Hearing Aid Compatibility (HAC) T-Coil Test Report

APPLICANT	:	**Motorola Solutions, Inc.**
EQUIPMENT	:	**Enterprise Digital Assistant (EDA)**
BRAND NAME	:	**Motorola**
MODEL NAME	:	**MC4597**
FCC ID	:	**UZ7MC4597**
STANDARD	:	**FCC 47 CFR §20.19** **ANSI C63.19-2007**
T CATEGORY	:	**T3**

The product sample completely tested on Oct. 30, 2012. 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:

Jones Tsai

Jones Tsai / Manager

ilac-MRA

TAF Testing Laboratory 1190

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Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
HA250901B	Rev. 01	Initial issue of report	Dec. 05, 2012
HA250901B	Rev. 02	Revise section 9.2 and section 9.4.	Dec. 07, 2012

1. Statement of Compliance

The Hearing Aid Compliance (HAC) maximum results found during testing for the **Motorola Solutions, Inc. Enterprise Digital Assistant (EDA) Motorola MC4597** are as follows (with expanded uncertainly ±8.1% for AMB1 and ±12.3% for AMB2):

Reference (63.19)	Description	Verdict	Section
7.3.1.1	Axial Field Intensity	Pass	9.2.1
7.3.1.2	Radial Field Intensity	Pass	9.2.2
7.3.2	Frequency Response	Pass	9.2.3
7.3.3	Signal Quality	T3	9.2.4

Band	(S+N)/N in dB	T Rating
GSM850	**22.11**	**T3**
GSM1900	**24.31**	**T3**
WCDMA V	**24.59**	**T3**
WCDMA II	**25.21**	**T3**

They are in compliance with HAC limits (HAC Rated category T3) specified in guidelines FCC 47CFR §20.19 and ANSI Standard ANSI C63.19.

Results Summary : T Category = T3 (ANSI C63.19-2007)

2. Administration Data

2.1 Testing Laboratory

Test Site	SPORTON INTERNATIONAL INC.
Test Site Location	No. 52, Hwa Ya 1st Rd., Hwa Ya Technology Park, Kwei-Shan Hsiang, Tao Yuan Hsien, Taiwan, R.O.C. TEL: +886-3-327-3456 FAX: +886-3-328-4978
Test Site No.	**Sporton Site No. :** SAR01-HY

2.2 Applicant

Company Name	Motorola Solutions, Inc.
Address	One Motorola Plaza, Holtsville, NY 11742-1300 USA

2.3 Manufacturer

Company Name	Inventec Appliances Corp.
Address	37, Wugong 5th Road, New Taipei industrial Park, Wugu District, New Taipei City, Taiwan 24890

2.4 Application Details

Date of Start during the Test	Oct. 29, 2012
Date of End during the Test	Oct. 30, 2012

3. General Information

3.1 Description of Device Under Test (DUT)

Product Feature & Specification	
DUT Type	Enterprise Digital Assistant (EDA)
Brand Name	Motorola
Model Name	MC4597
FCC ID	UZ7MC4597
Tx Frequency	GSM850 : 824.2 MHz ~ 848.8 MHz GSM1900 : 1850.2 MHz ~ 1909.8 MHz WCDMA Band V : 826.4 MHz ~ 846.6 MHz WCDMA Band II : 1852.4 MHz ~ 1907.6 MHz
Rx Frequency	GSM850 : 869.2 MHz ~ 893.8 MHz GSM1900 : 1930.2 MHz ~ 1989.8 MHz WCDMA Band V : 869.2 MHz ~ 893.8 MHz WCDMA Band II : 1932.4 MHz ~ 1987.6 MHz
Measure Maximum Average Output Power to Antenna	GSM850 : 32.94 dBm GSM1900 : 29.41 dBm WCDMA Band V : 23.76 dBm WCDMA Band II : 23.32 dBm
Antenna Type	PCB Antenna
HW Version	DV2.3
SW Version	BSP9.351
Type of Modulation	GSM : GMSK WCDMA : QPSK (Uplink)
DUT Stage	Identical Prototype

1.	Mobile Computing Terminal	OS Version	BSP9.351
2.		OEM Name	MC45
3.		OEM Version	DVT2.3
4.	Wireless (Fusion)	Part Number	WM-AG-AT-02-C
5.		Version	3.40.0.0.56

List of Accessory:

Specification of Accessory		
Battery	**Brand Name**	MOTOROLA
	Model Name	82-118524-01

Remark:

1. The above DUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.
2. The battery(03 Rev A) and battery(01 Rev C) spec are the same, only difference is label.

List of air interfaces / frequency bands

Air Interface	Band (MHz)	Voice/Data	C 63.19-2007 Tested	Concurrent connections	Reduced Power 20.19 (c)(1)
GSM	850,1900	Voice	Yes	WCDMA, WLAN, BT	No
WCDMA	850,1900	Voice	Yes	WLAN, BT	No
WLAN	2450	Data (*)	No	GSM, WCDMA	No
BT	2450	Data (*)	No	GSM, WCDMA	No

Note:

1. (*): The voice function maybe be activated via 3rd party software application.
2. Per KDB 285076 D01 v03)10)a), during T-Coil test, concurrent transmission is disabled.

3.2 Product Photos

Refer to Appendix C.

3.3 Applied Standards

The Standard ANSI C63.19:2007 represents 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.

3.4 Test Conditions

3.4.1 Ambient Condition

Ambient Temperature	20-24℃
Humidity	<60%
Acoustic Ambient Noise	>10dB below the measurement level

3.4.2 Test Configuration

The device was controlled by using a base station emulator R&S CMU200. Communication between the device and the emulator was established by coaxial connection. The DUT was set from the emulator to radiate maximum output power during all testing.

4. Hearing Aid Compliance (HAC)

4.1 Introduction

In September 2006, the T-Coil requirements of ANSI C63.19 Standard went into effect. The federal communication commission (FCC) adopted ANSI C63.19 as HAC test standard.

5. HAC T-Coil Measurement Setup

5.1 System Configuration

Fig. 5.1 T-Coil setup with HAC Test Arch and AMCC

The DASY system for performance compliance tests is illustrated above graphically. This system consists of the following items:

- A standard high precision 6-axis robot with controller, a teach pendant and software
- A data acquisition electronic (DAE) attached to the robot arm extension
- A dosimetric probe equipped with an optical surface detector system
- The electro-optical converter (EOC) performs the conversion between optical and electrical signals
- A measurement server performs the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the accuracy of the probe positioning
- A computer operating Windows XP
- DASY software
- Remove control with teach pendant and additional circuitry for robot safety such as warming lamps, etc.
- The SAM twin phantom
- A device holder
- Tissue simulating liquid
- Dipole for evaluating the proper functioning of the system

Some of the components are described in details in the following sub-sections.

