Hearing Aid Compatibility (HAC) T-Coil Test Report

APPLICANT	: Zebra Technologies Corporation
EQUIPMENT	: Touch computer
BRAND NAME	: Zebra
MODEL NAME	: TC75EK
FCC ID	: UZ7TC75EK
T-RATING	: T3
STANDARD	: FCC 47 CFR §20.19 ANSI C63.19-2011

We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample has been evaluated in accordance with the procedures and shown the compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC., the test report shall not be reproduced except in full.

Reviewed by: Eric Huang / Manager

Approved by: Jones Tsai / Manager

Testing Laboratory
1190

SPORTON INTERNATIONAL INC.

No.52, Hwa Ya 1st Rd., Hwa Ya Technology Park, Kwei-Shan District, Taoyuan City, Taiwan (R.O.C.)

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Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
HA822217B	Rev. 01	Initial issue of report	May 15, 2018

1. General Information

Product Feature & Specification	
Applicant Name	Zebra Technologies Corporation
Equipment Name	Touch computer
Brand Name	Zebra
Model Name	TC75EK
FCC ID	UZ7TC75EK
HW Version	REV.: B
SW Version	Android version 7.1.2
FW Version	91-01-49-NG-00-A
MFD	26FEB18
EUT Stage	Engineering Sample
Exposure category	General Population/Uncontrolled Exposure
Date Tested	2018/05/09 ~ 2018/05/11
Frequency Band	GSM850: 824.2 MHz ~ 848.8 MHz GSM1900: 1850.2 MHz ~ 1909.8 MHz WCDMA Band II: 1852.4 MHz ~ 1907.6 MHz WCDMA Band IV: 1712.4 MHz ~ 1752.6 MHz WCDMA Band V: 826.4 MHz ~ 846.6 MHz CDMA2000 BC0: 824.7 MHz ~ 848.31 MHz CDMA 2000 BC1: 1851.25 MHz ~ 1908.75 MHz CDMA 2000 BC10: 817.9 MHz ~ 823.1 MHz LTE Band 2: 1850 MHz ~ 1910 MHz LTE Band 4: 1710 MHz ~ 1755 MHz LTE Band 5: 824 MHz ~ 849 MHz LTE Band 12: 699 MHz ~ 716 MHz LTE Band 13: 777 MHz ~ 787 MHz LTE Band 17: 704 MHz ~ 716 MHz LTE Band 25: 1850 MHz ~ 1915 MHz LTE Band 26: 814 MHz ~ 849 MHz WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz WLAN 5.2GHz Band: 5180 MHz ~ 5240 MHz WLAN 5.3GHz Band: 5260 MHz ~ 5320 MHz WLAN 5.5GHz Band: 5500 MHz ~ 5720MHz WLAN 5.8GHz Band: 5745 MHz ~ 5825 MHz Bluetooth: 2402 MHz ~ 2480 MHz NFC: 13.56 MHz
Mode	GSM/GPRS/EGPRS AMR / RMC 12.2Kbps HSDPA HSUPA DC-HSDPA CDMA2000: 1xRTT/1xEv-Do(Rel.0)/1xEv-Do(Rev.A) LTE: QPSK, 16QAM 802.11a/b/g/n/ac HT20/HT40/VHT20/VHT40/VHT80 Bluetooth BR/EDR/LE NFC:ASK

2. Administration Data

Sporton Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 1190) and the FCC designation No. TW1190 under the FCC 2.948(e) by Mutual Recognition Agreement (MRA) in FCC test.

Testing Laboratory	
Test Site	SPORTON INTERNATIONAL INC.
Test Site Location	No.52, Hwa Ya 1st Rd., Hwa Ya Technology Park, Kwei-Shan District, Taoyuan City, Taiwan (R.O.C.) TEL: +886-3-327-3456 FAX: +886-3-328-4978
Test Site No.	Sporton Site No. : **SAR04-HY**
Applicant	
Company Name	Zebra Technologies Corporation
Address	1 Zebra Plaza Holtsville, NY 11742
Manufacturer	
Company Name	Wistron Corporation
Address	21F, No. 88, Sec. 1, Hsin Tai Wu Rd., Hsichih Dist, New Taipei City 221,Taiwan R.O.C.

3. Applied Standards

- FCC CFR47 Part 20.19
- ANSI C63.19 2011-version
- FCC KDB 285076 D01 HAC Guidance v05
- FCC KDB 285076 D02 T Coil testing v03
- FCC KDB 285076 D03 HAC FAQ v01

4. Air Interface and Operating Mode

Air Interface	Band MHz	Type	C63.19 Tested	Simultaneous Transmitter	Name of Voice Service	Power Reduction
GSM	EDGE850	VD	Yes	WLAN, BT	Google Duo(1) / Google hangouts(1) / WFC(1)(2)	No
	EDGE1900			WLAN, BT		No
WCDMA	850 HSPA	VD	Yes	WLAN, BT	Google Duo(1) / Google hangouts(1) / WFC(1)(2)	No
	1750 HSPA			WLAN, BT		No
	1900 HSPA			WLAN, BT		No
CDMA	BC0 EVDO	VD	Yes	WLAN, BT	Google Duo(1) / Google hangouts(1) / WFC(1)(2)	No
	BC1 EVDO			WLAN, BT		No
	BC10 EVDO			WLAN, BT		No
LTE (FDD)	Band 2	VD	Yes	WLAN, BT	Google Duo(1) / Google hangouts(1) / WFC(1)(2)	No
	Band 4			WLAN, BT		No
	Band 5			WLAN, BT		No
	Band 12			WLAN, BT		No
	Band 13			WLAN, BT		No
	Band 17			WLAN, BT		No
	Band 25			WLAN, BT		No
	Band 26			WLAN, BT		No
Wi-Fi	2450	VD	Yes	GSM,CDMA,WCDMA,LTE	Google Duo(1) / Google hangouts(1) / WFC(1)(2)	No
	5200			GSM,CDMA,WCDMA,LTE		No
	5300			GSM,CDMA,WCDMA,LTE		No
	5500			GSM,CDMA,WCDMA,LTE		No
	5800			GSM,CDMA,WCDMA,LTE		No
BT	2450	DT	No	GSM,CDMA,WCDMA,LTE	NA	No

