ANSI C63.19-2007

Hearing Aid Compatibility (HAC) T-Coil Test Report

For

PDA

Model: TNJ32

Trade Name: Trimble

Issued to

Trimble Navigation Ltd.
935 Stewart Drive, Sunnyvale, CA 94088-3642 U.S.A

Issued by

Compliance Certification Services Inc
No. 11, Wugong 6th Rd., Wugu Industrial Par
Taipei Hsien, 248 Taiwan.
http://www. ccsrf.com
service@ccsrf.com

Testing Laboratory
1309

Issued Date: January 16, 2012

Revision History

Rev.		Issue Date		Revisions	Effect Page	Revised By
00		January 16, 2012		Initial Issue	ALL	Peach Chang

Table of Contents

1. Statement of Compliance

Applicant: Trimble Navigation Ltd.
935 Stewart Drive, Sunnyvale, CA 94088-3642 U.S.A

Equipment Under Test: PDA

Trade Name: Trimble

Model Number: TNJ32

Date of Test: January 12~13, 2012

APPLICABLE STANDARDS	
STANDARD	**TEST RESULT**
ANSI C63.19-2007 (8 June, 2007)	No non-compliance noted
T-Coil RATE CATEGORY	
T3	

The device was tested by Compliance Certification Services Inc. in accordance with the measurement methods and procedures specified in ANSI C63.19-2007. The test results in this report apply only to the tested sample of the stated device/equipment. Other similar device/equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Reviewed by:

Jason Lin

Jason Lin
Section Manager
Compliance Certification Services Inc.

Tested by

Anson Lu

Anson Lu
Test Engineer
Compliance Certification Services Inc

2. General Information

2.1 Description of Device Under Test (DUT)

Product	PDA
Model Number	TNJ32
Trade Name	Trimble
Model Discrepancy	N/A
Frequency Range	GSM850 : 824 MHz ~ 849 MHz GSM1900 : 1850 MHz ~ 1910 MHz WCDMA Band V : 824 MHz ~ 849 MHz WCDMA Band II : 1850 MHz ~ 1910 MHz WCDMA Band IV: 1712.4 ~ 1752.6 MHz
Transmit Power(Average)	850 Band: GSM 850: 32.82 dBm WCDMA band V: 23.71 dBm 1900 Band: GSM 1900: 28.42 dBm WCDMA band II: 23.63 dBm WCDMA band IV: 24.34 dBm
Signal Quality (S+N)/N in dB	GSM 850 : 21.24 dB / **T3** GSM 1900 : 29.19 dB / **T3** WCDMA Band II : 43.13 dB / **T4** WCDMA Band IV: 44.12 dB / **T4** WCDMA Band V : 44.22 dB / **T4**
Modulation Technique	GSM / PCS: GMSK WCDMA: QPSK
Antenna Specification	WWAN antenna: PIFA antenna
Battery	Model: 707-00008-00A, Rating: 3.7VDC, 3060mAh, 11.32Wh

2.2 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.

2.3 Test Conditions

2.3.1 Ambient Condition

Ambient Temperature (^{o}C)	20-24℃
Humidity (%)	<60 ％
Acoustic Ambient Noise	>10dB below the measurement level

2.3.2 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.

3. Hearing Aid Compliance (HAC)

3.1 Introduction

In Aug.1 2007, the T-Coil requirements of ANSI C63.19-2007 Standard went into effect. The federal communication commission (FCC) adopted ANSI C63.19 as HAC test standard.

4. HAC T-Coil Measurement Setup

4.1 System Configuration

Figure 4.1: T-Coil setup with HAC Test Arch and AMCC

The DASY5 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
- DASY5 software
- Remove control with teach pendant and additional circuitry for robot safety such as warming lamps, etc.
- The SAM twin phantom
- A device holder
- Dipole for evaluating the proper functioning of the system
- Arch Phantom

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

4.2 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

4.2.1 Probe Tip Description

HAC field measurements take place in the close near field with high gradients. Increasing the measuring distance from the source will generally decrease the measured field values (in case of the validation dipole approx. 10％per mm).

Magnetic field sensors are measuring the integral of the H-field across their sensor area surrounded by the loop. They are calibrated in a precise, homogeneous field. When measuring a gradient field, the result will be very close to the field in the center of the loop which is equivalent to the value of a homogeneous field equivalent to the center value. But it will be different from the field at the field at the border of the loop.

Consequently, two sensors with different loop diameters – both calibrated ideally – would give different results when measuring from the edge of the probe sensor elements. The behavior for electrically small E-field sensors is equivalent. See below for distance plots from a WD which show the conservative nature of field readings at the probe element center vs. measurements at the sensor end.

