# HAC T-Coil TEST REPORT

## No. I15Z43256-SEM05

**For**

**TCL Communication Ltd.**

**CDMA EVDO BC0/BC1/LTE 2 band Mobile phone**

**Model Name: A571VL**

**With**

**SW version: vCBVA**

**HW: PIO**

**FCC ID: 2ACCJB027**

**Results Summary: T Category = T4**

**Issued Date: 2016-1-27**

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TESTING
CNAS L0570

**Note:**

The test results in this test report relate only to the devices specified in this report. This report shall not be reproduced except in full without the written approval of CTTL.

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## REPORT HISTORY

| Report Number | Revision | Issue Date | Description |
|---|---|---|---|
| I15Z43256-SEM05 | Rev.0 | 2016-1-27 | Initial creation of test report |

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# TABLE OF CONTENT

**1 TEST LABORATORY ..... 4**

1.1 TESTING LOCATION ..... 4
1.2 TESTING ENVIRONMENT ..... 4
1.3 PROJECT DATA ..... 4
1.4 SIGNATURE ..... 4

**2 CLIENT INFORMATION ..... 5**

2.1 APPLICANT INFORMATION ..... 5
2.2 MANUFACTURER INFORMATION ..... 5

**3 EQUIPMENT UNDER TEST (EUT) AND ANCILLARY EQUIPMENT (AE) ..... 6**

3.1 ABOUT EUT ..... 6
3.2 INTERNAL IDENTIFICATION OF EUT USED DURING THE TEST ..... 6
3.3 INTERNAL IDENTIFICATION OF AE USED DURING THE TEST ..... 6
3.4 AIR INTERFACES / BANDS INDICATING OPERATING MODES ..... 6

**4 CONDUCTED OUTPUT POWER MEASUREMENT ..... 7**

4.1 SUMMARY ..... 7
4.2 CONDUCTED POWER ..... 7

**5. REFERENCE DOCUMENTS ..... 7**

5.1 REFERENCE DOCUMENTS FOR TESTING ..... 7

**6 OPERATIONAL CONDITIONS DURING TEST ..... 8**

6.1 HAC MEASUREMENT SET-UP ..... 8
6.2 AM1D PROBE ..... 9
6.3 AMCC ..... 10
6.4 AMMI ..... 10
6.5 TEST ARCH PHANTOM & PHONE POSITIONER ..... 10
6.6 ROBOTIC SYSTEM SPECIFICATIONS ..... 11
6.7 T-COIL MEASUREMENT POINTS AND REFERENCE PLANE ..... 11

**7 T-COIL TEST PROCEDUERES ..... 13**

**8 T-COIL PERFORMANCE REQUIREMENTS ..... 14**

8.1 T-COIL COUPLING FIELD INTENSITY ..... 14
8.2 FREQUENCY RESPONSE ..... 14

**9 HAC T-COIL TEST DATA SUMMARY ..... 15**

9.1 NOISE AMBIENT ..... 15
9.2 T-COIL COUPLING FIELD INTENSITY ..... 15
9.2.1 TRANSVERSE FIELD INTENSITY ..... 15
9.2.2 PERPENDICULAR FIELD INTENSITY ..... 15
9.3 FREQUENCY RESPONSE AT PERPENDICULAR MEASUREMENT POINT ..... 16
9.4 SIGNAL QUALITY ..... 16
9.5 TOTAL MEASUREMENT CONCLUSION ..... 17

**10 MEASUREMENT UNCERTAINTY ..... 18**

**11 MAIN TEST INSTRUMENTS ..... 19**

**ANNEX A TEST LAYOUT ..... 20**

**ANNEX B TEST PLOTS ..... 21**

**ANNEX C FREQUENCY REPONSE CURVES ..... 29**

**ANNEX D PROBE CALIBRATION CERTIFICATE ..... 30**

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# 1 Test Laboratory

## 1.1 Testing Location

| | |
|---|---|
| Company Name: | CTTL(Shouxiang) |
| Address: | No. 51 Shouxiang Science Building, Xueyuan Road, Haidian District, Beijing, P. R. China100191 |

## 1.2 Testing Environment

| | |
|---|---|
| Temperature: | 18°C~25 °C, |
| Relative humidity: | 30%~ 70% |
| Ground system resistance: | < 0.5 Ω |
| Ambient noise is checked and found very low and in compliance with requirement of standards. Reflection of surrounding objects is minimized and in compliance with requirement of standards | |

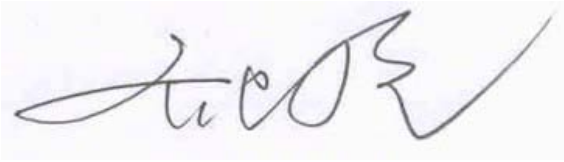
## 1.3 Project Data

| | |
|---|---|
| Project Leader: | Qi Dianyuan |
| Test Engineer: | Lin Hao |
| Testing Start Date: | January 1, 2016 |
| Testing End Date: | January 1, 2016 |