5.2 AM1D Probe

The AM1D probe is an active probe with a single sensor. It is fully RF-shielded and has a rounded tip 6mm in diameter incorporating a pickup coil with its center offset 3mm from the tip and the sides. The symmetric signal preamplifier in the probe is fed via the shielded symmetric output cable from the AMMI with a 48V “phantom” voltage supply. The 7-pin connector on the back in the axis of the probe does not carry any signals. It is mounted to the DAE for the correct orientation of the sensor. If the probe axis is tilted 54.7 degree from the vertical, the sensor is approximately vertical when the signal connector is at the underside of the probe (cable hanging downwards).

Specification:

Frequency Range	0.1 ~ 20 kHz (RF sensitivity <-100dB, fully RF shielded)
Sensitivity	<-50dB A/m @ 1 kHz
Pre-amplifier	40 dB, symmetric
Dimensions	Tip diameter/ length: 6/ 290 mm, sensor according to ANSI-PC63.19

5.2.1 Probe Calibration in AMCC

The probe sensitivity at 1 kHz is 0.06556 V/(A/m) (-23.66 dBV/(A/m)) was calibrated by AMCC coil for verification of setup performance. The evaluated probe sensitivity was able to be compared to the calibration of the AM1D probe. The frequency response and sensitivity was shown in Fig. 5.2. The probe signal is represented after application of an ideal integrator. The green curve represents the current though the AMCC, the blue curve the integrated probe signal. The DIFFERENCE between the two curves is equivalent to the frequency response of the probe system and shows the characteristics. The probe/system complies with the frequency response and linearity requirements in C63.19 according to the Speag's calibrated report as shown in Annex B (AM1D probe: SPAM100AF) (1)The frequency response has been tested within +/- 0.5 dB of ideal differentiator from 100 Hz to 10 kHz. (2)The linearity has also been tested within 0.1dB from 5 dB below limitation to 16 dB above noise level. The AMCC coil is qualified according to certificate report, SDHACPO02A as shown in Annex B.

	Coil	Probe
Internal calibration...	2.3029 V	1.1453 V
Probe sensitivity a...		0.06556 V/(A/m)

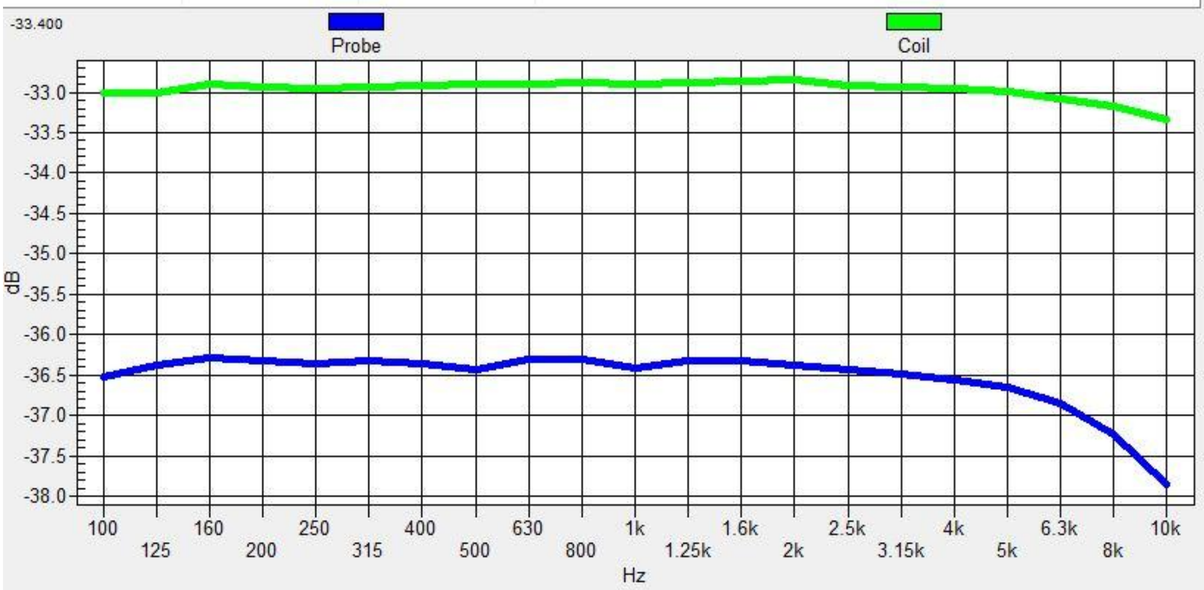


Fig. 5.2 The frequency response and sensitivity of AM1D probe

5.3 AMCC

The Audio Magnetic Calibration coil is a Helmholtz Coil designed for calibration of the AM1D probe. The two horizontal coils generate a homogeneous magnetic field in the z direction. The DC input resistance is adjusted by a series resistor to approximately 50Ohm, and a shunt resistor of 10 Ohm permits monitoring the current with a scale of 1:10.

Port description:

Signal	Connector	Resistance
Coil In	BNC	typically 50 Ohm
Coil Monitor	BNO	10Ohm ±1%(100mV corresponding to 1 A/m)

Specification:

Dimensions	370 x 370 x 196 mm, according to ANSI C63.19

5.4 AMMI

Fig. 5.3 AMMI front panel

The Audio Magnetic Measuring Instrument (AMMI) is a desktop 19-inch unit containing a sampling unit, a waveform generator for test and calibration signals, and a USB interface.

Specification:

Sampling rate	48 kHz/24 bit
Dynamic range	85 dB
Test signal generation	User selectable and predefined (vis PC)
Calibration	Auto-calibration/full system calibration using AMCC with monitor output
Dimensions	482 x 65 x 270 mm

5.5 DATA Acquisition Electronics (DAE)

The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock.