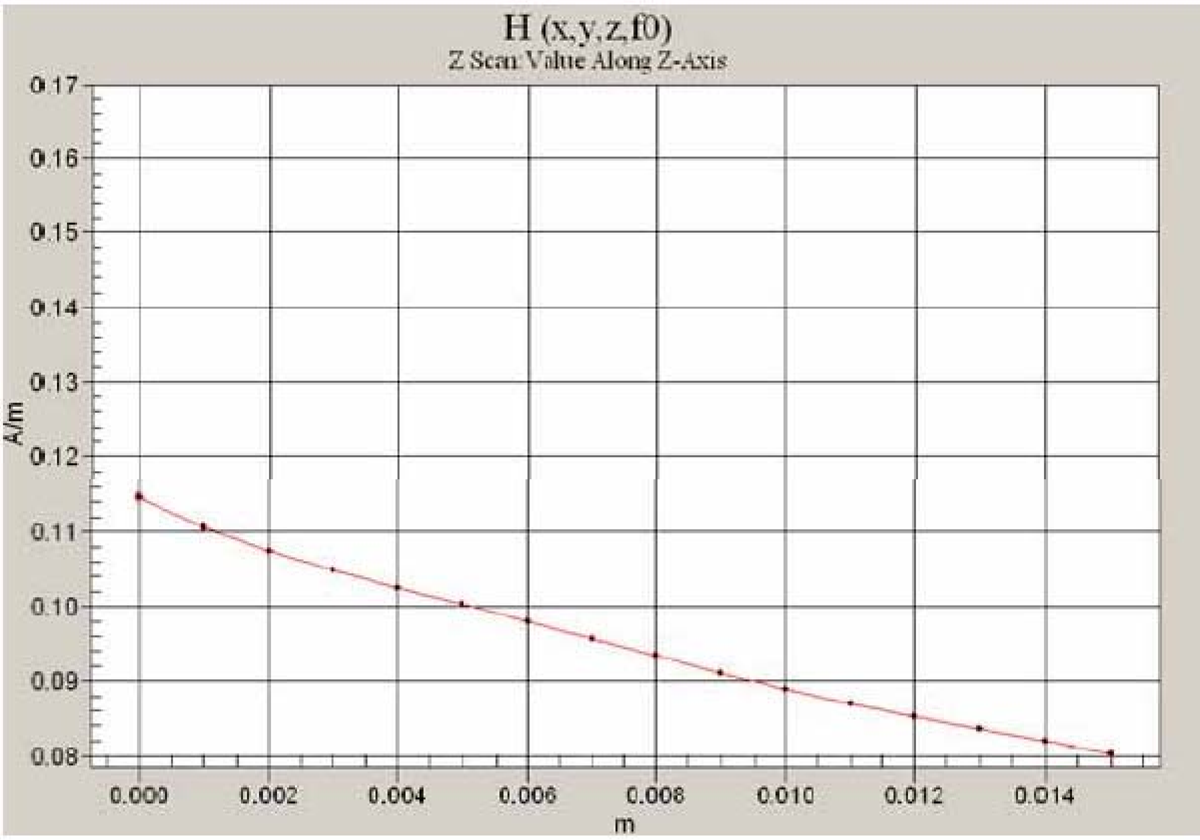
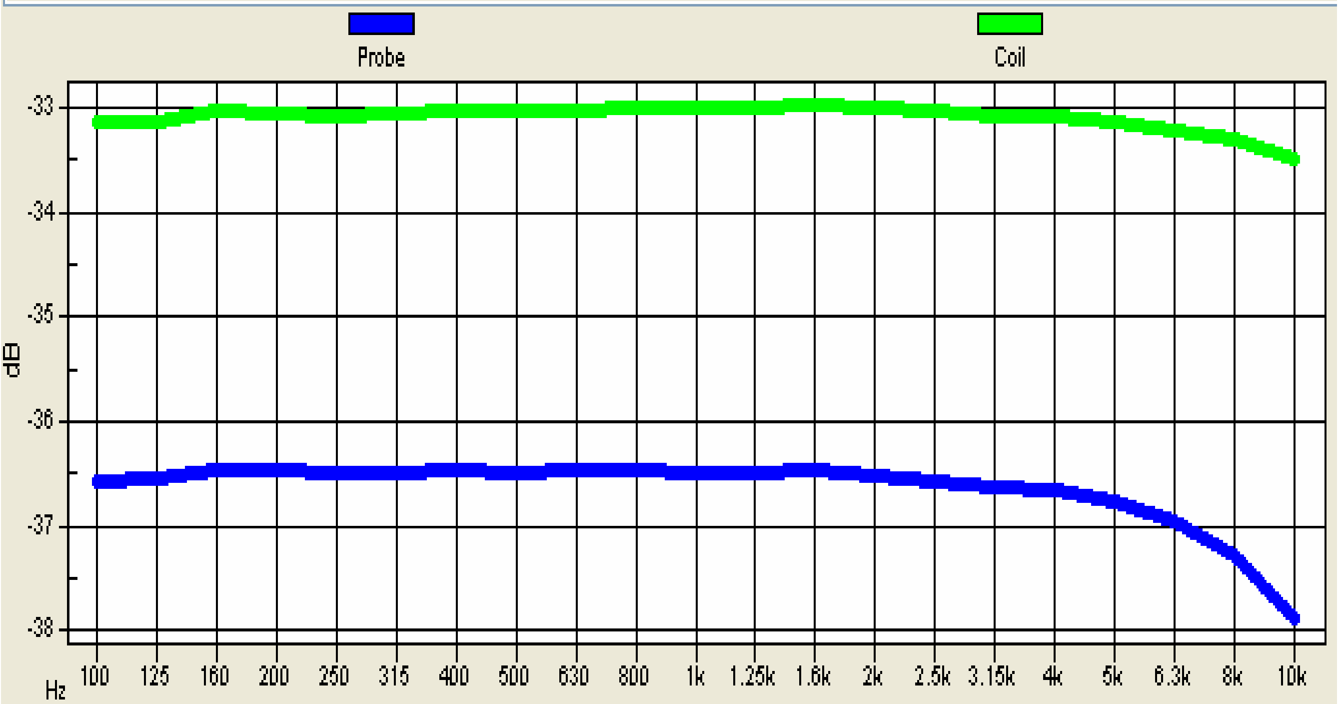