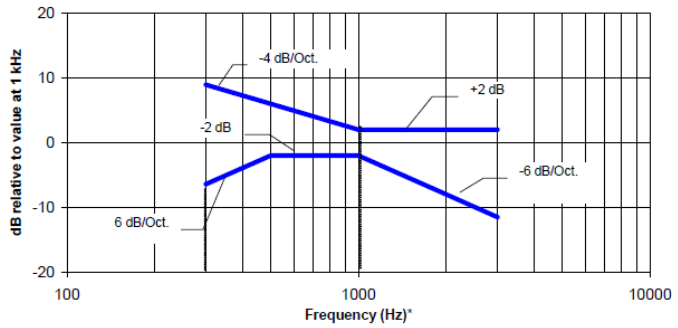
Type Transport:
VO= Voice only
DT= Digital Transport only (no voice)
VD= CMRS and IP Voice Service over Digital Transport

Remark:
1. For protocols not listed in Table 7.1 of ANSI C63.19-2011 or the ANSI C63.19-2011 VoLTE interpretation, the average speech level of −20 dBm0 should be used.
2. The Workforce Connect (WFC) is an over-the-top (OTT) – voice services operating over IP, and this voice application was development and pre-installed on a wireless handset by the Zebra Technologies Corporation.

5. Measurement standards for T-Coil

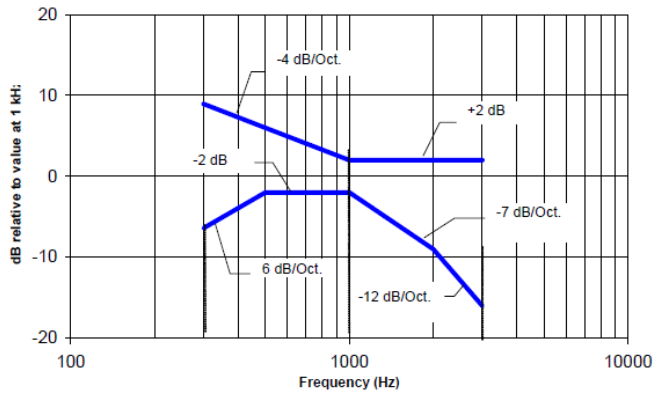
5.1 Frequency Response

The frequency response of the perpendicular component of the magnetic field, measured in 1/3 octave bands, shall follow the response curve specified in this sub-clause, over the frequency range 300 Hz to 3000 Hz.
Figure 1.1 and Figure 1.2 provide the boundaries as a function of frequency. These response curves are for true field-strength measurements of the T-Coil signal. Thus, the 6 dB/octave probe response has been corrected from the raw readings.



NOTE—The frequency response is between 300 Hz and 3000 Hz.

Fig. 1.1 Magnetic field frequency response for WDs with field strength≤-15dB at 1 KHz



NOTE—The frequency response is between 300 Hz and 3000 Hz.

Fig. 1.2 Magnetic field frequency response for WDs with a field that exceeds –15 dB(A/m) at 1 kHz

5.2 T-Coil Signal Quality Categories

This section provides the signal quality requirement for the intended T-Coil signal from a WD. Only the RF immunity of the hearing aid is measured in T-Coil mode. It is assumed that a hearing aid can have no immunity to an interference signal in the audio band, which is the intended reception band for this mode. A device is assessed beginning by determining the category of the RF environment in the area of the T-Coil source.
The RF measurements made for the T-Coil evaluation are used to assign the category T1 through T4. The limitation is given in Table 1. This establishes the RF environment presented by the WD to a hearing aid.

Category	Telephone parameters WD signal quality ((signal + noise) to noise ratio in dB)
Category T1	0 to 10 dB
Category T2	10 to 20 dB
Category T3	20 to 30 dB
Category T4	> 30 dB

Table 1 T-Coil Signal Quality Categories

6. T-Coil Test Procedure

Referenced to ANSI C63.19-2011, Section 7.4,

This section describes the procedures used to measure the ABM (T-Coil) performance of the WD. In addition to measuring the absolute signal levels, the A-weighted magnitude of the unintended signal shall also be determined. To assure that the required signal quality is measured, the measurement of the intended signal and the measurement of the unintended signal must be made at the same location for each measurement position. In addition, the RF field strength at each measurement location must be at or below that required for the assigned category.