## 1.4 Signature

**Lin Hao**

**(Prepared this test report)**



**Qi Dianyuan**

**(Reviewed this test report)**

**Xiao Li**

**Deputy Director of the laboratory**

**(Approved this test report)**

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# 2 Client Information

## 2.1 Applicant Information

| | |
|---|---|
| Company Name: | TCL Communication Ltd. |
| Address /Post: | 5F, C building, No. 232, Liang Jing Road, ZhangJiang High-Tech Park, Pudong Area, Shanghai, P.R. China. 201203 |
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## 2.2 Manufacturer Information

| | |
|---|---|
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| Address /Post: | 5F, C building, No. 232, Liang Jing Road, ZhangJiang High-Tech Park, Pudong Area, Shanghai, P.R. China. 201203 |
| City: | Shanghai |
| Postal Code: | 201203 |
| Country: | P.R.China |
| Contact: | Gong Zhizhou |
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| Fax: | +86 21 61460602 |

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# 3 Equipment Under Test (EUT) and Ancillary Equipment (AE)

## 3.1 About EUT

| | |
|---|---|
| Description: | CDMA EVDO BC0/BC1/LTE 2 band Moblie phone |
| Model name: | A571VL |
| Operating mode(s): | CDMA BC 0/1, LTE Band 4/13, BT, Wi-Fi |

## 3.2 Internal Identification of EUT used during the test

| EUT ID* | IMEI | HW Version | SW Version |
|---|---|---|---|
| EUT1 | 354161070001286 | PIO | vCBVA |
| EUT2 | 354161070001351 | PIO | vCBVA |

*EUT ID: is used to identify the test sample in the lab internally.

**Note:** It is performed to test T-coil with the EUT1 and conducted power with the EUT2.

## 3.3 Internal Identification of AE used during the test

| AE ID* | Description | Model | SN | Manufacturer |
|---|---|---|---|---|
| AE1 | Battery | TLi017C1 | CAB1780002C1 | BYD |

*AE ID: is used to identify the test sample in the lab internally.

## 3.4 Air Interfaces / Bands Indicating Operating Modes

| **Air-interface** | **Band(MHz)** | **Type** | **C63.19/tested** | **Simultaneous Transmissions** | **OTT** | **Power Reduction** |
|---|---|---|---|---|---|---|
| CDMA | BC0 | VO | Yes | BT, WLAN | NA | NA |
| | BC1 | | | | | |
| LTE | Band 4/13 | DT | NA | BT, WLAN | NA | NA |
| BT | 2450 | DT | NA | CDMA, LTE | NA | NA |
| WLAN | 2450 | DT | NA | CDMA, LTE | NA | NA |

VO: Voice CMRS/PSTN Service Only

V/D: Voice CMRS/PSTN and Data Service

DT: Digital Transport

* HAC Rating was not based on concurrent voice and data modes, Non current mode was found to represent worst case rating for both M and T rating

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# 4 CONDUCTED OUTPUT POWER MEASUREMENT

## 4.1 Summary

During the process of testing, the EUT was controlled via Agilent Digital Radio Communication tester (E5515C) to ensure the maximum power transmission and proper modulation. This result contains conducted output power for the EUT. In all cases, the measured output power should be greater and within 5% than EMI measurement.

## 4.2 Conducted Power

| | | | |
|---|---|---|---|
| **CDMA BC0** | **Conducted Power (dBm)** | | |
| | **777 (848.31MHz)** | **384 (836.52MHz)** | **1013 (824.7MHz)** |
| | 23.50 | 23.55 | 23.65 |
| **CDMA BC1** | **Conducted Power (dBm)** | | |
| | **1175 (1908.75MHz)** | **600 (1880MHz)** | **25 (1851.25MHz)** |
| | 23.11 | 23.78 | 23.37 |

# 5. Reference Documents

## 5.1 Reference Documents for testing

The following document listed in this section is referred for testing.

| Reference | Title | Version |
|---|---|---|
| ANSI C63.19-2011 | American National Standard for Methods of Measurement of Compatibility between Wireless Communication Devices and Hearing Aids | 2011 Edition |

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# 6 OPERATIONAL CONDITIONS DURING TEST

## 6.1 HAC MEASUREMENT SET-UP

These measurements are performed using the DASY5 NEO automated dosimetric assessment system. It is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland. It consists of high precision robotics system (Stäubli), robot controller, Intel Core2 computer, near-field probe, probe alignment sensor. The robot is a six-axis industrial robot performing precise movements. A cell controller system contains the power supply, robot controller, teach pendant (Joystick), and remote control, is used to drive the robot motors. The PC consists of the HP Intel Core2 1.86 GHz computer with Windows XP system and HAC Measurement Software DASY5 NEO, A/D interface card, monitor, mouse, and keyboard. The Stäubli Robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the PC plug-in card.