Figure 4.2: Z-Axis Scan at maximum point above a typical wireless device for H-field

4.2.2 Probe Calibration in AMCC

The probe sensitivity at 1 kHz is 0.0659911V/(A/m) (-24.0dBV/(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 Figure 5.3. 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 factor	2.36907 V	1.17005 V	
Probe sensitivity at 1 kHz		0.0659911 V/(A/m)	



Hz	100	125	160	200	250	315	400	500	630	800
Probe	-36.575	-36.552	-36.456	-36.460	-36.500	-36.488	-36.475	-36.477	-36.475	-36.459
Coil	-33.146	-33.139	-33.028	-33.069	-33.080	-33.064	-33.036	-33.037	-33.025	-33.000

Hz	1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k	6.3k	8k	10k
Probe	-36.476	-36.477	-36.474	-36.514	-36.564	-36.624	-36.661	-36.752	-36.945	-37.271	-37.866
Coil	-33.009	-33.003	-32.987	-33.012	-33.043	-33.077	-33.080	-33.127	-33.218	-33.304	-33.483

Figure 4.3: The frequency response and sensitivity of AM1D probe

4.3 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

4.4 AMMI

Figure 4.4: 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

4.5 DATA Acquisition Electronics (DAE)

The data acquisition electronics (DAE4) 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 mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection.

The input impedance of the DAE4 is 200M Ohm; the inputs are symmetrical and floating. Common mode rejection is above 80dB. 4

4.6 Robot

The DASY5 system uses the high precision robots TX60L type out of the newer series from Stäubli SA (France). For the 6-axis controller DASY5 system. The robot series have many features that are important for our application:

¾ High precision (repeatability 0.02 mm)
¾ High reliability (industrial design)
¾ Jerk-free straight movements
¾ Low ELF interference (the closed metallic construction shields against motor control fields)
¾ 6-axis controller

4.7 Measurement Server

The DASY5 measurement server is based on a PC/104 CPU board with

166 MHz CPU
32 MB chipset and
64 MB RAM.

Communication with
the DAE4 electronic box
the 16-bit AD-converter system for optical detection and digital I/O interface.

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

4.8 Phone Positioner

The phone positioner shown in Figure 4.5 is used to adjust DUT to the suitable position.

Figure 4.5: Phone Positioner

4.8.1 Test Arch Phantom

Construction	Enables easy and well defined positioning of the phone and validation dipoles as well as simple teaching of the robot.
Dimensions	370 x 370 x 370 mm

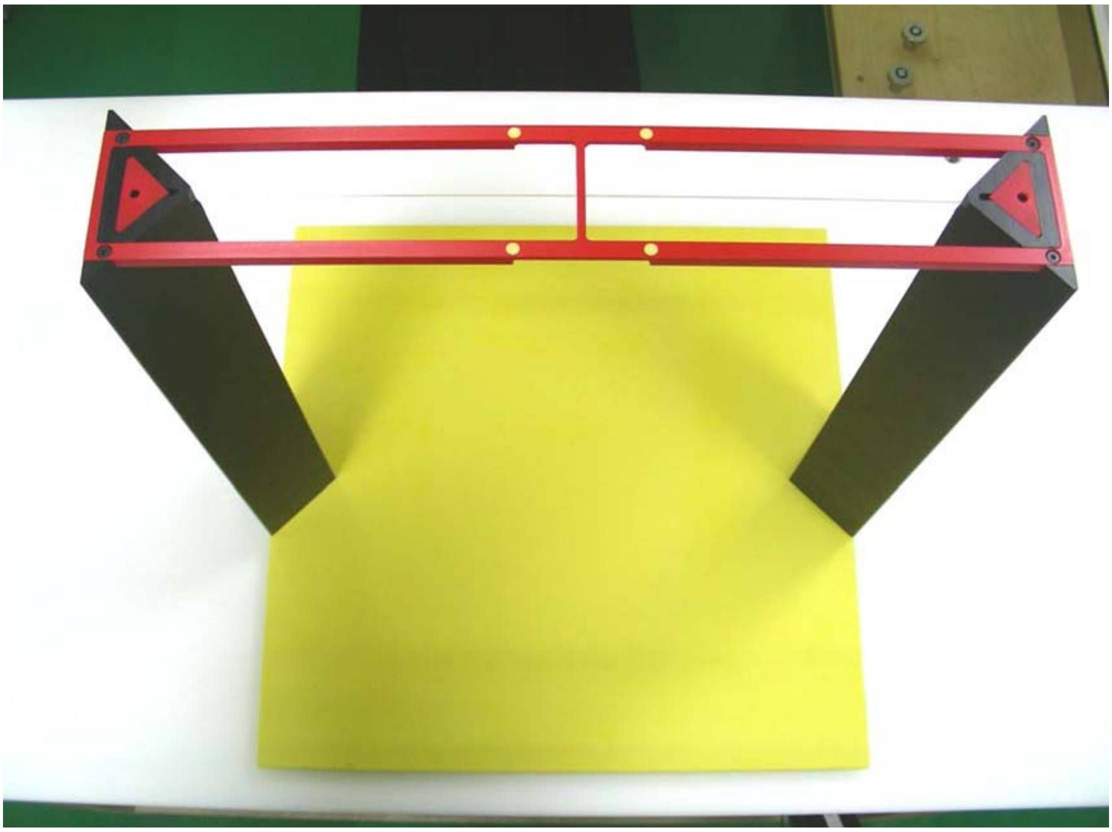


Figure 4.6: Test Arch Phantom

4.9 *Cabling of System*

The principal cabling of the T-Coil setup is shown in Figure 4.6. All cables provided with the basic setup have a length of approximately 5 m.