Measurements shall not include undesired properties from the WD's RF field; therefore, use of a coaxial connection to a base station simulator or non-radiating load, there might still be RF leakage from the WD, which can interfere with the desired measurement. Pre-measurement checks should be made to avoid this possibility. All measurements shall be performed with the WD operating on battery power with an appropriate normal speech audio signal input level given in ANSI C63.19-2011 Table 7.1. If the device display can be turned off during a phone call, then that may be done during the measurement as well,

Measurement shall be performed at two locations specified in ANSI C63.19-2011 A.3, with the correct probe orientation for a particular location, in a multistage sequence by first measuring the field intensity of the desired T-Coil signal the same location as the desired ABM or T-Coil signal (ABM1), and the ratio of desired to undesired magnetic components (ABM2) must be measured at the same location as the desired ABM or T-Coil signal (ABM1), and the ratio of desired to undesired ABM signals must be calculated. For the perpendicular field location, only the ABM1 frequency response shall be determined in a third measurement stage.

The following steps summarize the basic test flow for determining ABM1 and ABM2. These steps assume that a sine wave or narrowband 1/3 octave signal can be used for the measurement of ABM1.

a. A validation of the test setup and instrumentation may be performed using a TMFS or Helmholtz coil Measure the emissions and confirm that they are within the specified tolerance.
b. Position the WD in the test setup and connect the WD RF connector to a base station simulator or a non-radiating load. Confirm that equipment that requires calibration has been calibrated, and that the noise level meets the requirements given in ANSI C63.19-2011 clause 7.3.1.
c. The drive level to the WD ise set such that the reference input level specified in ANSI C63.19-2011 Table 7.1 is input to the base station simulator (or manufacturer's test mode equivalent) in 1 kHz, 1/3 octave band. This drive level shall be used for the T-Coil signal test (ABM1) at f = 1 kHz. Either a sine wave at 1025 Hz or a voice-like signal, band-limited to the 1 kHz 1/3 octave, as defined in ANSI C63.19-2011 clause 7.4.2, shall be used for the reference audio signal. If interference is found at 1025 Hz an alternative nearby reference audio signal frequency may be used. The same drive level shall be used for the ABM1 frequency response measurements at each 1/3 octave band center frequency. The WD volume control may be set at any level up to maximum, provided that a signal at any frequency at maximum modulation would not result in clipping or signal overload.
d. Determine the magnetic measurement locations for the WD device (A.3), if not already specified by the manufacturer, as described in ANSI C63.19-2011 clause 7.4.4.1.1 and 7.4.4.2.
e. At each measurement location, measure and record the desired T-Coil magnetic signals (ABM1 at fi) as described in ANSI C63.19-2011 clause 7.4.4.2 in each individual ISO 266-1975 R10 standard 1/3 octave band. The desired audio band input frequency (fi) shall be centered in each 1/3 octave band maintaining the same drive level as determined in item c) and the reading taken for that band.
f. Equivalent methods of determining the frequency response may also be employed, such as fast Fourier transform (FFT) analysis using noise excitation or input-output comparison using simulated speech. The full-band integrated probe output, as specified in D.9, may be used, as long as the appropriate calibration curve is applied to the measured result, so as to yield an accurate measurement of the field magnitude. (The resulting measurement shall be an accurate measurement in dB A/m.)
g. All Measurements of the desired signal shall be shown to be of the desired signal and not of an undesired signal. This may be shown by turning the desired signal ON and OFF with the probe measuring the same location. If the scanning method is used the scans shall show that all measurement points selected for the ABM1 measurement meet the ambient and test system noise criteria in ANSI C63.19-2011 clause 7.3.1.
h. At the measurement location for each orientation, measure and record the undesired broadband audio magnetic signal (ABM2) as specified in ANSI C63.19-2011 clause 7.4.4.4 with no audio signal applied (or digital zero applied, if appropriate) using A-weighting and the half-band integrator. Calculate the ratio of the desired to undesired signal strength (i,e., signal quality).
i. Obtain the data from the postprocessor, SEMCAD, and determine the category that properly classifies the signal quality based on ANSI C63.19-2011 Table 8.5.