The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

Fig. 5.4 Photo of DAE

5.6 Robot

The SPEAG DASY system uses the high precision robots (DASY4: RX90BL; DASY5: TX90XL) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY4: CS7MB; DASY5: CS8c) from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability ±0.035 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)
- 6-axis controller

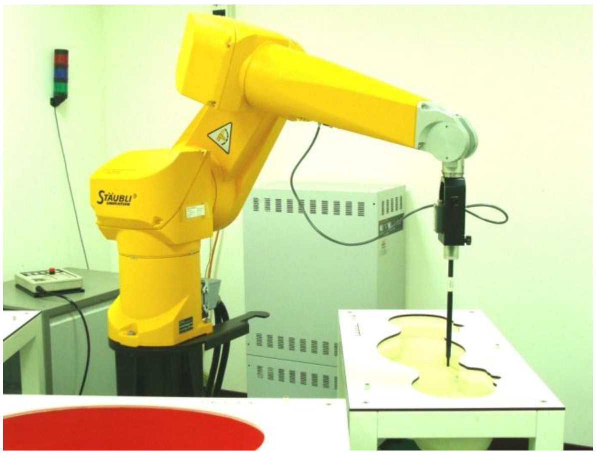


Fig. 5.5 Photo of DASY4

Fig. 5.6 Photo of DASY5

5.7 Measurement Server

The measurement server is based on a PC/104 CPU board with CPU (DASY4: 166 MHz, Intel Pentium; DASY5: 400 MHz, Intel Celeron), chipdisk (DASY4: 32 MB; DASY5: 128 MB), RAM (DASY4: 64 MB, DASY5: 128 MB). The necessary circuits for communication with the DAE electronic box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DASY I/O board, which is directly connected to the PC/104 bus of the CPU board.

The measurement server performs all the real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operations.

Fig. 5.7 Photo of Server for DASY4

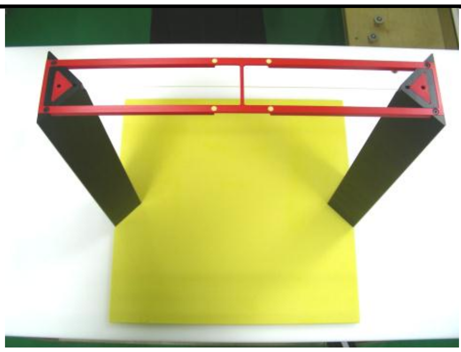
Fig. 5.8 Photo of Server for DASY5

5.8 Phone Positioner

The phone positioner shown in Fig. 5.9 is used to adjust DUT to the suitable position.

Fig. 5.9 Phone Positioner

5.9 Test Arch Phantom

Construction :	Enables easy and well defined positioning of the phone and validation dipoles as well as simple teaching of the robot.	 **Fig. 5.10 Photo of Arch Phantom**
Dimensions :	370 x 370 x 370 mm	

5.10 Cabling of System

The principal cabling of the T-Coil setup is shown in Fig. 5.11. All cables provided with the basic setup have a length of approximately 5 m.

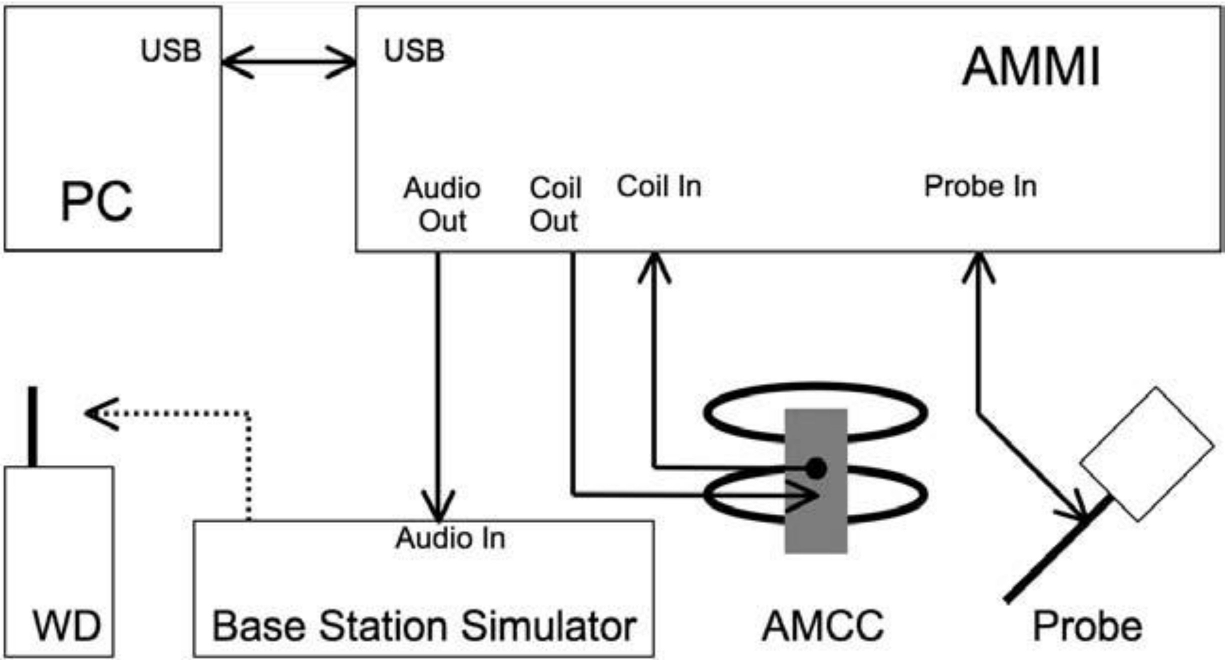


Fig. 5.11 T-Coil setup cabling

5.11 HAC Extension Software

Specification:

Precise teaching	Easy teaching with adaptive distance verification
Measurement area	Flexible selection of measurement area, predefined according to ANSI C63.19
Evaluation	ABM: spectral processing, filtering, weighting and evaluation according to ANSI C63.19
Report	Documentation ready for compliance report

5.12 Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	Audio Magnetic 1D Field Probe	AM1DV2	1038	Jan. 23, 2012	Jan. 22, 2013
SPEAG	Audio Magnetic Calibration Coil	AMCC	1049	NCR	NCR
SPEAG	Audio Measuring Instrument	AMMI	1041	NCR	NCR
SPEAG	Data Acquisition Electronics	DAE4	778	Aug. 27, 2012	Aug. 26, 2013
SPEAG	Data Acquisition Electronics	DAE4	1338	Jun. 12, 2012	Jun. 11, 2013
Wisewind	Thermometer	ETP-101	TM560	Nov. 16, 2011	Nov. 15, 2012
SPEAG	Test Arch Phantom	N/A	N/A	NCR	NCR
SPEAG	Phone Positioner	N/A	N/A	NCR	NCR
Agilent	ESG Vector Series Signal Generator	E4438C	MY49070755	Oct. 02, 2012	Oct. 01, 2013
Anritsu	Power Meter	ML2495A	1132003	Aug. 14, 2012	Aug. 13, 2013
R&S	Universal Digital Radio communication Tester	CMU200	114256	Jun. 29, 2012	Jun. 28, 2013
R&S	Spectrum Analyzer	FSP7	101131	Jul. 23, 2012	Jul. 22, 2013

Table 5.1 Test Equipment List

5.13 Reference Input of Audio Signal Spectrum

With the reference job "use as reference" in the beginning of a procedure, measure the spectrum of the current when applied to the AMCC, i.e. the input magnetic field spectrum, as shown below Fig. 5.12 and Fig. 5.13. For this, the delay of the window shall be set to a multiple of the signal period and at least 2s. From the measurement on the device, using the same signal, the postprocessor deducts the input spectrum, so the result represents the net DUT response.

