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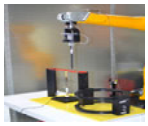

HEARING AID COMPATIBILITY

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

Date of Testing:
11/18/2019
Test Site/Location:
PCTEST Lab, Columbia, MD, USA
Test Report Serial No.:
1M1911080182-03.A3L
Date of Issue:
12/10/2019

FCC ID:	**A3LSMN976U**
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-N976U
Test Device Serial No.:	*Pre-Production Sample* [S/N: 0719M]
Class II Permissive Change(s):	See FCC Change Document
Original Grant Date:	11/15/2019

C63.19-2011 HAC Category:	**M4 (RF EMISSIONS CATEGORY, NR n41 Only)**

This report and category pertain only to NR n41 supported by this wireless portable 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 NR n41, 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

ACCREDITED
TESTING CERT#2041.01

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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-situ*

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

2. DUT DESCRIPTION

FCC ID:	A3LSMN976U
Manufacturer:	Samsung Electronics Co., Ltd. 129, Samsung-ro, Maetan dong, Yeongtong-gu, Suwon-si Gyeonggi-do 16677, Korea
Model:	SM-N976U
Serial Number:	0719M
Antenna Configurations:	Internal Antenna
DUT Type:	Portable Handset

I. Power Reduction for Licensed Modes

This device uses an independent fixed level power reduction mechanism for NR n41 during VoIP held to ear scenarios. Reduced powers were used to evaluate for low-power exemption in Section 7.II for these modes. Detailed descriptions of the power reduction mechanism are included in the operational description.

Table 2-1
A3LSMN976U HAC Air Interfaces

Air-Interface	Band (MHz)	Type Transport	HAC Tested	Simultaneous But Not Tested	Name of Voice Service
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)				
	790 (B14)				
	850 (B5)				
	850 (B26)				
	1700 (B4)				
	1700 (B66)				
	1900 (B2)				
	1900 (B25)				
	2300 (B30)				
	2500 (B7)				
LTE (TDD)	2600 (B38)	VD	No[2]	Yes: WIFI or BT	VoLTE, Google Duo
	2600 (B41)				
	3600 (B48)				
NR (FDD)	680 (n71)	VD	No[2]	Yes: WIFI or BT	Google Duo
	850 (n5)				
NR (TDD)	2600 (n41)	VD	No[1]	Yes: WIFI or BT	Google Duo
WIFI	2450	VD	No[2]	Yes: GSM, UMTS, LTE, or NR	VoWIFI, Google Duo
	5200 (U-NII 1)				
	5300 (U-NII 2A)				
	5500 (U-NII 2C)				
	5800 (U-NII 3)				
BT	2450	DT	No	Yes: GSM, UMTS, LTE, or NR	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 NR band n41. For full data, please refer to the Original Certification Test Report (Report S/N: 1M1909040147-18-R1.A3L).

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

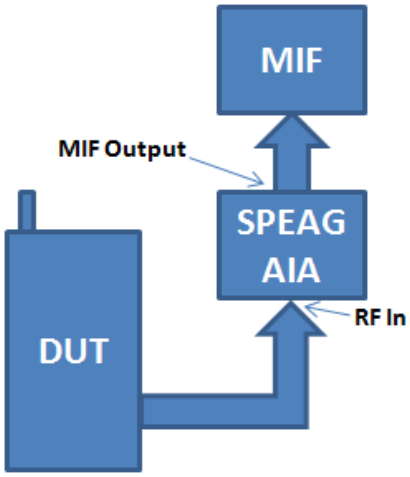

Figure 4-1
MIF Measurement Setup

III. Measured Modulation Interference Factors:

Table 4-1
NR TDD Modulation Interference Factors[1]

NR Band	Frequency [MHz]	Channel	Bandwidth [MHz]	Waveform	Modulation	RB Size	RB Offset	MIF [dB]
n41	2593.0	518598	100	DFT-s-OFDM	16QAM	1	0	-11.69
n41	2593.0	518598	100	DFT-s-OFDM	QPSK	1	1	-20.49
n41	2593.0	518598	100	DFT-s-OFDM	64QAM	1	0	-11.74
n41	2593.0	518598	100	DFT-s-OFDM	256QAM	1	0	-17.99
n41	2593.0	518598	100	CP-OFDM	16QAM	1	0	-15.37
n41	2593.0	518598	100	CP-OFDM	QPSK	1	1	-13.76
n41	2593.0	518598	100	CP-OFDM	64QAM	1	0	-10.56
n41	2593.0	518598	100	CP-OFDM	256QAM	1	0	-14.12
n41	2593.0	518598	100	CP-OFDM	64QAM	1	137	-10.85
n41	2593.0	518598	100	CP-OFDM	64QAM	1	271	-10.35
n41	2593.0	518598	100	CP-OFDM	64QAM	135	0	-24.02
n41	2593.0	518598	100	CP-OFDM	64QAM	270	0	-26.71
n41	2593.0	518598	90	CP-OFDM	64QAM	1	243	-12.28
n41	2593.0	518598	80	CP-OFDM	64QAM	1	216	-11.24
n41	2593.0	518598	60	CP-OFDM	64QAM	1	160	-13.98
n41	2593.0	518598	50	CP-OFDM	64QAM	1	132	-12.65
n41	2593.0	518598	40	CP-OFDM	64QAM	1	105	-14.16
n41	2593.0	518598	20	CP-OFDM	64QAM	1	50	-13.36