6.1 Test Flow Chart

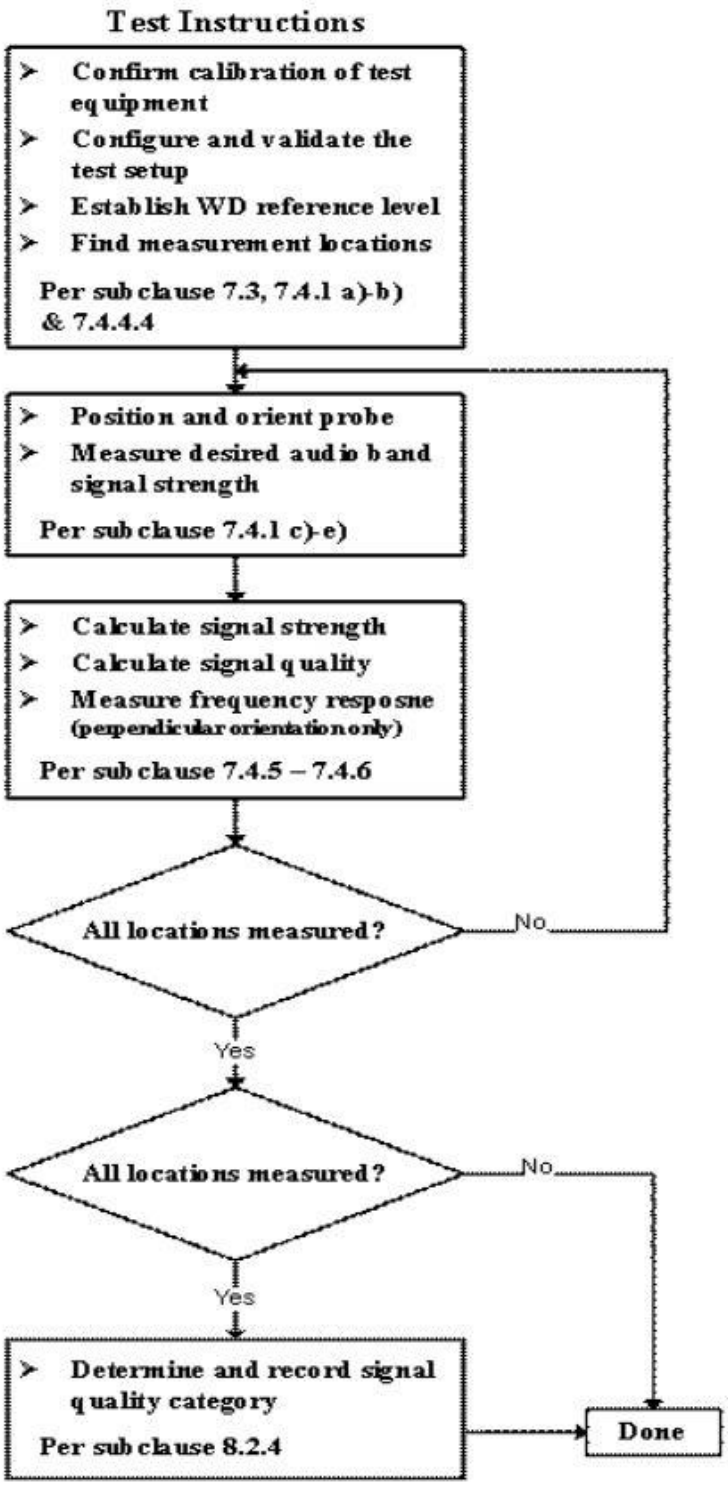
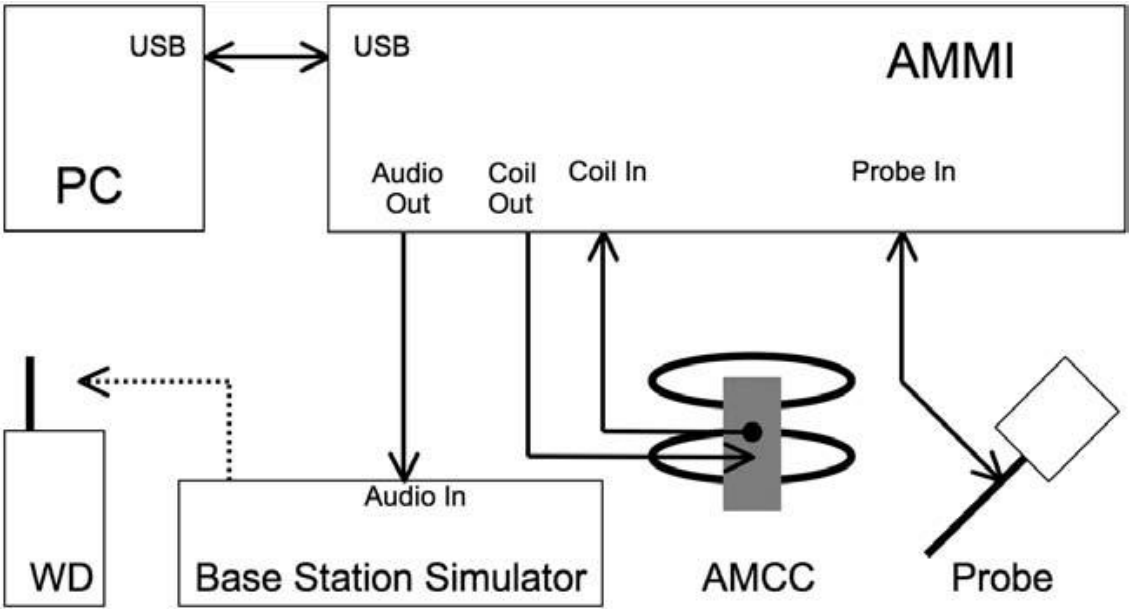


Fig. 2 T-Coil Signal Test flowchart

6.2 Test Setup Diagram



General Note:

1. Define the all applicable input audio level as below according to ANSI C63.19 2011 and KDB 285076 D02v03:
   - OTT VoIP input Level: -20dBm0
2. The test setup used for Google DUO / Google hangouts VoIP call is via the data application unit on CMW500 connection to the Internet, also connection to the other auxiliary VoIP unit which is used to configure the audio codec and bit rate and also monitor the audio input level of -20dBm0.
3. The test setup used for WFC VoIP application is via the data application unit on CMW500 connection to the Internet, also connection to the other auxiliary VoIP unit which is used to configure the audio codec and determined the audio input level of -20dBm0.

1. The Required gain factor for the specific signal shall typically be multiplied by this factor to achieve approx. the same level as for the 1kHz sine signal
2. The below calculation formula is an example and showing how to determine the input level for the device.

