer from hearing loss.

Compatibility Tests Involved:

The standard calls for wireless communications devices to be measured for:

- RF Electric-field emissions
- T-coil mode, magnetic-signal strength in the audio band
- T-coil mode, magnetic-signal frequency response through the audio band
- T-coil mode, magnetic-signal and noise articulation index

The hearing aid must be measured for:

- RF immunity in microphone mode
- RF immunity in T-coil mode

In the following tests and results, this report includes the evaluation for a wireless communications device.

Figure 1-1 Hearing Aid *in-vitu*

[1] FCC Rule & Order, WT Docket 01-309 RM-8658

2. DUT DESCRIPTION

FCC ID:	A3LSMF700U
Manufacturer:	Samsung Electronics Co., Ltd. 129, Samsung-ro, Maetan dong, Yeongtong-gu, Suwon-si Gyeonggi-do 16677, Korea
Model:	SM-F700U/DS
Additional Model(s):	SM-F700U1/DS, SM-F700W/DS
Serial Number:	0278M
Antenna Configurations:	Internal Antenna
DUT Type:	Portable Handset

Table 2-1
SM-F700U/DS & SM-F700U1/DS HAC Air Interfaces

Air-Interface	Band (MHz)	Type Transport	HAC Tested	Simultaneous But Not Tested	Name of Voice Service
CDMA	835	VO	No[2]	Yes: WIFI or BT	CMRS Voice
	1900				
	EvDO	VD	No[2]	Yes: WIFI or BT	Google Duo
GSM	850	VO	No[2]	Yes: WIFI or BT	CMRS Voice
	1900				
	GPRS/EDGE	VD	No[2]	Yes: WIFI or BT	Google Duo
UMTS	850	VD	No[2]	Yes: WIFI or BT	CMRS Voice
	1700				
	1900				
	HSPA	VD	No[2]	Yes: WIFI or BT	Google Duo
LTE (FDD)	680 (B71)	VD	No[2]	Yes: WIFI or BT	VoLTE, Google Duo
	700 (B12)		No[2]		
	780 (B13)				
	790 (B14)				
	850 (B5)		No[1]		
	850 (B26)		No[2]		
	1700 (B4)				
	1700 (B66)		No[1]		
	1900 (B2)		No[2]		
	1900 (B25)				
	2300 (B30)				
	2500 (B7)				
LTE (TDD)	2600 (B38)	VD	No[2]	Yes: WIFI or BT	VoLTE, Google Duo
	2600 (B41)		No[1]		
WIFI	2450	VD	No[2]	Yes: CDMA, GSM, UMTS, or LTE	VoWIFI, Google Duo
	5200 (U-NII 1)				
	5300 (U-NII 2A)				
	5500 (U-NII 2C)				
	5800 (U-NII 3)				
BT	2450	DT	No	Yes: CDMA, GSM, UMTS, or LTE	N/A

Type Transport
VO = Voice Only
DT = Digital Data - Not intended for Voice Services
VD = CMRS and/or IP Voice over Data Transport

Notes:
1. Evaluated for MIF and low-power exemption.
2. This report only pertains to LTE ULCA configurations. Please refer to the Original Certification test report (Report S/N: 1M1912020212-16-R1.A3L) for full test data on this mode.