[1] Note: Since n41 at 100MHz bandwidth is the overall worst-case NR TDD MIF and does not support 3 non-overlapping channels, MIF measurements were made only on the middle channel.

5. RF CONDUCTED POWER MEASUREMENTS

I. HAC Measurement Conditions

Output Power Verification

Maximum output power is verified on the High, Middle and Low channels for all applicable air interfaces. See Table 5-1 for air interface specific settings of transmit power parameters.

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

Air Interface:	Parameter Name:	Parameter Set To:
NR	Mfr Configured	Mfr Specified

II. Setup Used to Measure RF Conducted Powers

Figure 5-1
Power Measurement Setup for licensed modes

III. NR Conducted Powers

a. NR n41

Table 5-2
NR n41 (2593.0) Reduced Conducted Powers – 100MHz Bandwidth[1]

NR Band n41 100 MHz Bandwidth					
			Channel		
Modulation	RB Size	RB Offset	518598 (2592.99 MHz) Conducted Power [dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
DFT-s-OFDM QPSK	1	1	20.81	0	0
	1	137	20.60		0
	1	271	20.35		0
	135	0	20.78	0-1	0
	135	68	20.61	0	0
	135	138	20.31	0-1	0
	270	0	20.59		0
DFT-s-OFDM 16QAM	1	1	20.24	0-1	0
CP-OFDM QPSK	1	1	19.95	0-1.5	0

[1] Note: This device utilizes independent power reduction mechanisms for NR n41 in held-to-ear scenarios.

Table 5-3
NR n41 (2593.0) Reduced Conducted Powers – 90MHz Bandwidth[1]

NR Band n41 90 MHz Bandwidth						
			Channel			
Modulation	RB Size	RB Offset	508200 (2541 MHz)	528996 (2644.98 MHz)	MPR Allowed per 3GPP [dB]	MPR [dB]
			Conducted Power [dBm]			
DFT-s-OFDM QPSK	1	1	20.99	20.77	0	0
	1	123	20.64	20.69		0
	1	243	20.48	20.61		0
	120	0	20.68	20.72	0-1	0
	120	61	20.57	20.74	0	0
	120	123	20.48	20.79	0-1	0
	243	0	20.57	20.76		0
DFT-s-OFDM 16QAM	1	1	21.00	20.79	0-1	0
CP-OFDM QPSK	1	1	20.93	20.73	0-1.5	0

Table 5-4
NR n41 (2593.0) Reduced Conducted Powers – 80MHz Bandwidth[1]

NR Band n41 80 MHz Bandwidth						
			Channel			
Modulation	RB Size	RB Offset	507204 (2536.02 MHz)	529998 (2649.99 MHz)	MPR Allowed per 3GPP [dB]	MPR [dB]
			Conducted Power [dBm]			
DFT-s-OFDM QPSK	1	1	20.60	20.62	0	0
	1	109	20.17	20.66		0
	1	215	20.13	20.38		0
	108	0	20.47	20.56	0-1	0
	108	54	20.32	20.59	0	0
	108	109	20.26	20.58	0-1	0
	216	0	20.39	20.59		0
DFT-s-OFDM 16QAM	1	1	20.55	20.52	0-1	0
CP-OFDM QPSK	1	1	20.77	20.73	0-1.5	0

Table 5-5
NR n41 (2593.0) Reduced Conducted Powers – 60MHz Bandwidth[1]

NR Band n41 60 MHz Bandwidth							
			Channel				
Modulation	RB Size	RB Offset	505200 (2526 MHz)	518598 (2592.99 MHz)	531996 (2659.98 MHz)	MPR Allowed per 3GPP [dB]	MPR [dB]
			Conducted Power [dBm]				
DFT-s-OFDM QPSK	1	1	20.45	20.24	20.15	0	0
	1	81	20.27	20.17	20.15		0
	1	160	20.25	20.07	20.20		0
	81	0	20.37	20.30	20.32	0-1	0
	81	40	20.24	20.25	20.34	0	0
	81	81	20.22	20.24	20.33	0-1	0
	162	0	20.28	20.27	20.35		0
DFT-s-OFDM 16QAM	1	1	20.45	20.36	19.97	0-1	0
CP-OFDM QPSK	1	1	20.34	20.25	20.25	0-1.5	0

[1] Note: This device utilizes independent power reduction mechanisms for NR n41 in held-to-ear scenarios.