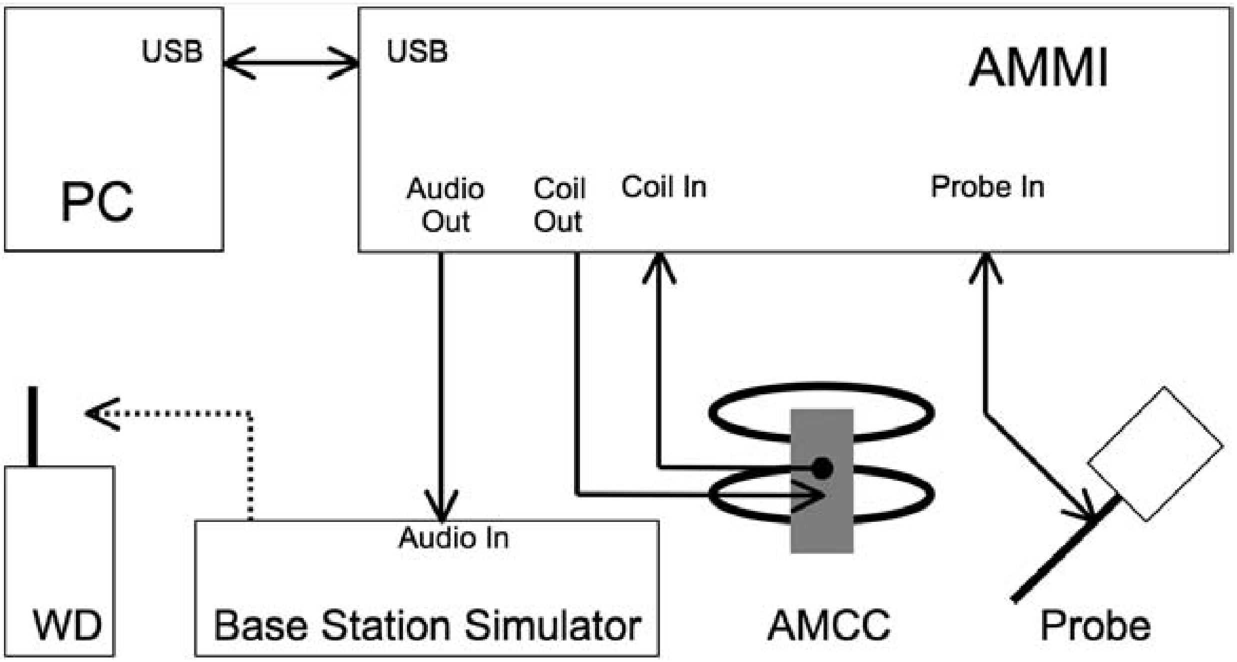


Figure 4.7: T-Coil setup cabling

4.10 HAC Extension Software for DASY5

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

4.11 Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	Audio Magnetic 1D Field Probe	AM1DV2	1080	2011/04/18	2012/04/17
SPEAG	Audio Magnetic Calibration Coil	AMCC	1077	NCR	NCR
SPEAG	Audio Measuring Instrument	AMMI	1077	NCR	NCR
SPEAG	835MHz Calibration Dipole	CD835V3	1031	2011/12/06	2012/12/05
SPEAG	1880MHz Calibration Dipole	CD1880V3	1024	2011/12/06	2012/12/05
SPEAG	Data Acquisition Electronics	DAE4	877	2011/03/18	2012/03/17
SPEAG	Test Arch Phantom	N/A	N/A	NCR	NCR
SPEAG	Phone Positoiner	N/A	N/A	NCR	NCR
R&S	Radio Communication Test	CMU200	116604	2011/11/20	2012/11/19

Table 4.1 Test Equipment List

4.12 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. 4.8 and Fig. 4.9. 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.