The predefined signal types have the following differences / factors compared to the 1kHz sine signal:

Signal [file name]	Duration [s]	Peak-to-RMS [dB]	RMS [dB]	Required gain factor *)	Gain setting
1kHz sine	---	3.0	0.0	1.00	
48k_1.025kHz_10s.wav	10	3.0	0.0	1.00	
48k_1kHz_3.15kHz_10s.wav	10	6.0	-3.0	1.42	
48k_315Hz_1kHz_10s.wav	10	6.0	-2.9	1.40	
48k_csek_8k_441_white_10s.wav	10	13.8	-10.5	3.34	
48k_multisine_50-5000_10s.wav	10	11.1	-7.9	2.49	
48k_voice_1kHz_1s.wav	1	16.2	-12.7	4.33	
48k_voice_300-3000_2s.wav	2	21.6	-18.6	8.48	

(*) The gain for the specific signal shall typically be multiplied by this factor to acheive approx. the same level as for the 1kHz sine signal.

Insert the gain applicable for your setup in the last column of the table.

Calculation formula:
- Audio Level at -16dBm0 = ((-16dBm0) – (3.14dBm0)) + X dBv
- Calculated Gain at -16dBm0 = 10((audio level at -16dBm0 – Y dBm0) / 20) * 10
- Gatting setting at -16dBm0 = required gain factor * calculated gain

Gain Value	20* log(gain)	AMCC Coil In	Level
(linear)	dB	(dBv RMS)	dBm0
		-2.47	3.14
10	20	-19.85	-14.24
8.17	18.24	-21.61	-16

Signal Type	Duration (s)	Peak to RMS (dB)	RMS (dB)	Required Gain Factor	Calculated Gain Setting
1kHz sine	-	3	0	1	8.17
48k_voice_1kHz	1	16.2	-12.7	4.33	35.36
48k_voice_300Hz ~ 3kHz	2	21.6	-18.6	8.48	69.25

6.3 Description of EUT Test Position

Fig.3 illustrate the references and reference plane that shall be used in a typical EUT emissions measurement. The principle of this section is applied to EUT with similar geometry. Please refer to Appendix C for the setup photographs.

- The area is 5 cm by 5 cm.
- The area is centered on the audio frequency output transducer of the EUT.
- The area is in a reference plane, which is defined as the planar area that contains the highest point in the area of the phone that normally rests against the user's ear. It is parallel to the centerline of the receiver area of the phone and is defined by the points of the receiver-end of the EUT handset, which, in normal handset use, rest against the ear.
- The measurement plane is parallel to, and 10 mm in front of, the reference plane.

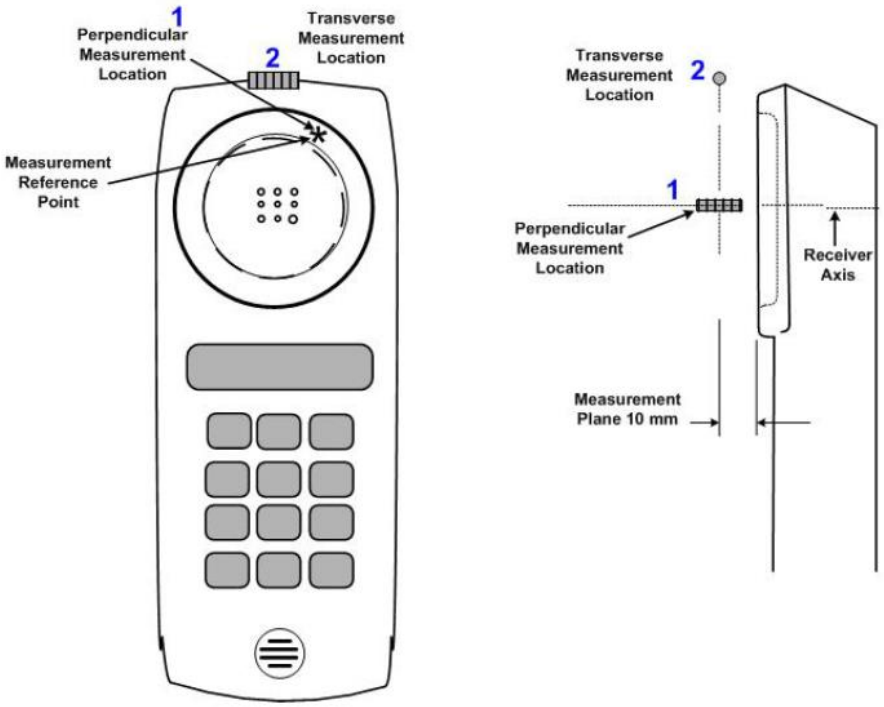


Fig.3 A typical EUT reference and plane for T-Coil measurements

7. Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	Audio Magnetic 1D Field Probe	AM1DV3	3130	Nov. 21, 2017	Nov. 20, 2018
SPEAG	Data Acquisition Electronics	DAE3	577	Sep. 25, 2017	Sep. 24, 2018
SPEAG	Audio Magnetic Calibration Coil	AMCC	1049	NCR	NCR
SPEAG	Audio Measuring Instrument	AMMI	1041	NCR	NCR
Gencom	Thermometer	TE1	TM685-1	Mar. 16, 2018	Mar. 15, 2019
R&S	Base Station	CMW500	149637	Jul. 26, 2017	Jul. 25, 2018
SPEAG	Test Arch Phantom	N/A	N/A	NCR	NCR
SPEAG	Phone Positoiner	N/A	N/A	NCR	NCR

Note:

1. NCR: “No-Calibration Required”

8. T-Coil testing for OTT VoIP Calling

General Notes:

1. The Google Duo / Google hangouts VoIP call software is pre-installed on this device and head-to-ear scenario should be consideration, the Google Duo / Google hangouts only support OPUS audio codec and support 6Kbpa to 75Kbps bitrate. According to KDB 285076 D02, all air interfaces via a data connection with google hangouts VoIP calling would be consideration to be tested.
2. The test setup used for Google Duo / Google hangouts VoIP call is via the data application unit on CMW500 connection to the Internet, also connection to the other auxiliary VoIP unit which is used to configure the audio codec and bit rate and also monitor the audio input level of -20dBm0.
3. The WFC VoIP application software is pre-installed on this device and head-to-ear scenario should be consideration, the WFC VoIP application support several audio codecs as below table. According to KDB 285076 D02, all air interfaces via a data connection with WFC VoIP calling would be consideration to be tested.
4. The test setup used for WFC VoIP application is via the data application unit on CMW500 connection to the Internet, also connection to the other auxiliary VoIP unit which is used to configure the audio codec and bit rate and can be determined the audio input level of -20dBm0.
5. For OTT over LTE or OTT over WiFi radio configuration investigation is choose either one codec and an investigation was performed on all frequency band, data rates and modulations and RB configuration to determine the radio configuration to be used for testing, the following tests results which the worst case configuration would be remarked to be used for the testing for the handset.
6. For OTT VoIP codec investigation test reduction, due to all air interface have the same codec configuration, therefore, the codec investigation was choose UMTS B2 to determine the audio codec configuration to be used for others air interfaces testing. the following codec investigation tests results which the worst case codec would be remarked to be used for the testing for the handset.
7. This device supports the following pairs of LTE bands with similar frequencies: LTE B12 & B17, LTE B5 & B26, LTE B2& B25. Each pair of LTE bands share the same transmission path. Since the supported frequency spans for the smaller LTE bands are completely covered by the larger LTE bands, only the larger LTE bands (LTE B12, B26 and LTE B25) were evaluated for hearing-aid compliance.

<Radio configure Investigation>

Air Interface	BW (MHz)	Modulation	RB Size	RB offset	Channel	ABM1 dB (A/m)	ABM2 dB (A/m)	Signal Quality dB
LTE B25	20	QPSK	1	0	26340	-14.40	-47.27	32.87
LTE B25	20	QPSK	50	0	26340	-14.41	-47.34	32.93
LTE B25	20	QPSK	100	0	26340	-14.43	-47.32	32.89
LTE B25	20	16QAM	1	0	26340	-14.39	-47.39	33.00
LTE B25	15	QPSK	1	0	26340	-14.41	-47.39	32.98
LTE B25	10	QPSK	1	0	26340	-14.39	-47.44	33.05
LTE B25	5	QPSK	1	0	26340	-14.45	-47.40	32.95
LTE B25	3	QPSK	1	0	26340	-14.41	-47.36	32.95
LTE B25	1.4	QPSK	1	0	26340	-14.39	-47.37	32.98

Air Interface	BW (MHz)	Mode	Channel	ABM1 dB (A/m)	ABM2 dB (A/m)	Signal Quality dB
802.11b	20	1M	6	-16.00	-38.98	22.98
802.11b	20	11M	6	-16.00	-39.14	23.14
802.11g	20	6M	6	-15.97	-39.12	23.15
802.11g	20	54M	6	-15.97	-39.00	23.03
802.11n-HT20	20	MCS0	6	-15.97	-39.01	23.04
802.11n-HT20	20	MCS7	6	-15.98	-38.99	23.01
802.11n-HT40	40	MCS0	6	-15.98	-39.02	23.04
802.11n-HT40	40	MCS7	6	-15.99	-39.25	23.26
802.11ac-VHT20	20	MCS0	6	-15.90	-38.93	23.03
802.11ac-VHT20	20	MCS8	6	-15.92	-39.10	23.18
802.11ac-VHT40	40	MCS0	6	-15.98	-39.20	23.22
802.11ac-VHT40	40	MCS8	6	-15.93	-39.01	23.08
802.11a	20	6M	40	-15.57	-39.29	23.72
802.11a	20	54M	40	-15.52	-39.30	23.78
802.11an-HT20	20	MCS0	40	-15.51	-39.29	23.78
802.11an-HT20	20	MCS7	40	-15.54	-39.37	23.83
802.11an-HT40	40	MCS0	38	-15.50	-39.32	23.82
802.11an-HT40	40	MCS7	38	-15.51	-39.30	23.79
802.11ac-VHT20	20	MCS0	40	-15.49	-39.33	23.84
802.11ac-VHT20	20	MCS8	40	-15.49	-39.35	23.86
802.11ac-VHT40	40	MCS0	38	-15.50	-39.35	23.85
802.11ac-VHT40	40	MCS8	38	-15.50	-39.34	23.84
802.11ac-VHT80	80	MCS0	50	-15.51	-39.24	23.73
802.11ac-VHT80	80	MCS8	50	-15.52	-39.39	23.87

<Google Duo Codec Investigation>

Codec	Bitrate 6Kbps	Bitrate 40Kbps	Bitrate 75Kbps	Orientation	Band / Channel
ABM 1 (dBA/m)	-7.54	-8.07	-7.38	Axial	WCDMA II / 9400
ABM 2 (dBA/m)	-47.46	-47.95	-47.51		
Signal Quality (dB)	39.92	39.88	40.13		
Freq. Response	PASS	PASS	PASS		

<Google hangouts Codec Investigation>

Codec	Bitrate 6Kbps	Bitrate 40Kbps	Bitrate 75Kbps	Orientation	Band / Channel
ABM 1 (dBA/m)	-4.72	-4.55	-4.59	Axial	WCDMA II / 9400
ABM 2 (dBA/m)	-48.62	-49.5	-48.74		
Signal Quality (dB)	43.9	44.95	44.15		
Freq. Response	PASS	PASS	PASS		