Table 2-2
SM-F700W/DS HAC Air Interfaces

Air-Interface	Band (MHz)	Type Transport	HAC Tested	Simultaneous But Not Tested	Name of Voice Service
CDMA	835	VO	No[2]	Yes: WIFI or BT	CMRS Voice
	EvDO	VD	No[2]	Yes: WIFI or BT	Google Duo
GSM	850	VO	No[2]	Yes: WIFI or BT	CMRS Voice
	1900				
	GPRS/EDGE	VD	No[2]	Yes: WIFI or BT	Google Duo
UMTS	850	VD	No[2]	Yes: WIFI or BT	CMRS Voice
	1700				
	1900				
	HSPA	VD	No[2]	Yes: WIFI or BT	Google Duo
LTE (FDD)	680 (B71)	VD	No[2]	Yes: WIFI or BT	VoLTE, Google Duo
	700 (B12)				
	780 (B13)				
	850 (B5)				
	1700 (B4)				
	1700 (B66)		No[1]		
	1900 (B2)		No[2]		
	1900 (B25)				
	2300 (B30)				
	2500 (B7)				
LTE (TDD)	2600 (B38)	VD	No[2]	Yes: WIFI or BT	VoLTE, Google Duo
	2600 (B41)		No[1]		
WIFI	2450	VD	No[2]	Yes: CDMA, GSM, UMTS, or LTE	VoWIFI, Google Duo
	5200 (U-NII 1)				
	5300 (U-NII 2A)				
	5500 (U-NII 2C)				
	5800 (U-NII 3)				
BT	2450	DT	No	Yes: CDMA, GSM, UMTS, or LTE	N/A

Type Transport
VO = Voice Only
DT = Digital Data - Not intended for Voice Services
VD = CMRS and/or IP Voice over Data Transport

Notes:
1. Evaluated for MIF and low-power exemption.
2. This report only pertains to LTE ULCA configurations. Please refer to the Original Certification test report (Report S/N: 1M1912020212-16-R1.A3L) for full test data on this mode.

3. ANSI/IEEE C63.19 PERFORMANCE CATEGORIES

I. RF EMISSIONS

The ANSI Standard presents performance requirements for acceptable interoperability of hearing aids with wireless communications devices. When these parameters are met, a hearing aid operates acceptably in close proximity to a wireless communications device.

Category	Telephone RF Parameters
Near field Category	**E-field emissions CW dB(V/m)**
f < 960 MHz	
M1	50 to 55
M2	45 to 50
M3	40 to 45
M4	< 40
f > 960 MHz	
M1	40 to 45
M2	35 to 40
M3	30 to 35
M4	< 30

Table 3-1
WD near-field categories as defined in ANSI C63.19-2011

4. MODULATION INTERFERENCE FACTOR

I. Measuring Modulation Interference Factors

For any specific fixed and repeatable modulated signal, a modulation interference factor (MIF, expressed in dB) may be determined that relates its interference potential to its steady-state RMS signal level or average power level. This factor is a function only of the audio-frequency amplitude modulation characteristics of the signal and is the same for field-strength and conducted power measurements. The MIF is valid only for a specific repeatable audio-frequency amplitude modulation characteristic; any change in modulation characteristic requires determination and application of a new MIF.

The MIF may be determined using a radiated RF field or a conducted RF signal:

a. Using RF illumination or conducted coupling, apply the specific modulated signal in question to the measurement system at a level within its confirmed operating dynamic range.
b. Measure the steady-state RMS level at the output of the fast probe or sensor.
c. Measure the steady-state average level at the weighting output.
d. Without changing the square-law detector or weighting system, and using RF illumination or conducted coupling, substitute for the specific modulated signal a 1 kHz, 80% amplitude modulated carrier at the same frequency and adjust its strength until the level at the weighting output equals the step c) measurement.
e. Without changing the carrier level from step d), remove the 1 kHz modulation and again measure the steady-state RMS level indicated at the output of the fast probe or sensor.
f. The MIF for the specific modulation characteristic is provided by the ratio of the step e) measurement to the step b) measurement, expressed in dB (20 × log[(step e)/(step b)]).

The following procedure was used to measure the MIF using the SPEAG Audio Interference Analyzer (AIA), Type No: SE UMS 170 CB, Serial No.: 1010:

1. The device was placed into a simulated call using a base station simulator or set to transmit using test software for a given mode.
2. The device was then set to continuously transmit at maximum power.
3. Using a coupler if needed, the device output signal was connected to the RF In port of the AIA, which was connected to a desktop computer. Alternatively, a radiated RF signal may be used with the AIA's built-in antenna.
4. The MIF measurement procedure in the DASY software was run, and the resulting MIF value was recorded.
5. Steps 1-4 were repeated for all CMRS air interfaces, frequency bands, and modulations.