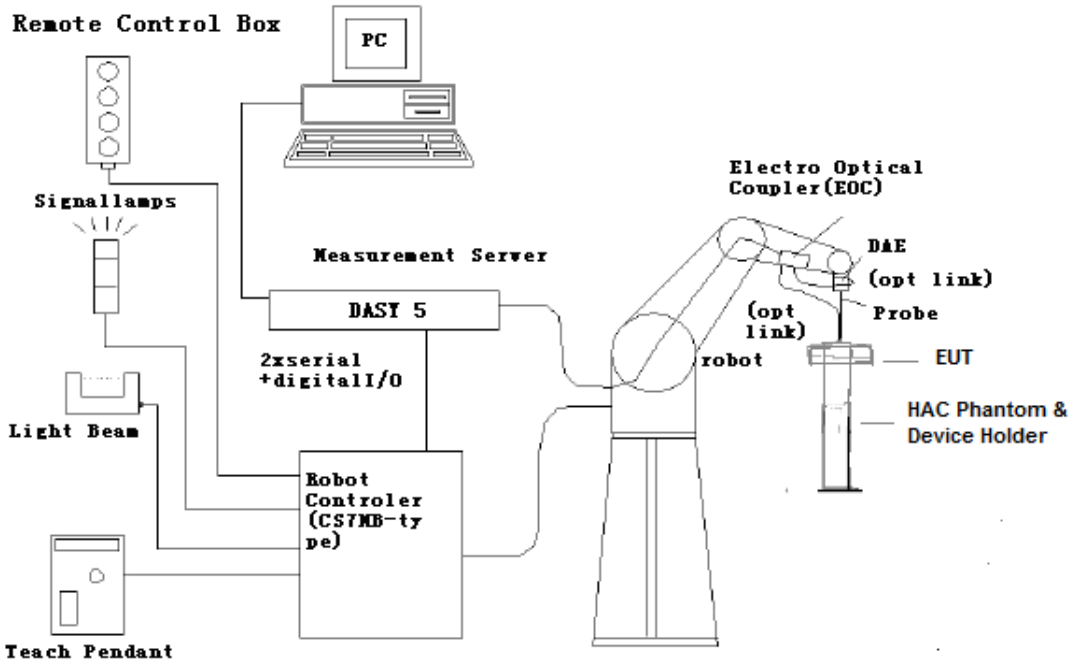


**Figure 6.1 HAC Test Measurement Set-up**

The 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 PC-card is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer.

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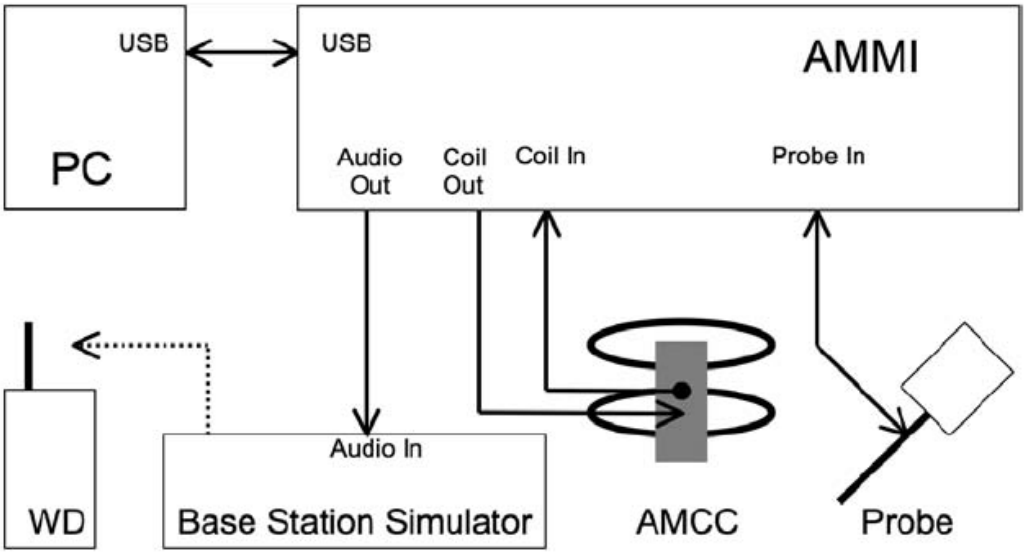


**Figure 6.2 T-Coil setup with HAC Test Arch and AMCC**

## 6.2 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

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vertical when the signal connector is at the underside of the probe (cable hanging downwards).
Specification:

| | |
|---|---|
| **Frequency range** | 0.1~20kHz (RF sensitivity < -100dB, fully RF shielded) |
| **Sensitivity** | < -50dB A/m @ 1kHz |
| **Pre-amplifier** | 40dB, symmetric |
| **Dimensions** | Tip diameter/length: 6/290mm, sensor according to ANSI-C63.19 |

## 6.3 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 10Ohm permits monitoring the current with a scale of 1:10

Port description:

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

Specification:

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

## 6.4 AMMI

**Figure 6.3 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 |

## 6.5 Test Arch Phantom & Phone Positioner

The Test Arch phantom should be positioned horizontally on a stable surface. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot. It 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

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370 mm).