<WFC Codec Investigation>

Codec	G.711 a-Law	G.711 u-Law	G.729	G.722 16KHz	GSM 8KHz	Orientation	Band / Channel
ABM 1 (dBA/m)	-10.2	-9.66	-10.57	-10.09	-10.6	Axial	WCDMA II / 9400
ABM 2 (dBA/m)	-49.53	-48.98	-49.62	-49.01	-49.58		
Signal Quality (dB)	39.33	39.32	39.05	38.92	38.98		
Freq. Response	PASS	PASS	PASS	PASS	PASS		

<Summary Test Results>

Plot No.	Air Interface	Mode	Channel	Ant Status	Probe Position	ABM1 dB (A/m)	ABM2 dB (A/m)	Ambient Noise dB (A/m)	Freq. Response Variation dB	Signal Quality dB	T Rating	Frequency Response
1	GSM850	EDGE 2 Tx slots	189	-	Axial (Z)	-14.38	-34.70	-50.33	1.50	20.32	T3	PASS
					Transversal (Y)	-17.83	-43.29	-50.21		25.46	T3	
2	GSM1900	EDGE 2 Tx slots	661	-	Axial (Z)	-15.47	-40.53	-50.29	1.49	25.06	T3	PASS
					Transversal (Y)	-17.66	-46.11	-50.18		28.45	T3	
3	WCDMA II	HSPA	9400	-	Axial (Z)	-10.09	-49.01	-50.26	1.64	38.92	T4	PASS
					Transversal (Y)	-17.54	-48.57	-50.16		31.03	T4	
4	WCDMA IV	HSPA	1413	-	Axial (Z)	-11.25	-49.63	-50.35	1.68	38.38	T4	PASS
					Transversal (Y)	-17.81	-48.45	-50.25		30.64	T4	
5	WCDMA V	HSPA	4182	-	Axial (Z)	-12.21	-49.76	-50.27	1.65	37.55	T4	PASS
					Transversal (Y)	-17.72	-49.31	-50.16		31.59	T4	
6	CDMA BC0	RTAP 153.6Kbps	384	-	Axial (Z)	-10.96	-50.36	-50.32	1.62	39.40	T4	PASS
					Transversal (Y)	-17.51	-49.00	-50.28		31.49	T4	
7	CDMA BC1	RTAP 153.6Kbps	600	-	Axial (Z)	-11.43	-48.99	-50.26	1.65	37.56	T4	PASS
					Transversal (Y)	-17.57	-48.81	-50.22		31.24	T4	
8	CDMA BC10	RTAP 153.6Kbps	580	-	Axial (Z)	-11.43	-50.13	-50.20	1.63	38.70	T4	PASS
					Transversal (Y)	-17.59	-49.20	-50.25		31.61	T4	
9	LTE Band 4	20M_QPSK_1_0	20175	-	Axial (Z)	-11.12	-48.11	-50.24	1.69	36.99	T4	PASS
					Transversal (Y)	-17.65	-48.11	-50.25		30.46	T4	
10	LTE Band 12	10M_QPSK_1_0	23095	-	Axial (Z)	-11.74	-48.95	-50.21	1.67	37.21	T4	PASS
					Transversal (Y)	-17.85	-48.66	-50.26		30.81	T4	
11	LTE Band 13	10M_QPSK_1_0	23230	-	Axial (Z)	-10.61	-49.15	-50.28	1.68	38.54	T4	PASS
					Transversal (Y)	-17.64	-48.70	-50.27		31.06	T4	
12	LTE Band 25	20M_QPSK_1_0	26340	-	Axial (Z)	-10.61	-49.04	-50.24	1.69	38.43	T4	PASS
					Transversal (Y)	-17.70	-48.12	-50.32		30.42	T4	
13	LTE Band 26	15M_QPSK_1_0	26865	-	Axial (Z)	-10.94	-49.89	-50.28	1.64	38.95	T4	PASS
					Transversal (Y)	-17.61	-48.20	-50.24		30.59	T4	
14	WLAN2.4GHz	802.11b 1Mbps	6	Ant 1	Axial (Z)	-16.31	-39.12	-50.31	1.63	22.81	T3	PASS
					Transversal (Y)	-17.80	-44.32	-50.26		26.52	T3	
15	WLAN2.4GHz	802.11b 1Mbps	6	Ant 2	Axial (Z)	-16.08	-38.90	-50.41	1.74	22.82	T3	PASS
					Transversal (Y)	-17.56	-43.97	-50.23		26.41	T3	
16	WLAN5GHz	802.11a 6Mbps	40	Ant 1	Axial (Z)	-16.04	-39.58	-50.32	1.61	23.54	T3	PASS
					Transversal (Y)	-17.57	-44.38	-50.28		26.81	T3	
17	WLAN5GHz	802.11a 6Mbps	60	Ant 1	Axial (Z)	-16.03	-39.54	-50.27	1.67	23.51	T3	PASS
					Transversal (Y)	-17.60	-43.98	-50.22		26.38	T3	
18	WLAN5GHz	802.11a 6Mbps	124	Ant 1	Axial (Z)	-16.03	-39.46	-50.29	1.69	23.43	T3	PASS
					Transversal (Y)	-17.59	-44.49	-50.31		26.90	T3	
19	WLAN5GHz	802.11a 6Mbps	157	Ant 1	Axial (Z)	-15.79	-39.07	-50.26	1.73	23.28	T3	PASS
					Transversal (Y)	-17.67	-44.88	-50.23		27.21	T3	
20	WLAN5GHz	802.11a 6Mbps	40	Ant 2	Axial (Z)	-16.62	-39.43	-50.28	1.69	22.81	T3	PASS
					Transversal (Y)	-17.78	-44.27	-50.31		26.49	T3	
21	WLAN5GHz	802.11a 6Mbps	60	Ant 2	Axial (Z)	-15.94	-38.77	-50.24	1.66	22.83	T3	PASS
					Transversal (Y)	-17.75	-42.82	-50.23		25.07	T3	
22	WLAN5GHz	802.11a 6Mbps	124	Ant 2	Axial (Z)	-15.95	-38.72	-50.22	1.70	22.77	T3	PASS
					Transversal (Y)	-17.80	-44.65	-50.26		26.85	T3	
23	WLAN5GHz	802.11a 6Mbps	157	Ant 2	Axial (Z)	-16.64	-39.36	-50.31	1.73	22.72	T3	PASS
					Transversal (Y)	-17.85	-44.25	-50.26		26.40	T3	