Table 5-6
NR n41 (2593.0) Reduced Conducted Powers – 50MHz Bandwidth[1]

NR Band n41 50 MHz Bandwidth							
			Channel				
Modulation	RB Size	RB Offset	504204 (2521.02 MHz)	518598 (2592.99 MHz)	532998 (2664.99 MHz)	MPR Allowed per 3GPP [dB]	MPR [dB]
			Conducted Power [dBm]				
DFT-s-OFDM QPSK	1	1	20.73	20.39	20.63	0	0
	1	67	20.31	20.03	20.41		0
	1	131	20.41	20.02	20.31		0
	64	0	20.46	20.33	20.36	0-1	0
	64	33	20.24	20.27	20.32	0	0
	64	69	20.14	20.22	20.29	0-1	0
	128	0	20.28	20.27	20.32		0
DFT-s-OFDM 16QAM	1	1	20.68	20.67	20.55	0-1	0
CP-OFDM QPSK	1	1	20.48	20.50	20.49	0-1.5	0

Table 5-7
NR n41 (1882.5MHz) Reduced Conducted Powers – 40MHz Bandwidth[1]

NR Band n41 40 MHz Bandwidth								
			Channel					
Modulation	RB Size	RB Offset	503202 (2516.01 MHz)	513468 (2567.34 MHz)	523734 (2618.67 MHz)	534000 (2670 MHz)	MPR Allowed per 3GPP [dB]	MPR [dB]
			Conducted Power [dBm]					
DFT-s-OFDM QPSK	1	1	21.00	20.97	20.80	20.82	0	0
	1	53	20.88	20.71	20.46	20.67		0
	1	104	20.67	20.81	20.61	20.74		0
	50	0	20.95	20.80	20.69	20.85	0-1	0
	50	26	20.72	20.72	20.54	20.71	0	0
	50	56	20.72	20.71	20.52	20.71	0-1	0
	100	0	20.79	20.73	20.60	20.73		0
DFT-s-OFDM 16QAM	1	1	20.84	21.00	20.93	20.82	0-1	0
CP-OFDM QPSK	1	1	20.95	20.99	20.79	20.98	0-1.5	0

Table 5-8
NR n41 (1882.5MHz) Reduced Conducted Powers – 20MHz Bandwidth[1]

NR Band n41 20 MHz Bandwidth									
			Channel						
Modulation	RB Size	RB Offset	501204 (2506.02 MHz)	509898 (2549.49 MHz)	518598 (2592.99 MHz)	527298 (2636.49 MHz)	535998 (2679.99 MHz)	MPR Allowed per 3GPP [dB]	MPR [dB]
			Conducted Power [dBm]						
DFT-s-OFDM QPSK	1	1	20.61	20.34	20.24	20.33	20.40	0	0
	1	26	20.42	20.15	20.13	20.22	20.41		0
	1	49	20.38	20.31	20.20	20.21	20.24		0
	25	0	20.55	20.23	20.28	20.28	20.35	0-1	0
	25	13	20.46	20.17	20.20	20.25	20.34	0	0
	25	26	20.37	20.16	20.27	20.31	20.33	0-1	0
	50	0	20.48	20.18	20.22	20.28	20.32		0
DFT-s-OFDM 16QAM	1	1	20.62	20.08	20.42	20.68	20.22	0-1	0
CP-OFDM QPSK	1	1	20.56	20.37	20.30	20.26	20.61	0-1.5	0

[1] Note: This device utilizes independent power reduction mechanisms for NR n41 in held-to-ear scenarios.

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
NR TDD	14.98*	-10.35	4.63	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.

III. Low-Power Exemption Conclusions

NR n41 is exempt from RF emissions testing and rated M4 under the low power exemption of Clause 4 from ANSI C63.19-2011.

7. EQUIPMENT LIST

Table 7-1
Equipment List

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	N9020A	MXA Signal Analyzer	4/20/2019	Annual	4/20/2020	US46470561
Seekonk	NC-100	Torque Wrench (8" lb)	5/10/2018	Biennial	5/10/2020	21053
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 NR n41 of the wireless communications device complies 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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