The Phone Positioner supports accurate and reliable positioning of any phone with effect on near field <±0.5 dB.

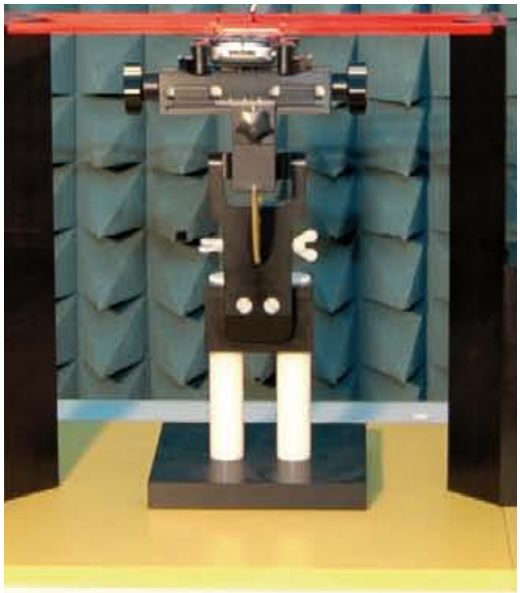

**Figure 6.4 HAC Phantom & Device Holder**

## 6.6 Robotic System Specifications

### Specifications

**Positioner:** Stäubli Unimation Corp. Robot Model: RX160L
**Repeatability:** ±0.02 mm
**No. of Axis:** 6

### Data Acquisition Electronic (DAE) System

**Cell Controller**
**Processor:** Intel Core2
**Clock Speed:** 1.86 GHz
**Operating System:** Windows XP
**Data Converter**
**Features:**Signal Amplifier, multiplexer, A/D converter, and control logic
**Software:** DASY5 software
**Connecting Lines:** Optical downlink for data and status info.
Optical uplink for commands and clock

## 6.7 T-Coil measurement points and reference plane

Figure 6.5 illustrates the standard probe orientations. Position 1 is the perpendicular orientation of the probe coil; orientation 2 is the transverse orientations. The space between the measurement positions is not fixed. It is recommended that a scan of the WD be done for each probe coil orientation and that the maximum level recorded be used as the reading for that orientation of the probe coil.

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1) The reference plane is 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 WD handset, which, in normal handset use, rest against the ear.
2) The measurement plane is parallel to, and 10 mm in front of, the reference plane.
3) The reference axis is normal to the reference plane and passes through the center of the receiver speaker section (or the center of the hole array); or may be centered on a secondary inductive source. The actual location of the measurement point shall be noted in the test report as the measurement reference point.
4) The measurement points may be located where the axial and radial field intensity measurements are optimum with regard to the requirements. However, the measurement points should be near the acoustic output of the WD and shall be located in the same half of the phone as the WD receiver. In a WD handset with a centered receiver and a circularly symmetrical magnetic field, the measurement axis and the reference axis would coincide.
5) The relative spacing of each measurement orientation is not fixed. The axial and two radial orientations should be chosen to select the optimal position.
6) The measurement point for the axial position is located 10 mm from the reference plane on the measurement axis. The actual location of the measurement point shall be noted in test reports and designated as the measurement reference point.