The modulation interference factors obtained were applied to readings taken of the actual wireless device in order to obtain an accurate audio interference level reading using the formula:

Audio Interference Level [dB(V/m)] = 20 * log[Raw Field Value (V/m)] + MIF (dB)

Because the MIF value is output power independent, MIF values for a given mode should be constant across all devices; however, per C63.19-2011 §D.7, MIF values should be measured for each device being evaluated. The voice modes for this device have been investigated in this section of the report.

II. MIF Measurement Block Diagrams

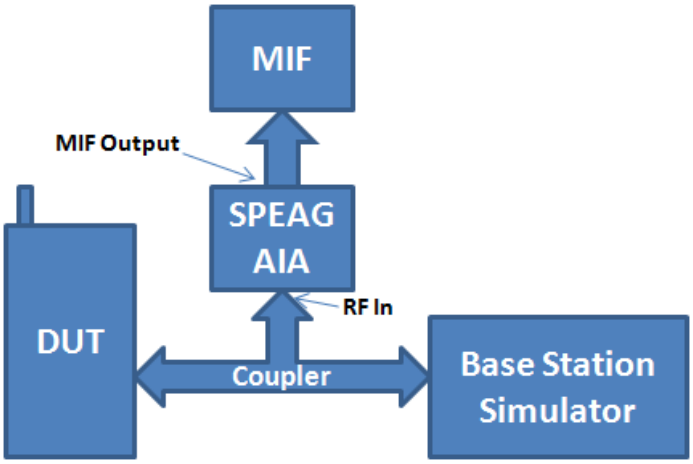

Figure 4-1
MIF Measurement Setup
for licensed modes

III. Measured Modulation Interference Factors:

Table 4-1
LTE FDD Uplink Carrier Aggregation Modulation Interference Factors[1,2]

Combination	PCC							SCC							MIF (dB)
	PCC Band	PCC Bandwidth [MHz]	PCC (UL) Channel	PCC (UL) Frequency [MHz]	Modulation	PCC UL# RB	PCC UL RB Offset	SCC Band	SCC Bandwidth [MHz]	SCC (UL) Channel	SCC (UL) Frequency [MHz]	Modulation	SCC UL# RB	SCC UL RB Offset	
CA_5B	LTE B5	10	20525	836.5	16QAM	1	0	LTE B5	5	20453	829.3	16QAM	1	24	-12.00
CA_66B	LTE B66	10	132322	1745.0	16QAM	1	0	LTE B66	10	132223	1735.1	16QAM	1	49	-11.38
CA_66C	LTE B66	20	132322	1745.0	16QAM	1	0	LTE B66	20	132124	1725.2	16QAM	1	99	-11.18

Table 4-2
LTE TDD Uplink Carrier Aggregation Modulation Interference Factors[1,3]

Combination	PCC							SCC							MIF (dB)
	PCC Band	PCC Bandwidth [MHz]	PCC (UL/DL) Channel	PCC (UL/DL) Frequency [MHz]	Modulation	PCC UL# RB	PCC UL RB Offset	SCC Band	SCC Bandwidth [MHz]	SCC (UL/DL) Channel	SCC (UL/DL) Frequency [MHz]	Modulation	SCC UL# RB	SCC UL RB Offset	
CA_41C (PC3)	LTE B41	20	40620	2593.0	16QAM	1	0	LTE B41	20	40422	2573.2	16QAM	1	99	3.54
CA_41C (PC2)	LTE B41	20	40620	2593.0	16QAM	1	0	LTE B41	20	40422	2573.2	16QAM	1	99	1.36

[1] Note: Measured MIF values may be lower than sample MIF values provided in ANSI C63.19-2011 Annex D.7 Table D.5 due to manufacturing variations for each device, however per Annex D.7, the sample MIF values of Table D.5 are not intended to substitute for measurements of actual devices under test and their respective operating modes.

[2] Note: LTE FDD ULCA was evaluated to ensure LTE FDD standalone was the worst-case scenario. The configurations in Table 4-1 were determined from Table 7-6 in the Original Certification Test Report and satisfy the configuration requirements as defined in 3GPP 36.101.