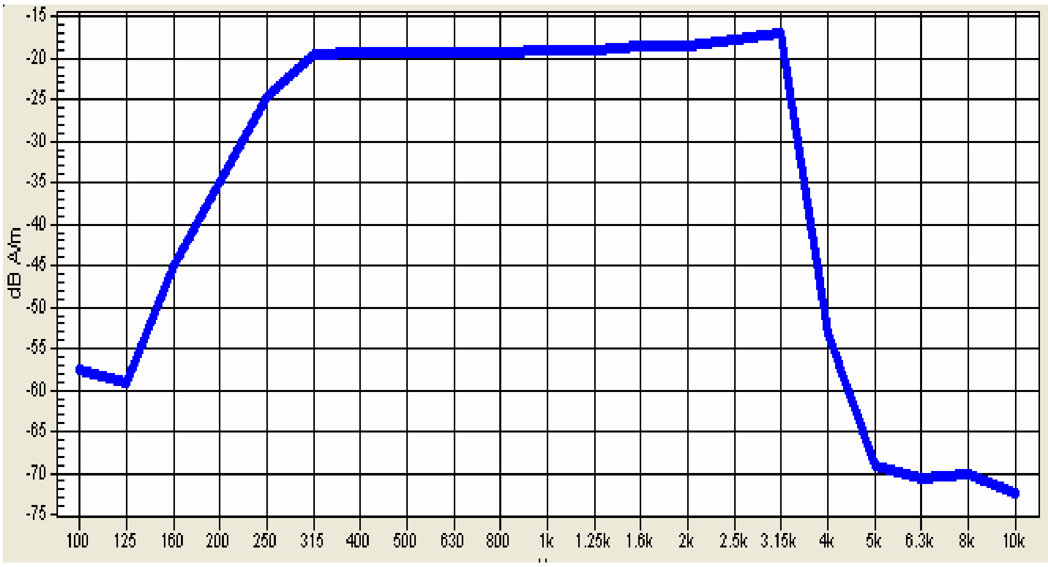


Figure 4.8: Audio signal spectrum of the broadband signal (48kHz_voice_300Hz~3 kHz)

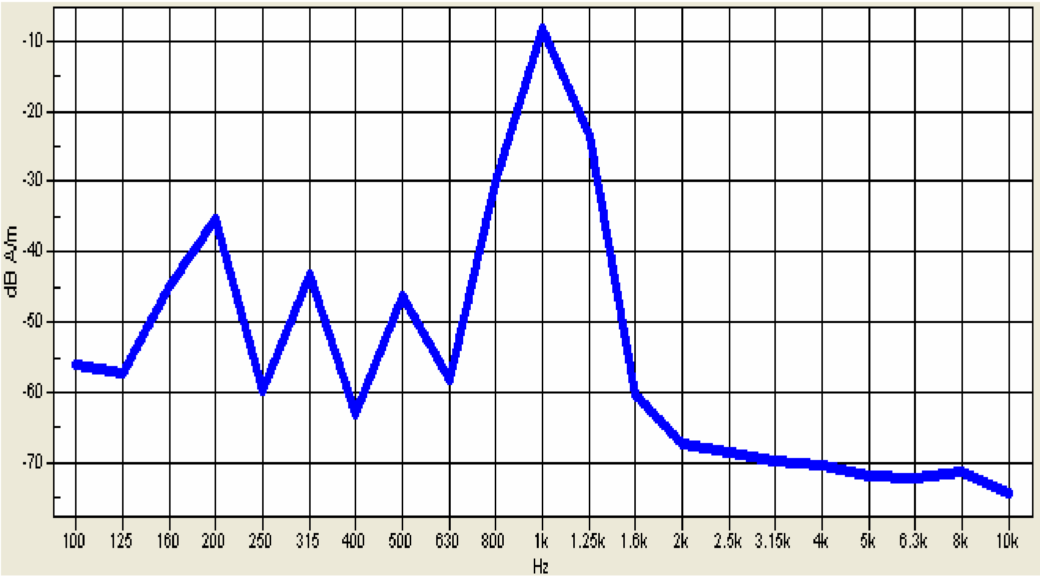


Figure 4.9: Audio signal spectrum of the narrowband signal (48kHz_voice_1kHz)

4.13 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 1kHz 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 -16dBm0:

3.14 dBm0 = -2.39 dBV
-16 dBm0 = -21.53 dBV

Determine the 1 kHz input level to generate the desired signal level of -18 dBm0. Select CMU200 Network Bitstream "Codec Cal" to loop the input via the codec to the output. Run the measurement job (AMMI 1kHz 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 = -20.81 dBV
Difference for -16 dBm0 = -21.53 - (-20.81) = -0.72 dB
Gain factor = 10 ^ ((-0.72) / 20) = 0.92
Resulting Gain = 10 x 0.92 = 9.2

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	39.8555
300Hz ~ 3kHz	2	21.6	-18.6	8.48	78.0541

5. Description for DUT Testing Position

Figure 5.1 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.

- The grid is 5 cm by 5 cm area that is divided into 9 evenly sized blocks or sub-grids.
- The grid is centered on the audio frequency output transducer of the DUT.
- The grid 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 1.0 cm in front of, the reference plane.

Figure 5.1: A typical DUT reference and plane for HAC measurements

6. 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 4.2 mm spacing).
   Only ABM1 was measured in order to find the location of T-Coil source.

   (2) Fine resolution scans (1 kHz signal at 8 x 8 mm grid area with 2 mm spacing for Axial, 42 x 6 mm grid area with 3 mm spacing for Longitudinal, 6 x 42 mm grid area with 3 mm spacing for Transversal).
   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 DASY5 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.