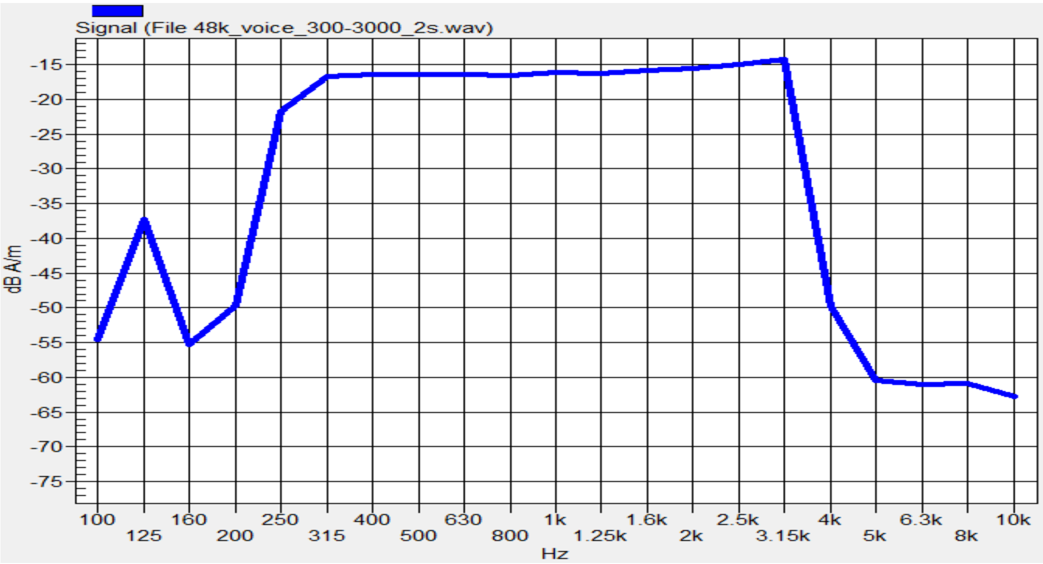


Fig. 5.12 Audio signal spectrum of the broadband signal (48kHz_voice_300Hz~3 kHz)

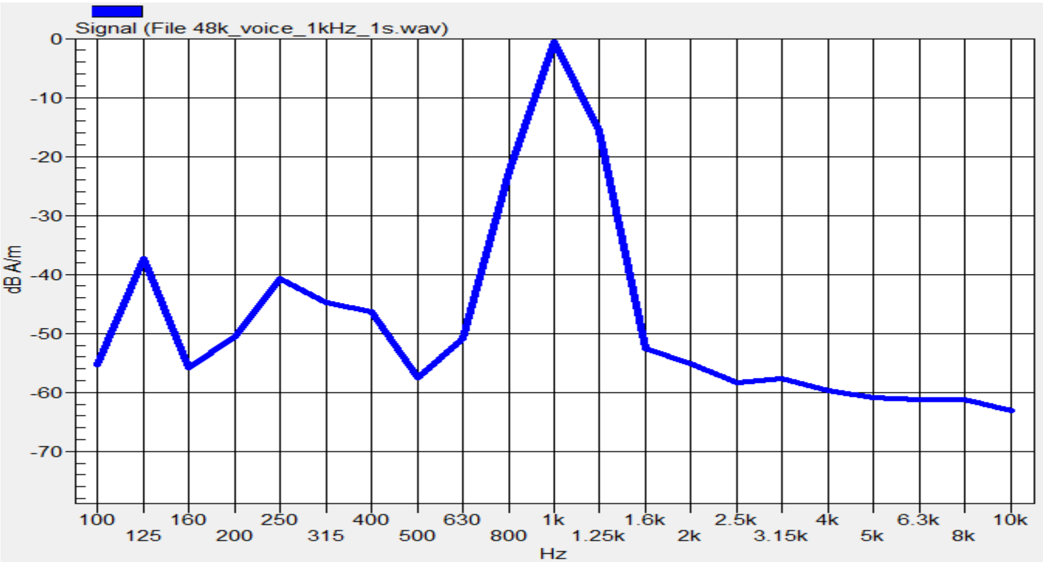


Fig. 5.13 Audio signal spectrum of the narrowband signal (48kHz_voice_1kHz)

5.14 Signal Verification

According to ANSI C63.19:2007 section 6.3.2.1, the normal speech input level for HAC T-coil tests shall be set to -16 dBm0 for GSM and UMTS (WCDMA), and to -18 dBm0 for CDMA. This technical note shows a possibility to evaluate and set the correct level with the HAC T-Coil setup with a Rohde&Schwarz communication tester CMU200 with audio option B52 and B85.

Establish a call from the CMU200 to a wireless device. Select CMU200 Network Bitstream ”Decoder Cal” to have a 1 kHz signal with a level of 3.14 dBm0 at the speech output. Run the measurement job and read the voltage level at the multi-meter display “Coil signal”. Read the RMS voltage corresponding to 3.14 dBm0 and note it. Calculate the desired signal levels of -16 dBm0:

3.14 dBm0 = -2.15 dBV
-16 dBm0 = -21.65 dBV

Determine the 1 kHz input level to generate the desired signal level of -16 dBm0. Select CMU200 Network Bitstream “Codec Cal” to loop the input via the codec to the output. Run the measurement job (AMMI 1 kHz signal with gain 10 inserted) and read the voltage level at the multimeter display “Coil signal”. Calculate the required gain setting for the above levels:

Gain 10 = -20.65 dBV
Difference for -16 dBm0 = -21.65 - (-20.65) = -1 dB
Gain factor = 10 ^ ((-1) / 20) = -0.891
Resulting Gain = 10 x 0.891 = 8.91

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

Signal Type	Duration (s)	Peak to RMS (dB)	RMS (dB)	Gain Factor	Gain Setting
1kHz	1	16.2	-12.7	4.33	3.80
300Hz ~ 3kHz	2	21.6	-18.6	8.48	7.44

6. Description for DUT Testing Position

Fig.6.1 illustrate the references and reference plane that shall be used in a typical DUT emissions measurement. The principle of this section is applied to DUT with similar geometry. Please refer to Appendix D for the setup photographs.