[3] Note: LTE TDD ULCA was evaluated to ensure LTE TDD standalone was the worst-case scenario. The configurations in Table 4-2 were determined from Tables 7-7 & 7-8 from the Original Certification Test Report and satisfy the configuration requirements as defined in 3GPP 36.101. These MIFs were evaluated with UL-DL Configuration 5 for Power Class 3 LTE TDD and UL-DL Configuration 2 for Power Class 2 LTE TDD.

5. RF CONDUCTED POWER MEASUREMENTS

I. Procedures Used to Establish RF Signal for HAC Testing

The handset was configured to transmit the required air interface in a shielded chamber. Measurements were taken with a fully charged battery.

II. HAC Measurement Conditions

Output Power Verification

Maximum output power is verified on the High, Middle and Low channels for all applicable air interfaces for which full testing scans are required. Modes which are exempted from full testing according to Section 9 of this report have only their conducted power targets listed below, not measured values. See Table 5-1 for air interface specific settings of transmit power parameters. See Table 6-1 for more information regarding which modes required full testing and had conducted power measurements taken.

Table 5-1
Power Control Parameters and Settings by Air Interface

Air Interface:	Parameter Name:	Parameter Set To:
LTE	TPC	"Max Power"

III. Setup Used to Measure RF Conducted Powers

The general setup for conducted power is shown in Figure 5-1 below. The power measurement equipment could be a base station simulator, signal analyzer, or power meter depending on the applicable air interface.

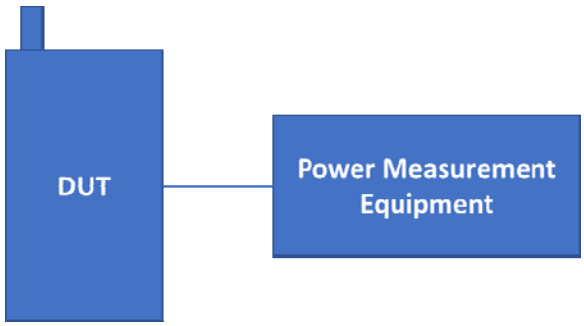

Figure 5-1
Power Measurement Setup

IV. LTE FDD Conducted Powers

Table 5-2
LTE FDD Uplink Carrier Aggregation Conducted Powers

Combination	PCC							SCC							Power
	PCC Band	PCC Bandwidth [MHz]	PCC (UL/DL) Channel	PCC (UL/DL) Frequency [MHz]	Modulation	PCC UL# RB	PCC UL RB Offset	SCC Band	SCC Bandwidth [MHz]	SCC (UL/DL) Channel	SCC (UL/DL) Frequency [MHz]	Modulation	SCC UL# RB	SCC UL RB Offset	LTE Tx.Power with UL CA Enabled
CA_5B	LTE B5	10	20525	836.5	16QAM	1	0	LTE B5	5	20453	829.3	16QAM	1	24	24.53
CA_66B	LTE B66	10	132322	1745.0	16QAM	1	0	LTE B66	10	132223	1735.1	16QAM	1	49	23.48
CA_66C	LTE B66	20	132322	1745.0	16QAM	1	0	LTE B66	20	132124	1725.2	16QAM	1	99	23.15

V. LTE TDD Conducted Powers

Table 5-3
LTE TDD Uplink Carrier Aggregation Conducted Powers

Combination	PCC							SCC							Power
	PCC Band	PCC Bandwidth [MHz]	PCC (UL/DL) Channel	PCC (UL/DL) Frequency [MHz]	Modulation	PCC UL# RB	PCC UL RB Offset	SCC Band	SCC Bandwidth [MHz]	SCC (UL/DL) Channel	SCC (UL/DL) Frequency [MHz]	Modulation	SCC UL# RB	SCC UL RB Offset	LTE Tx.Power with UL CA Enabled
CA_41C (PC3)	LTE B41	20	40620	2593.0	16QAM	1	0	LTE B41	20	40422	2573.2	16QAM	1	99	23.06
CA_41C (PC2)	LTE B41	20	40620	2593.0	16QAM	1	0	LTE B41	20	40422	2573.2	16QAM	1	99	24.97