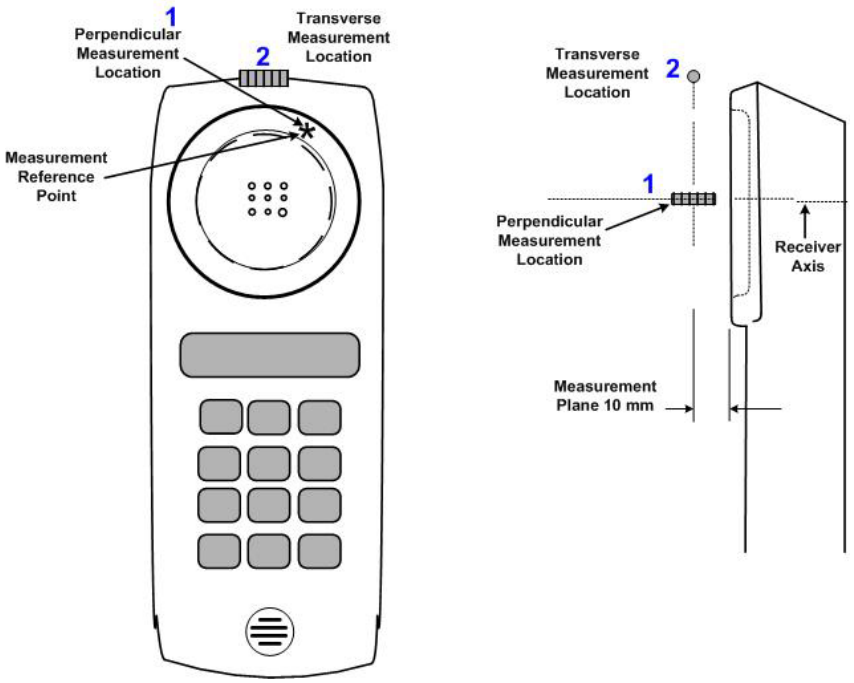


**Figure 6.5 Axis and planes for WD audio frequency magnetic field measurements**

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# 7 T-Coil TEST PROCEDUERES

**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 7.4.2.1.

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.

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 7.4.4.2. 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.

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 there samples.

9) At an optimal point measurement, the SNR (ABM1/ABM2) was calculated for perpendicular and transverse orientation, and the frequency response was measured for perpendicular.

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.

11) In SEMCAD postprocessing, 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.

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# 8 T-Coil PERFORMANCE REQUIREMENTS

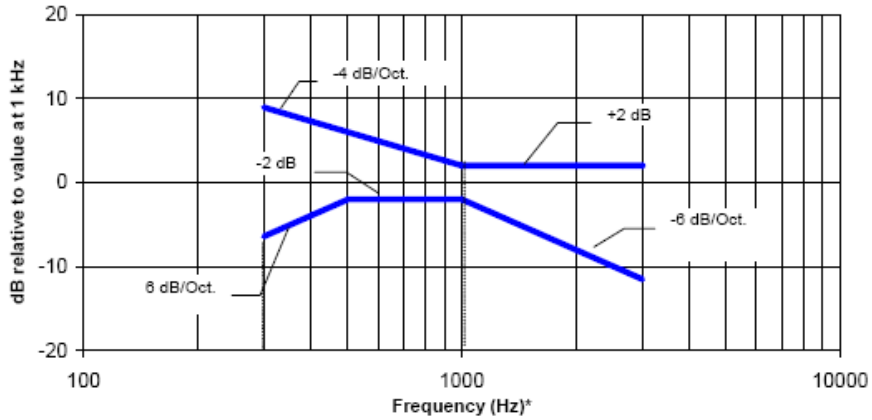
In order to be rated for T-Coil use, a WD shall meet the requirements for signal level and signal quality contained in this part.

## 8.1 T-Coil coupling field intensity

When measured as specified in ANSI C63.19, the T-Coil signal shall be ≥ –18 dB (A/m) at 1 kHz, in a 1/3 octave band filter for all orientations.

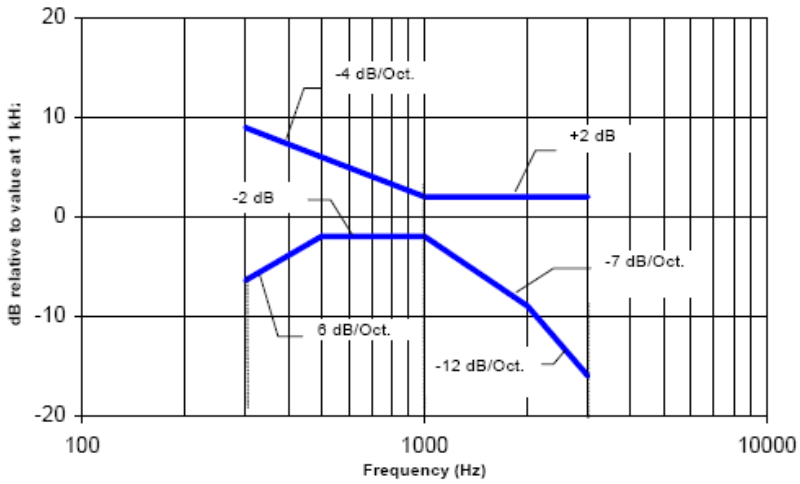
## 8.2 Frequency response

The frequency response of the axial 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 7.1 and Figure 7.2 provide the boundaries for the specified 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—Frequency response is between 300 Hz and 3000 Hz.

**Figure 8.1—Magnetic field frequency response for WDs with a field ≤ –15 dB (A/m) at 1 kHz**




NOTE—Frequency response is between 300 Hz and 3000 Hz.

**Figure 8.2—Magnetic field frequency response for WDs with a field that exceeds –15 dB(A/m) at 1 kHz**

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### 8.3 Signal quality

This part 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. So, the only criteria that can be measured is the RF immunity in T-Coil mode. This is measured using the same procedure as for the audio coupling mode and at the same levels.