7. T-Coil Articulation Weighting Factor and Signal Quality Categories

7.1 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 7.1. 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 decibels]
Category T1	0 dB to 10 dB
Category T2	10 dB to 20 dB
Category T3	20 dB to 30 dB
Category T4	> 30 dB

Table 7.1: T-Coil signal quality categories

8. Summary of Measurement Result

8.1 Test Result

8.1.1 Conducted Power

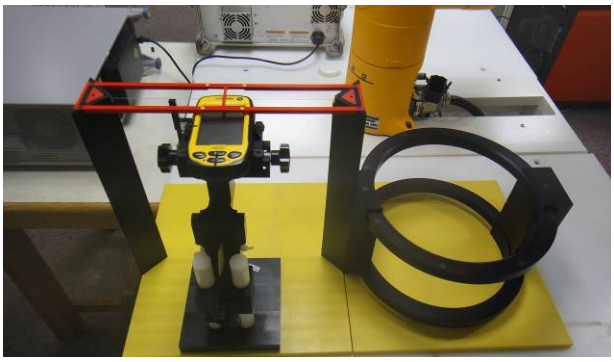
Band	GSM 850			GSM 1900		
Channel	128	189	251	512	661	810
GSM	32.71	32.82	32.72	28.80	28.42	28.40

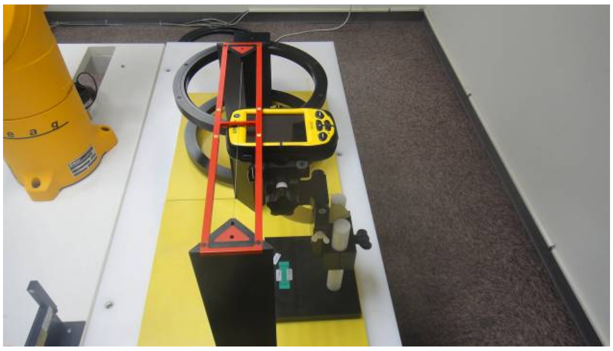
Band	WCDMA Band V			WCDMA Band II		
Channel	4132	4182	4233	9262	9400	9538
AMR	23.71	23.66	23.50	23.33	23.18	23.63

Band	WCDMA Band IV		
Channel	1312	1412	1513
AMR	24.16	24.25	24.34

※**Unit: dBm**

8.1.2 EUT Setup photo





8.1.3 Magnitude Result

The Table 8.1 & 8.2 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.

Band	Channel	Probe Position	Measurement Position (x mm, y mm)	Ambient Background Noise (dB A/m)	ABM2 (dB A/m)	ABM1 (dB A/m)	SNR (dB)	Category
GSM 850	190	Longitudinal(x)	(-25,-25)	-41.83	-25.32	-4.07	21.24	T3
		Transversal(y)	(-16.7,8.3)	-44.02	-32.91	7.35	40.26	
		Axial(z)	(-12.5,-12.5)	-53.28	-25.86	6.22	32.08	
PCS 1900	661	Longitudinal(x)	(-25,20.8)	-41.59	-31.77	-2.58	29.19	T3
		Transversal(y)	(-12.5,8.3)	-44.01	-34.60	9.70	44.30	
		Axial(z)	(-12.5,-12.5)	-53.16	-34.50	6.33	40.83	
WCDMA Band II	9400	Longitudinal(x)	(-12.5,20.8)	-40.58	-39.03	4.11	43.13	T4
		Transversal(y)	(-4.2,0)	-43.73	-37.23	10.39	47.61	
		Axial(z)	(-8.3,25)	-53.02	-39.47	8.86	48.34	
WCDMA Band IV	1413	Longitudinal(x)	(-12.5,16.7)	-41.38	-40.24	3.88	44.12	T4
		Transversal(y)	(-8.3,4.2)	-43.80	-36.86	11.19	48.05	
		Axial(z)	(-8.3,0)	-52.98	-40.79	7.86	48.65	
WCDMA Band V	4183	Longitudinal(x)	(-12.5,20.8)	-41.22	-40.34	3.88	44.22	T4
		Transversal(y)	(-4.2,12.5)	-43.69	-38.20	9.93	48.12	
		Axial(z)	(-8.3,0)	-52.86	-40.73	7.94	48.67	

Table 8.1: Test Result for Various Positions

Remark: The HAC mode of DUT is turn on and LCD backlight, Bluetooth and WLAN functions are turn off, and volume is adjusted to maximum level during T-Coil testing.