6. JUSTIFICATION OF HELD TO EAR MODES TESTED

I. Analysis of RF Air Interface Technologies

An analysis was performed, following the guidance of §4.3 and §4.4 of the ANSI standard, of the RF air interface technologies being evaluated. The factors that will affect the RF interference potential were evaluated, and the worst-case operating modes were identified and used in the evaluation. A WD's interference potential is a function both of the WD's average near-field field strength and of the signal's audio-frequency amplitude modulation characteristics. Per §4.4, RF air interface technologies that have low power have been found to produce sufficiently low RF interference potential, so it is possible to exempt them from the product testing specified in Clause 5 of the ANSI standard. An RF air interface technology of a device is exempt from testing when its average antenna input power plus its MIF is ≤17dBm for all of its operating modes. RF air interface technologies exempted from testing in this manner are automatically assigned an M4 rating to be used in determining the overall rating for the WD.

The worst-case MIF plus the worst-case average antenna input power for all modes are investigated below to determine the testing requirements for this device.

II. Individual Mode Evaluations

Table 6-1

Max Power + MIF calculations for Low Power Exemptions

Air Interface	Maximum Average Power (dBm)	Worst Case MIF (dB)	Total (Power + MIF, dB)	C63.19 Testing Required
LTE FDD - Uplink Carrier Aggregation	24.53	-11.18	13.35	No
LTE TDD - Uplink Carrier Aggregation	18.27*	1.36	19.63	No**

* Note: ANSI C63.19-2011 Sec. 4.4 Footnote 20 indicates the use of a long averaging time for measuring the antenna input power when using this method of exclusion. Therefore, the frame averaged power was calculated for these modes in this investigation.

** Note: LTE TDD Uplink Carrier Aggregation was considered but not tested as LTE TDD standalone data modes were found to be the worst-case modes for the LTE TDD air interface. Please refer to the Original Certification Test Report for full data on LTE TDD standalone data modes.

III. Low-Power Exemption Conclusions

LTE FDD Uplink Carrier Aggregation is exempt from RF emissions testing and rated M4 under the low power exemption of Clause 4 from ANSI C63.19-2011. LTE TDD Uplink Carrier Aggregation is covered by LTE TDD standalone data modes, please refer to the Original Certification Test Report for full data on LTE TDD standalone data modes.

7. EQUIPMENT LIST

Table 7-1
Equipment List

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Control Company	4040	Temperature / Humidity Monitor	2/28/2018	Biennial	2/28/2020	150761911
Pasternack	PE2237-20	Bidirectional Coupler	N/A	CBT*	N/A	N/A
Rohde & Schwarz	CMW500	Radio Communication tester	8/14/2019	Annual	8/14/2020	140144
Seekonk	NC-100	Torque Wrench (8" lb)	5/23/2018	Biennial	5/23/2020	N/A
SPEAG	AIA	Audio Interference Analzyer	N/A	CBT*	N/A	1010

Calibration traceable to the National Institute of Standards and Technology (NIST).

***Note: CBT (Calibrated Before Testing).** Prior to testing, the measurement paths containing a cable, attenuator, coupler or filter were connected to a calibrated source (i.e. a signal generator) to determine the losses of the measurement path. The power meter offset was then adjusted to compensate for the measurement system losses. This level offset is stored within the power meter before measurements are made. This calibration verification procedure applies to the system verification and output power measurements. The calibrated reading is then taken directly from the power meter after compensation of the losses for all final power measurements.

8. CONCLUSION

The measurements indicate that LTE ULCA configurations supported by the wireless communications device comply with the HAC limits specified in accordance with the ANSI C63.19 Standard and FCC WT Docket No. 01-309 RM-8658. Precise laboratory measures were taken to assure repeatability of the tests. The tested device complies with the requirements in respect to all parameters specific to the test. The test results and statements relate only to the item(s) tested.

Please note that the M-rating for this equipment only represents the field interference possible against a hypothetical and typical hearing aid. The measurement system and techniques presented in this evaluation are proposed in the ANSI standard as a means of best approximating wireless device compatibility with a hearing-aid. The literature is under continual re-construction.

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