The worst signal quality of the three T-Coil signal measurements shall be used to determine the T-Coil mode category per Table 1

**Table 1: T-Coil signal quality categories**

| Category | Telephone parameters<br>WD signal quality<br>[(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 |

## 9 HAC T-Coil TEST DATA SUMMARY

### 9.1 Noise ambient

| Probe Position | ABM2 (dB A/m) |
|---|---|
| **Transverse** | -59.99 |
| **Perpendicular** | -60.16 |

### 9.2 T-Coil Coupling Field Intensity

#### 9.2.1 Transverse Field Intensity

| Cell Phone Mode | Minimum limit (dB A/m) | Result (dB A/m) | Verdict |
|---|---|---|---|
| **CDMA BC0** | -18 | 2.90 | **Pass** |
| **CDMA BC1** | -18 | 4.10 | **Pass** |

#### 9.2.2 Perpendicular Field Intensity

| Cell Phone Mode | Minimum limit (dB A/m) | Result (dB A/m) | Verdict |
|---|---|---|---|
| **CDMA BC0** | -18 | 4.21 | **Pass** |
| **CDMA BC1** | -18 | 4.50 | **Pass** |

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## 9.3 Frequency Response at Perpendicular Measurement Point

| Cell Phone Mode | Channel | Frequency Response Curve | Verdict |
|---|---|---|---|
| **CDMA BC0** | 384 | Figure C.1 | **Pass** |
| **CDMA BC1** | 600 | Figure C.2 | **Pass** |

## 9.4 Signal Quality

| Probe Position | Band | Ch. | Measurement Position (x mm, y mm) | ABM1 (dB A/m) | SNR (dB) | T category |
|---|---|---|---|---|---|---|
| **Transverse** | **CDMA BC0** | 384 | 11.3，-13.3 | 2.90 | 47.94 | T4 |
| | **CDMA BC1** | 600 | 8.3，-12.5 | 4.10 | 49.74 | T4 |
| **Perpendicular** | **CDMA BC0** | 384 | 7.5，-7.9 | 4.21 | 49.12 | T4 |
| | **CDMA BC1** | 600 | 7.9，-7.9 | 4.50 | 49.24 | T4 |

Note:

1. Bluetooth and WiFi function is turn off and microphone is muted.
2. Signal strength measurement scan plots are presented in Annex B.

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## 9.5 Total Measurement Conclusion

| Probe Position | Frequency Band(MHz) | Channel | ABM1 | Frequency Response | T Category |
|---|---|---|---|---|---|
| **Transverse** | **CDMA BC0** | 384 | Pass | / | T4 |
| | **CDMA BC1** | 600 | Pass | | T4 |
| **Perpendicular** | **CDMA BC0** | 384 | Pass | Pass | T4 |
| | **CDMA BC1** | 600 | Pass | Pass | T4 |

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# 10 MEASUREMENT UNCERTAINTY

| No. | Error source | Type | Uncertainty Value $a_i$ (%) | Prob. Dist. | Div. | ABM1 ci | ABM2 ci | Std. Unc. ABM1 $u_i'$ (%) | Std. Unc. ABM2 $u_i'$ (%) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | System Repeatability | A | 0.016 | N | 1 | 1 | 1 | 0.016 | 0.016 |
| **Probe Sensitivity** | | | | | | | | | |
| 2 | Reference Level | B | 3.0 | R | $\sqrt{3}$ | 1 | 1 | 3.0 | 3.0 |
| 3 | AMCC Geometry | B | 0.4 | R | $\sqrt{3}$ | 1 | 1 | 0.2 | 0.2 |
| 4 | AMCC Current | B | 0.6 | R | $\sqrt{3}$ | 1 | 1 | 0.4 | 0.4 |
| 5 | Probe Positioning during Calibration | B | 0.1 | R | $\sqrt{3}$ | 1 | 1 | 0.1 | 0.1 |
| 6 | Noise Contribution | B | 0.7 | R | $\sqrt{3}$ | 0.0143 | 1 | 0.0 | 0.4 |
| 7 | Frequency Slope | B | 5.9 | R | $\sqrt{3}$ | 0.1 | 1 | 0.3 | 3.5 |
| **Probe System** | | | | | | | | | |
| 8 | Repeatability / Drift | B | 1.0 | R | $\sqrt{3}$ | 1 | 1 | 0.6 | 0.6 |
| 9 | Linearity / Dynamic Range | B | 0.6 | N | 1 | 1 | 1 | 0.4 | 0.4 |
| 10 | Acoustic Noise | B | 1.0 | R | $\sqrt{3}$ | 0.1 | 1 | 0.1 | 0.6 |
| 11 | Probe Angle | B | 2.3 | R | $\sqrt{3}$ | 1 | 1 | 1.4 | 1.4 |
| 12 | Spectral Processing | B | 0.9 | R | $\sqrt{3}$ | 1 | 1 | 0.5 | 0.5 |
| 13 | Integration Time | B | 0.6 | N | 1 | 1 | 5 | 0.6 | 3.0 |
| 14 | Field Distribution | B | 0.2 | R | $\sqrt{3}$ | 1 | 1 | 0.1 | 0.1 |
| **Test Signal** | | | | | | | | | |
| 15 | Ref.Signal Spectral Response | B | 0.6 | R | $\sqrt{3}$ | 0 | 1 | 0.0 | 0.4 |
| **Positioning** | | | | | | | | | |
| 16 | Probe Positioning | B | 1.9 | R | $\sqrt{3}$ | 1 | 1 | 1.1 | 1.1 |
| 17 | Phantom Thickness | B | 0.9 | R | $\sqrt{3}$ | 1 | 1 | 0.5 | 0.5 |