- The area is 5 cm by 5 cm.
- The area is centered on the audio frequency output transducer of the DUT.
- 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 DUT 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.

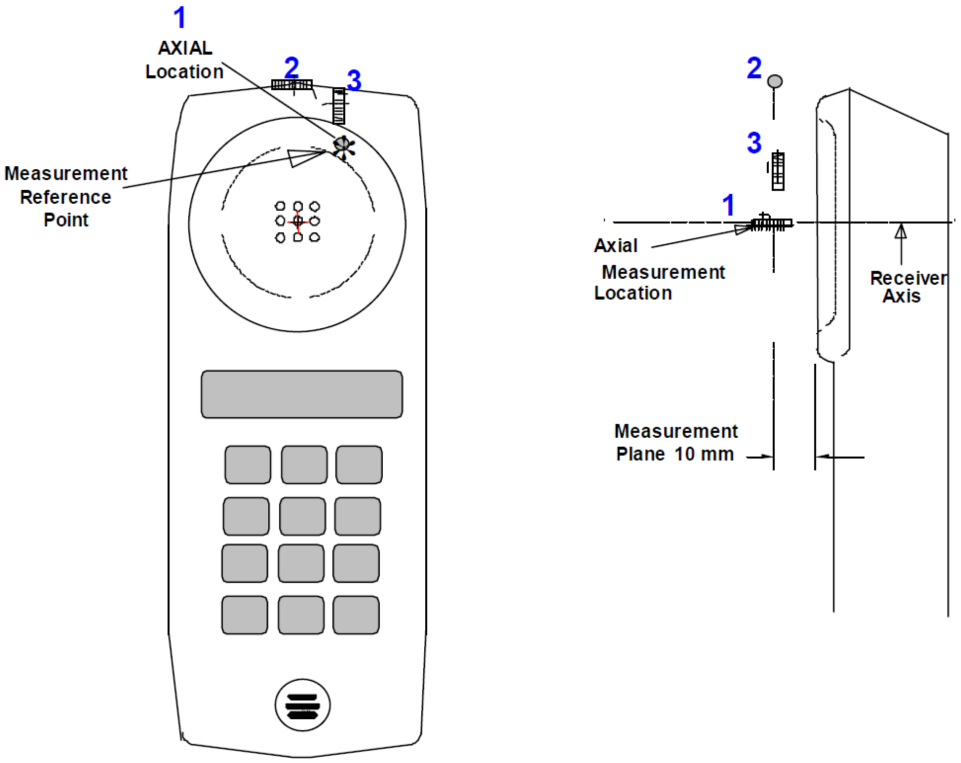


Fig 6.1 A typical DUT reference and plane for T-Coil measurements

7. T-Coil Test Procedure

The following illustrate a typical test scan over a wireless communications device:

1. Geometry and signal check: system probe alignment, proper operation of the field probe, probe measurement system, other instrumentation, and the positioning system was confirmed. A surface calibration was performed before each setup change to ensure repeatable spacing and proper maintenance of the measurement plane using the test Arch.
2. Set the reference drive level of signal voice defined in C63.19 per 6.3.2.1, as shown in this report of section 5.12.
3. The ambient and test system background noise (dB A/m) was measured as well as ABM2 over the full measurement. The maximum noise level must be at least 10dB below the limit of C63.19 per 7.3.2.
4. The DUT was positioned in its intended test position, acoustic output point of the device perpendicular to the field probe.
5. The DUT operation for maximum rated RF output power was configured and connected by using of coaxial cable connection to the base station simulator at the test channel and other normal operating parameters as intended for the test. The battery was ensured to be fully charged before each test. The center sub-grid was centered over the center of the acoustic output (also audio band magnetic output, if applicable). The DUT audio output was positioned tangent (as physically possible) to the measurement plane.
6. The DUT's RF emission field was eliminated from T-coil results by using a well RF-shielding of the probe, AM1D, and by using of coaxial cable connection to a Base Station Simulator. One test channel was pre-measurement to avoid this possibility.
7. Determined the optimal measurement locations for the DUT by following the three steps, coarse resolution scan, fine resolution scans, and point measurement, as described in C63.19 per 6.3.4.4. At each measurement locations, samples in the measurement window duration were evaluated to get ABM1 and the signal spectrum. The noise measurement was performed after the scan with the signal, the same happened, just with the voice signal switched off. The ABM2 was calculated from this second scan.

   (1) Coarse resolution scans (1 kHz signal at 50 x 50 mm grid area with 10 mm spacing). Only ABM1 was measured in order to find the location of T-Coil source.

   (2) Fine resolution scans (1 kHz signal at 10 x 10 mm grid area with 2 mm spacing). The positioned appropriately based on optimal AMB1 of coarse resolution scan. Both ABM1 and ABM2 were measured in order to find the location of the SNR point.

   (3) Point measurement (1 kHz signal) for ABM1 and ABM2 in axial, radial transverse and radial longitudinal. The positioned appropriately based on optimal SNR of fine resolution scan. The SNR was calculated for axial, radial transverse and radial longitudinal orientation.

   (4) Point measurement (300Hz to 3 kHz signal) for frequency response in axial. The positioned appropriately based on optimal SNR of fine resolution axial scan.

8. All results resulting from a measurement point in a T-Coil job were calculated from the signal samples during this window interval. ABM values were averaged over the sequence of these samples.
9. At an optimal point measurement, the SNR (ABM1/ABM2) was calculated for axial, radial transverse and radial longitudinal orientation, and the frequency response was measured in axial axis.
10. Corrected for the frequency response after the DUT measurement since the DASY system had known the spectrum of the input signal by using a reference job, as shown in this report of section 5.12.
11. In SEMCAD post-processing, the spectral points are in addition scaled with the high-pass (half-band) and the A-weighting, bandwidth compensated factor (BWC) and those results are final as shown in this report.
12. Classified the signal quality based on the table 8.1: T-Coil Signal Quality Categories.