8.1.4 Frequency Response

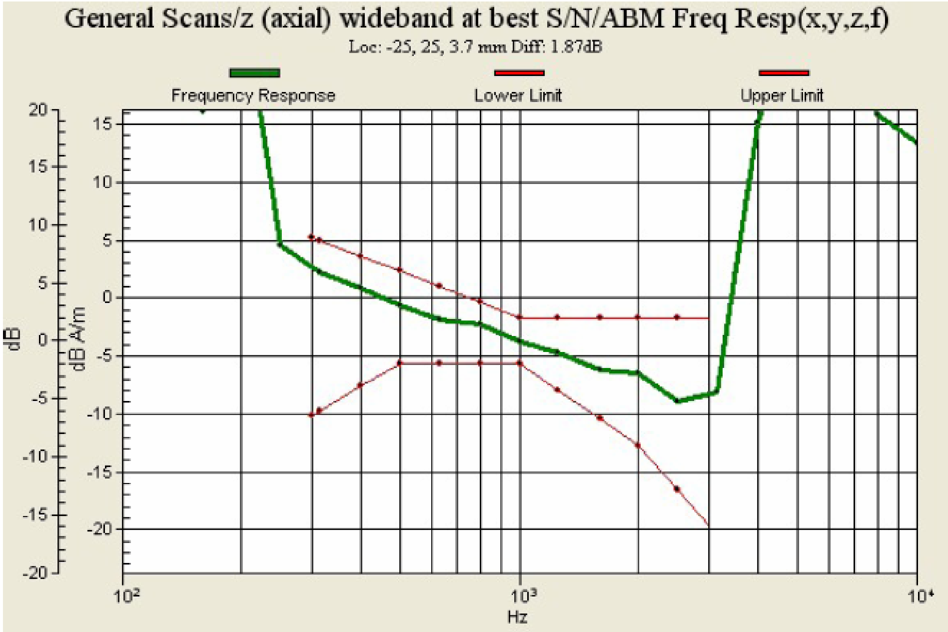


Figure 8.1: Frequency Response of GSM850 for Ch190

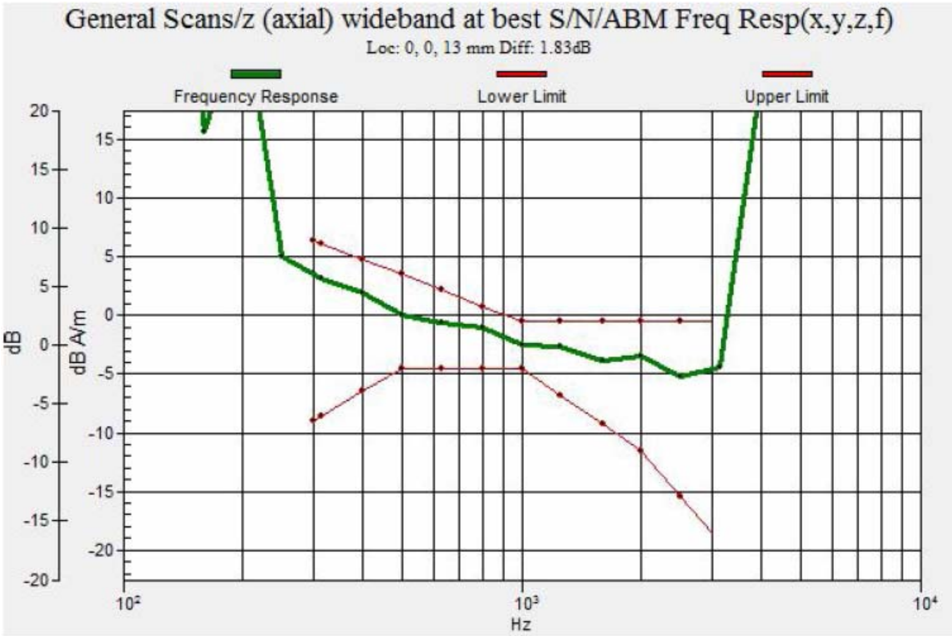


Figure 8.2: Frequency Response of GSM1900 for Ch661

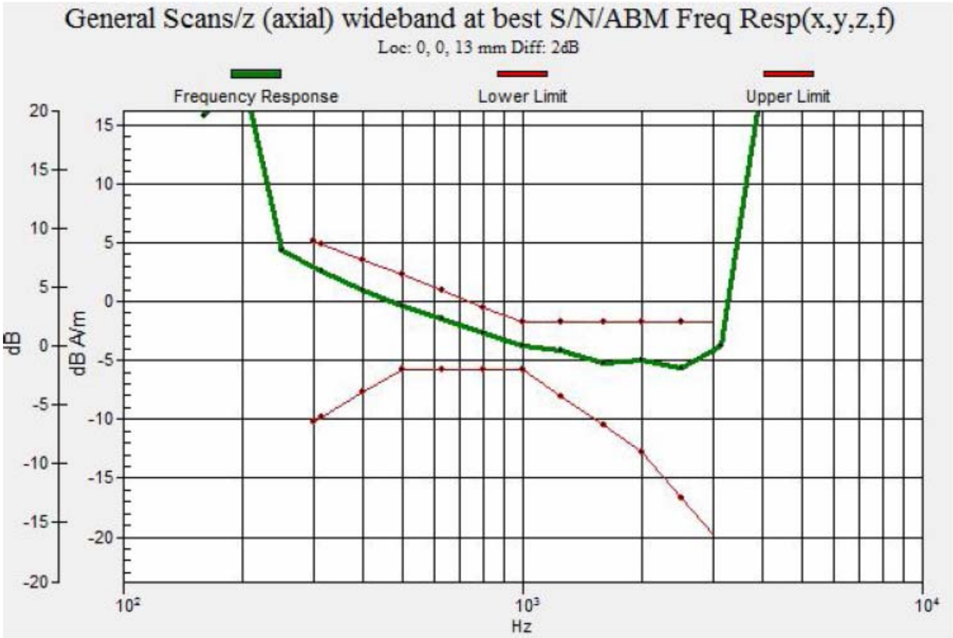


Figure 8.3: Frequency Response of WCDMA Band II for Ch9400

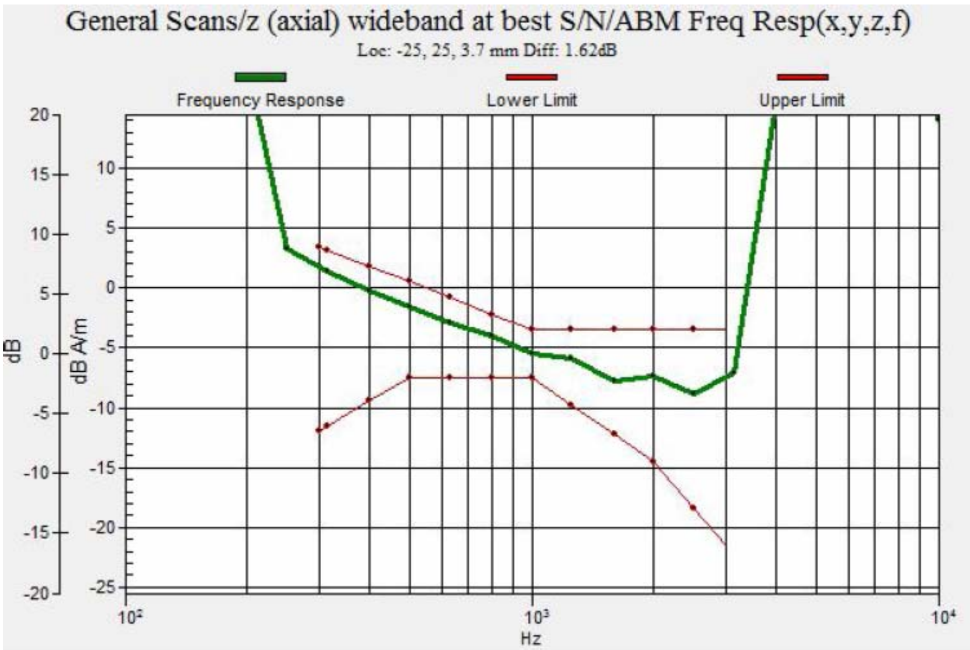


Figure 8.4: Frequency Response of WCDMA Band V for Ch4183

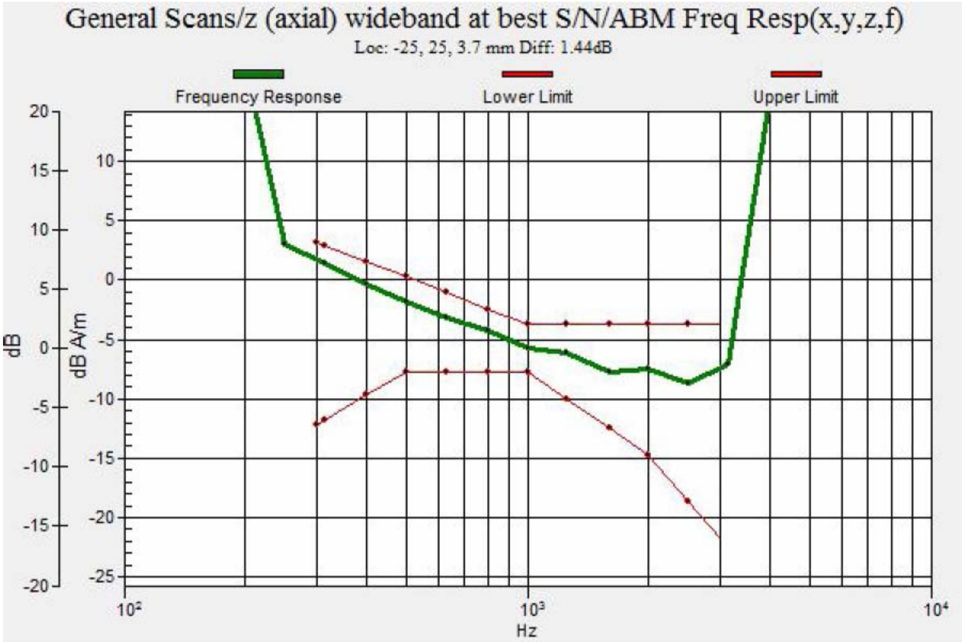


Figure 8.5: Frequency Response of WCDMA Band IV for Ch1413

:

9. 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 9.1

Uncertainty Distributions	Normal	Rectangular	Triangular	U-shape
Multiplying factor[(a)]	1/k [(b)]	1/√	1/√	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) K is the coverage factor

Table 9.1: Uncertainty classification

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 DASY5 uncertainty Budget is showed in Table 9.2.

Error Description	Uncertainty Value (± %)	Probability Distribution	Divisor	(Ci) ABM1	(Ci) ABM2	Std. Unc. ABM1	Std. Unc. 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	± 0.6%	Rectangular	√3	1	0.145	± 0.4%	± 0.4%
Probe Positioning during Calibration	± 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	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 Distribution	± 0.2%	Rectangular	√3	1	1	± 0.1%	± 0.1%
Test Signal							
Ref. 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 Uncertainty							
Combined Std. Uncertainty (ABM Field)						± 4.1%	± 6.1%
Expanded Std. Uncertainty						**± 8.1%**	**± 12.3%**

Table 9.2: Uncertainty of audio band magnetic measurements

10. References

[1] ANSI C63.19 2007, "American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids"
[2] DASY5 System Hand book.

11. Attachments

No.	Contents
1	T-coil Test Plots
2	Certificate of AM1DV2 Probe SN:1080
3	Certificate of System Validation Dipole CD835V3 SN:1149
4	Certificate of System Validation Dipole CD1880V3 SN:1135