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 18 | DUT Positioning | B | 1.9 | R | $\sqrt{3}$ | 1 | 1 | 1.1 | 1.1 |
| **External Contributions** | | | | | | | | | |
| 19 | RF Interference | B | 0.0 | R | $\sqrt{3}$ | 1 | 0.3 | 0.0 | 0.0 |
| 20 | Test Signal Variation | B | 2.0 | R | $\sqrt{3}$ | 1 | 1 | 1.2 | 1.2 |
| Combined Std. Uncertainty (ABM Field) | | $u_c^{'} = \sqrt{\sum_{i=1}^{20} c_i^2 u_i^2}$ | | | | | | 4.1 | 6.1 |
| Expanded Std. Uncertainty | | $u_e = 2u_c$ | | N | $k = 2$ | | | 8.2 | 12.2 |

## 11 MAIN TEST INSTRUMENTS

**Table 2: List of Main Instruments**

| No. | Name | Type | Serial Number | Calibration Date | Valid Period |
|---|---|---|---|---|---|
| 01 | Audio Magnetic 1D Field Probe | AM1DV3 | 3128 | January 6, 2015 | NCR |
| 02 | Audio Magnetic Calibration Coil | AMCC | 1064 | NCR | NCR |
| 03 | Audio Measuring Instrument | AMMI | 1044 | NCR | NCR |
| 04 | HAC Test Arch | N/A | 1014 | NCR | NCR |
| 05 | DAE | DAE4 | 771 | January 27, 2015 | One year |
| 06 | Software | DASY5 V5.0 Build 119.9 | N/A | NCR | NCR |
| 07 | Software | SEMCAD V13.2 Build 87 | N/A | NCR | NCR |
| 08 | Universal Radio Communication Tester | CMU 200 | 105948 | September 17, 2015 | One year |

***END OF REPORT BODY***

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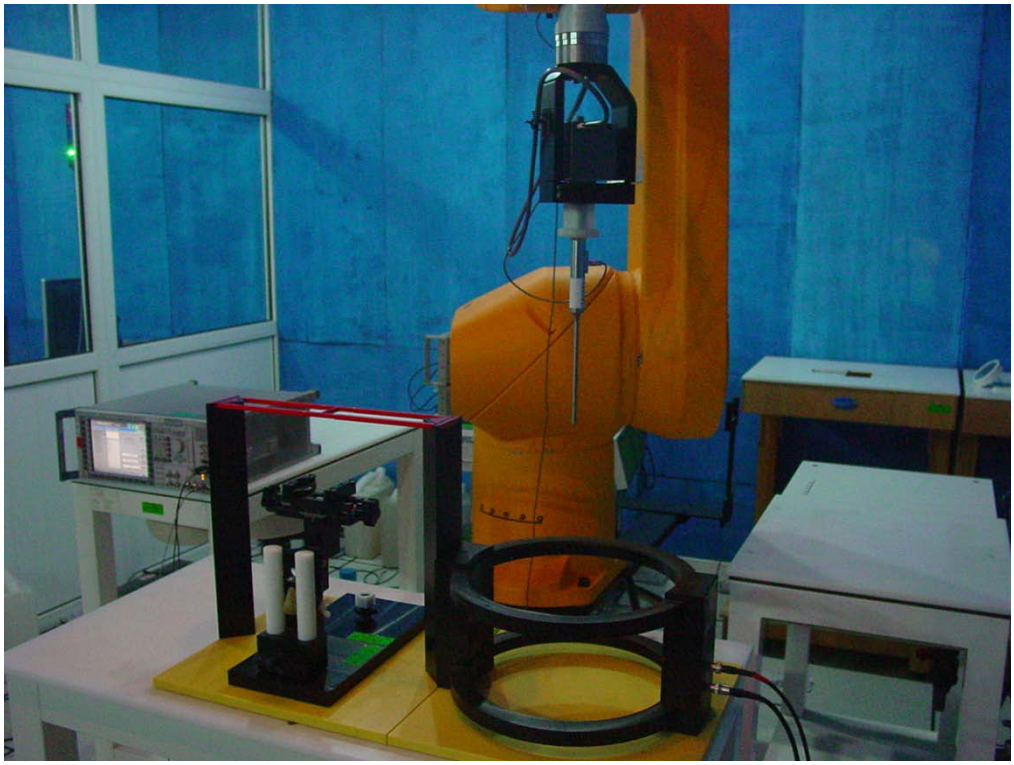
## ANNEX A TEST LAYOUT