8. 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 8.1. 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 8.1 T-Coil Signal Quality Categories

9. HAC T-Coil Test Results

9.1 Conducted Power (Unit: dBm)

Band	GSM850			GSM1900		
Channel	128	189	251	512	661	810
Frequency (MHz)	824.2	836.4	848.8	1850.2	1880.0	1909.8
GSM	32.68	32.86	**32.94**	**29.41**	29.26	29.30

Band	WCDMA Band V			WCDMA Band II		
Channel	4132	4182	4233	9262	9400	9538
Frequency (MHz)	826.4	836.4	846.6	1852.4	1880.0	1907.6
RMC 12.2K	23.48	**23.76**	23.73	23.13	**23.32**	23.05

9.2 Magnitude Result

The Table 9.1 shows testing result in position coordinates which are defined as deviation from earpiece center in millimeters. Axial measurement location was defined by the manufacture of the device. Signal strength measurement scans are presented in appendix A.

Plot No.	Band	Mode	Ch.	Probe Position	ABM1 (dB A/m)	ABM2 (dB A/m)	SNR (dB)	T Rating
1	**GSM850**	**Voice**	**128**	Axial (Z)	11.52	-12.92	24.44	T3
				Radial 1 (X)	**2.87**	**-19.24**	**22.11**	**T3**
				Radial 2 (Y)	3.40	-20.86	24.26	T3
2	GSM850	Voice	189	Axial (Z)	9.15	-15.73	24.88	T3
				Radial 1 (X)	3.51	-19.61	23.12	T3
				Radial 2 (Y)	3.33	-21.62	24.95	T3
3	GSM850	Voice	251	Axial (Z)	7.39	-17.16	24.55	T3
				Radial 1 (X)	3.93	-19.25	23.18	T3
				Radial 2 (Y)	3.63	-21.26	24.89	T3
5	GSM1900	Voice	512	Axial (Z)	11.38	-13.63	25.01	T3
				Radial 1 (X)	3.62	-21.19	24.81	T3
				Radial 2 (Y)	3.36	-21.49	24.85	T3
6	**GSM1900**	**Voice**	**661**	Axial (Z)	10.71	-14.54	25.25	T3
				Radial 1 (X)	**1.55**	**-22.76**	**24.31**	**T3**
				Radial 2 (Y)	1.93	-22.76	24.69	T3
7	GSM1900	Voice	810	Axial (Z)	10.41	-14.91	25.32	T3
				Radial 1 (X)	3.89	-20.92	24.81	T3
				Radial 2 (Y)	3.54	-21.03	24.57	T3
9	WCDMA V	Voice	4132	Axial (Z)	5.20	-20.84	26.04	T3
				Radial 1 (X)	2.81	-23.01	25.82	T3
				Radial 2 (Y)	3.44	-21.67	25.11	T3
10	**WCDMA V**	**Voice**	**4182**	Axial (Z)	9.98	-16.00	25.98	T3
				Radial 1 (X)	4.74	-21.19	25.93	T3
				Radial 2 (Y)	**3.12**	**-21.47**	**24.59**	**T3**
11	WCDMA V	Voice	4233	Axial (Z)	7.03	-19.20	26.23	T3
				Radial 1 (X)	0.55	-25.65	26.20	T3
				Radial 2 (Y)	3.61	-21.70	25.31	T3

Plot No.	Band	Mode	Ch.	Probe Position	ABM1 (dB A/m)	ABM2 (dB A/m)	SNR (dB)	T Rating
17	WCDMA II	Voice	9262	Axial (Z)	10.82	-15.51	26.33	T3
				Radial 1 (X)	0.39	-25.62	26.01	T3
				Radial 2 (Y)	3.45	-21.94	25.39	T3
18	**WCDMA II**	**Voice**	**9400**	Axial (Z)	7.14	-19.30	26.44	T3
				Radial 1 (X)	4.61	-21.52	26.13	T3
				Radial 2 (Y)	**2.14**	**-23.07**	**25.21**	**T3**
19	WCDMA II	Voice	9538	Axial (Z)	10.62	-15.74	26.36	T3
				Radial 1 (X)	2.91	-23.30	26.21	T3
				Radial 2 (Y)	3.57	-21.70	25.27	T3

Table 9.1 Test Result for Various Positions

Remark:

1. There is no special HAC mode software on this DUT.
2. The volume was adjusted to maximum level and the backlight turned off during T-Coil testing.
3. Test Engineer：San Lin and Bevis Chang