Remark:

1. Phone Condition: Mute on; Backlight off; Max Volume
2. The detail frequency response results please refer to appendix A.
3. Test Engineer：Nick Yu.

9. Uncertainty Assessment

The evaluation of uncertainly by the statistical analysis of a series of observations is termed a Type A evaluation of uncertainty. The evaluation of uncertainty by means other than the statistical analysis of a series of observation is termed a Type B evaluation of uncertainty. Each component of uncertainty, however evaluated, is represented by an estimated standard deviation, termed standard uncertainty, which is determined by the positive square root of the estimated variance. The combined standard uncertainty of the measurement result represents the estimated standard deviation of the result. It is obtained by combining the individual standard uncertainties of both Type A and Type B evaluation using the usual “root-sum-squares” (RSS) methods of combining standard deviations by taking the positive square root of the estimated variances. Expanded uncertainty is a measure of uncertainty that defines an interval about the measurement result within which the measured value is confidently believed to lie. It is obtained by multiplying the combined standard uncertainty by a coverage factor. For purpose of this document, a coverage factor two is used, which corresponds to confidence interval of about 95 %. The DASY uncertainty Budget is showed in Table 8.2.

Error Description	Uncertainty Value (±%)	Probability Distribution	Divisor	Ci (ABM1)	Ci (ABM2)	Standard Uncertainty (ABM1)	Standard Uncertainty (ABM2)
Probe Sensitivity							
Reference Level	3.0	Normal	1	1	1	± 3.0 %	± 3.0 %
AMCC Geometry	0.4	Rectangular	√3	1	1	± 0.2 %	± 0.2 %
AMCC Current	1.0	Rectangular	√3	1	1	± 0.6 %	± 0.6 %
Probe Positioning During Calibrate	0.1	Rectangular	√3	1	1	± 0.1 %	± 0.1 %
Noise Contribution	0.7	Rectangular	√3	0.0143	1	± 0.0 %	± 0.4 %
Frequency Slope	5.9	Rectangular	√3	0.1	1	± 0.3 %	± 3.5 %
Probe System							
Repeatability / Drift	1.0	Rectangular	√3	1	1	± 0.6 %	± 0.6 %
Linearity / Dynamic Range	0.6	Rectangular	√3	1	1	± 0.4 %	± 0.4 %
Acoustic Noise	1.0	Rectangular	√3	0.1	1	± 0.1 %	± 0.6 %
Probe Angle	2.3	Rectangular	√3	1	1	± 1.4 %	± 1.4 %
Spectral Processing	0.9	Rectangular	√3	1	1	± 0.5 %	± 0.5 %
Integration Time	0.6	Normal	1	1	5	± 0.6 %	± 3.0 %
Field Disturbation	0.2	Rectangular	√3	1	1	± 0.1 %	± 0.1 %
Test Signal							
Reference Signal Spectral Response	0.6	Rectangular	√3	0	1	± 0.0 %	± 0.4 %
Positioning							
Probe Positioning	1.9	Rectangular	√3	1	1	± 1.1 %	± 1.1 %
Phantom Thickness	0.9	Rectangular	√3	1	1	± 0.5 %	± 0.5 %
EUT Positioning	1.9	Rectangular	√3	1	1	± 1.1 %	± 1.1 %
External Contributions							
RF Interference	0.0	Rectangular	√3	1	0.3	± 0.0 %	± 0.0 %
Test Signal Variation	2.0	Rectangular	√3	1	1	± 1.2 %	± 1.2 %
Combined Standard Uncertainty						± 4.1 %	± 6.1 %
Coverage Factor for 95 %						K = 2	
Expanded Uncertainty						± 8.1 %	± 12.3 %

Table 8.2 Uncertainty Budget of audio band magnetic measurement

10. References

[1] ANSI C63.19-2011, “American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids”, 27 May 2011.

[2] FCC KDB 285076 D01v05, “Equipment Authorization Guidance for Hearing Aid Compatibility”, Sep 2017

[3] FCC KDB 285076 D02v03, “Guidance for performing T-Coil tests for air interfaces supporting voice over IP (e.g., LTE and WiFi) to support CMRS based telephone services”, Sep 2017

[4] FCC KDB 285076 D03v01, “Hearing aid compatibility frequently asked questions”, Sep 2017

[5] SPEAG DASY System Handbook