9.3 Frequency Response Plots

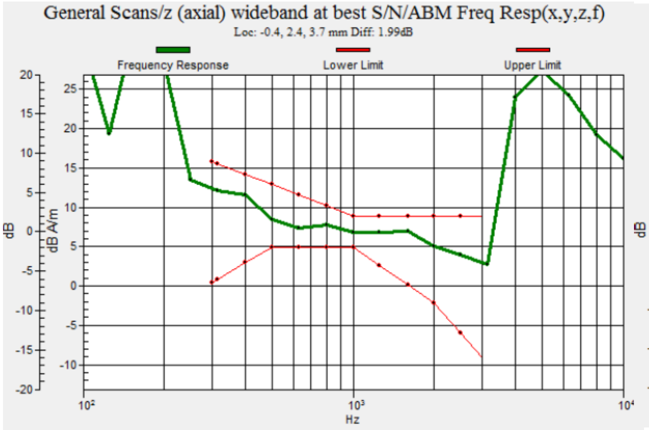


Fig 9.1 GSM850 Ch128

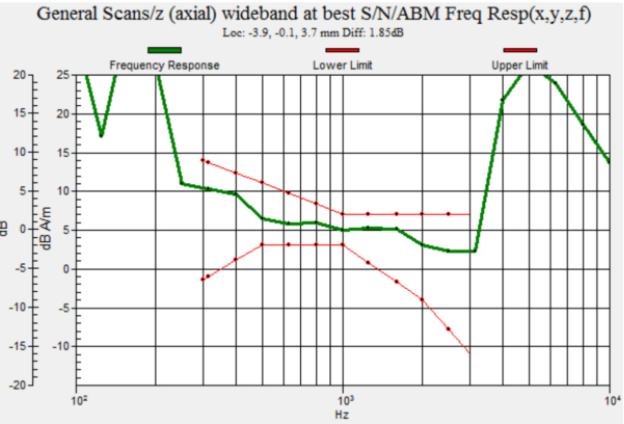


Fig 9.2 GSM850 Ch189

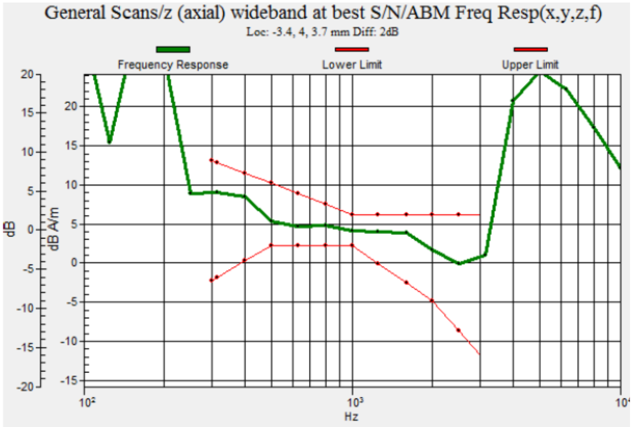


Fig 9.3 GSM850 Ch251

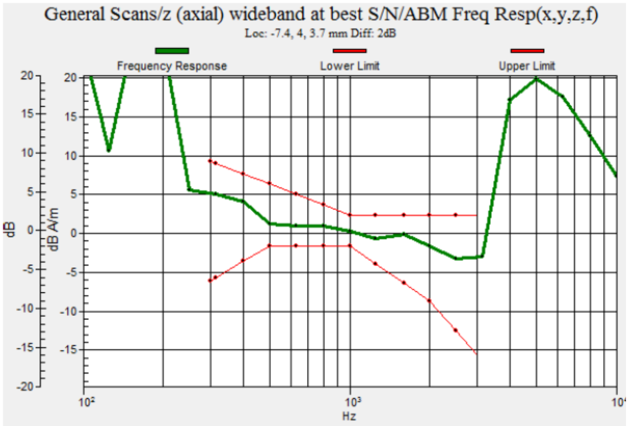


Fig 9.4 GSM1900 Ch512

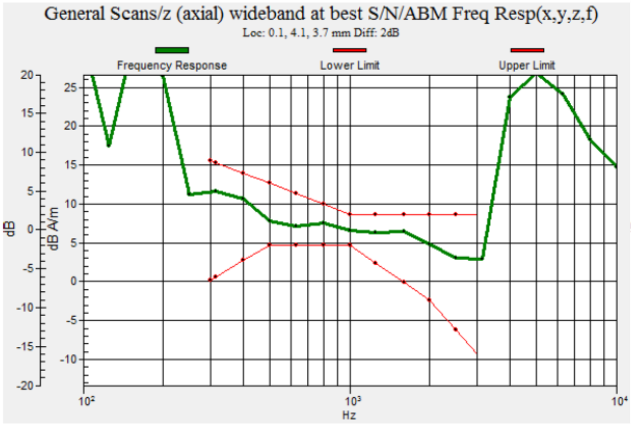


Fig 9.5 GSM1900 Ch661

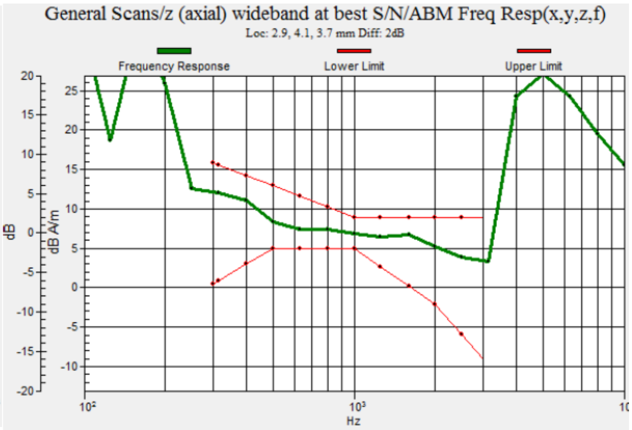


Fig 9.6 GSM1900 Ch810

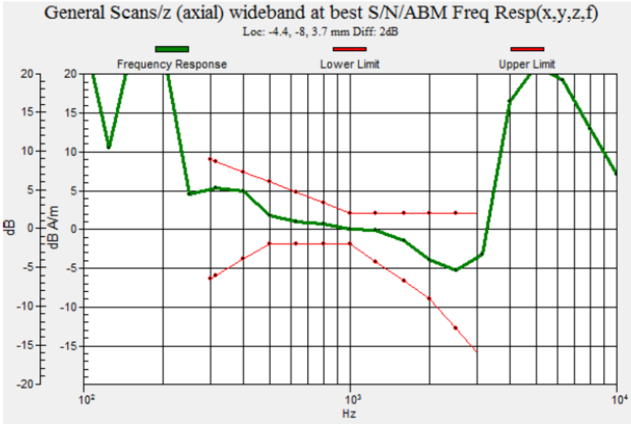


Fig 9.7 WCDMA Band V Ch4132

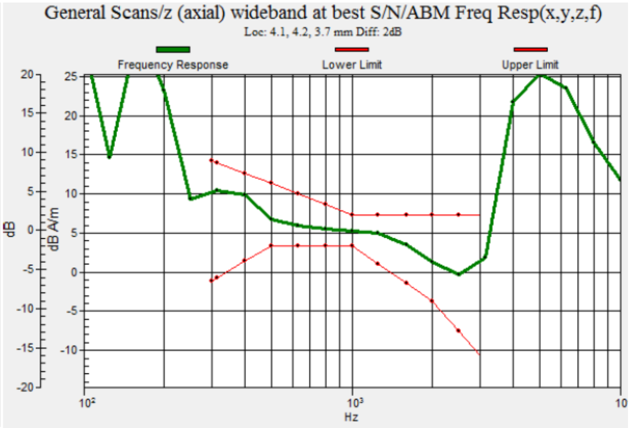


Fig 9.8 WCDMA Band V Ch4182

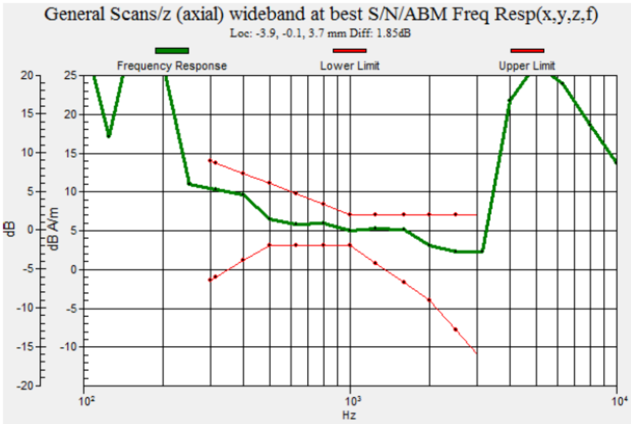


Fig 9.9 WCDMA Band V Ch4233

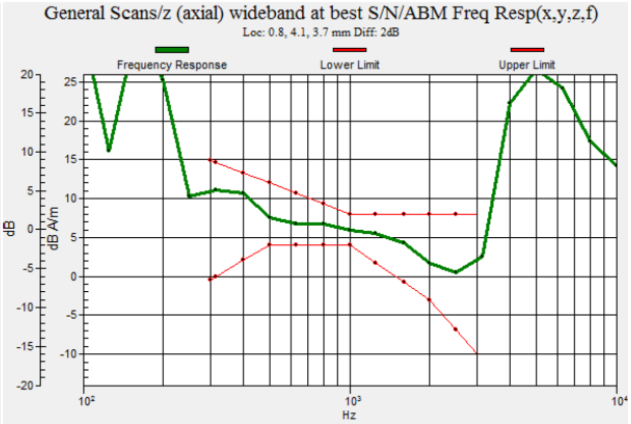


Fig 9.10 WCDMA Band II Ch9262

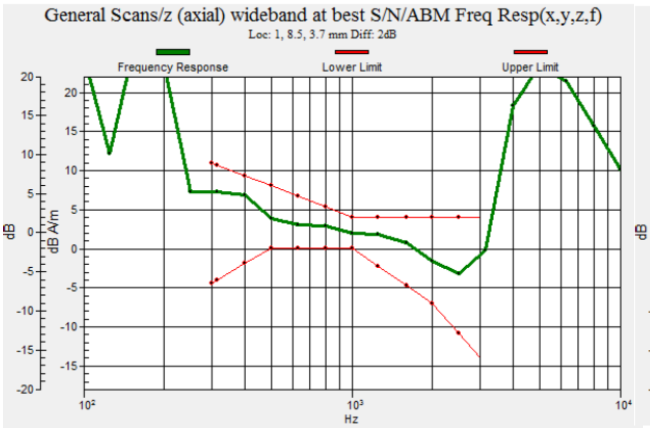


Fig 9.11 WCDMA Band II Ch9400

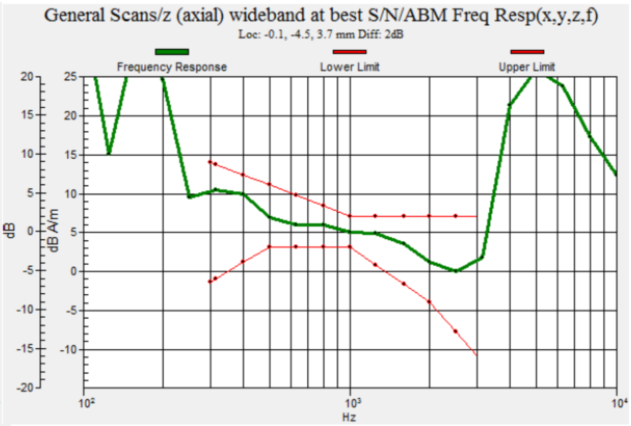


Fig 9.12 WCDMA Band II Ch9538

9.4 T-Coil Coupling Field Intensity

9.4.1 Axial Field Intensity

Cell Phone Mode	Minimum limit (dB A/m)	Result (dB A/m)	Verdict
GSM850	-18	7.39	Pass
GSM1900	-18	10.41	Pass
WCDMA V	-18	5.20	Pass
WCDMA II	-18	7.14	Pass

9.4.2 Radial Field Intensity

Cell Phone Mode	Minimum limit (dB A/m)	Result (dB A/m)	Verdict
GSM850	-18	2.87	Pass
GSM1900	-18	1.55	Pass
WCDMA V	-18	0.55	Pass
WCDMA II	-18	0.39	Pass

9.4.3 Frequency Response at Axial Measurement Point

Cell Phone Mode	Verdict
GSM850	Pass
GSM1900	Pass
WCDMA V	Pass
WCDMA II	Pass

9.4.4 Signal Quality

Cell Phone Mode	Minimum limit (dB)				Minimum Result (dB)	Verdict
	T1	T2	T3	T4		
GSM850	0	10	20	>30	**22.11**	T3
GSM1900	0	10	20	>30	**24.31**	T3
WCDMA V	0	10	20	>30	**24.59**	T3
WCDMA II	0	10	20	>30	**25.21**	T3

10. Uncertainty Assessment

The component of uncertainly may generally be categorized according to the methods used to evaluate them. 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.

A Type A evaluation of standard uncertainty may be based on any valid statistical method for treating data. This includes calculating the standard deviation of the mean of a series of independent observations; using the method of least squares to fit a curve to the data in order to estimate the parameter of the curve and their standard deviations; or carrying out an analysis of variance in order to identify and quantify random effects in certain kinds of measurement.

A type B evaluation of standard uncertainty is typically based on scientific judgment using all of the relevant information available. These may include previous measurement data, experience and knowledge of the behavior and properties of relevant materials and instruments, manufacture's specification, data provided in calibration reports and uncertainties assigned to reference data taken from handbooks. Broadly speaking, the uncertainty is either obtained from an outdoor source or obtained from an assumed distribution, such as the normal distribution, rectangular or triangular distributions indicated in Table 10.1.

Uncertainty Distributions	Normal	Rectangular	Triangular	U-shape
Multiplying factor[(a)]	1/k [(b)]	1/√3	1/√6	1/√2

(a) standard uncertainty is determined as the product of the multiplying factor and the estimated range of variations in the measured quantity

(b) κ is the coverage factor

Table 10.1 Multiplying Factions for Various Distributions

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. Typically, the coverage factor ranges from 2 to 3. Using a coverage factor allows the true value of a measured quantity to be specified with a defined probability within the specified uncertainty range. 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 10.2.

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 %
DUT 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 10.2 Uncertainty Budget of DASY

11. References

[1] ANSI C63.19 2007, “American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids”, 8 June 2007

[2] SPEAG DASY System Handbook

Appendix A. Plots of T-Coil Measurement

The plots are shown as follows.

Appendix B. Calibration Data

The DASY calibration certificates are shown as follows.