**Picture A1: HAC T-Coil System Layout**

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# ANNEX B TEST PLOTS

## T-Coil CDMA BC0 Transverse – Channel 384

**Date: 2016-1-1**
Electronics: DAE4 Sn771
Medium: Air
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature:22.8$^o$C
Communication System: CDMA BC0; Frequency: 836.52 MHz; Duty Cycle: 1:1
Probe: AM1DV2 - 1064;

**Transverse 4.2mm 50 x 50/ABM Interpolated Signal(x,y,z) (121x121x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 37.15
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.15 dB
Device Reference Point: 0, 0, -6.3 mm

**Cursor:**
ABM1 = 5.38 dBA/m
BWC Factor = 0.15 dB
Location: 5, -14.6, 3.7 mm

**Transverse 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 37.15
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.15 dB
Device Reference Point: 0, 0, -6.3 mm

**Cursor:**
ABM1/ABM2 = 47.94 dB
ABM1 comp = 2.90 dBA/m
BWC Factor = 0.15 dB
Location: 11.3, -13.3, 3.7 mm

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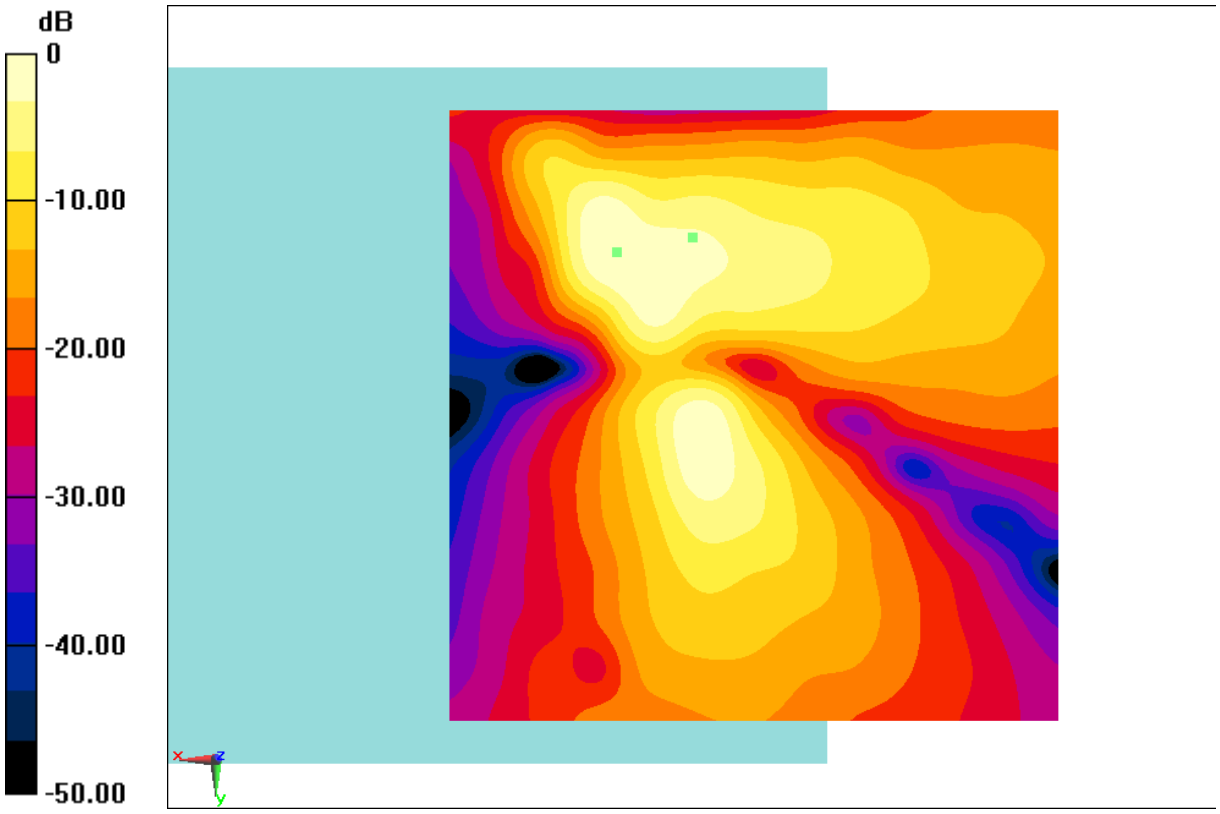


0 dB = 1.858 A/m = 5.38 dBA/m

**Fig B.1 T-Coil CDMA BC0_Channel 384**

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## T-Coil CDMA BC0 Perpendicular – Channel 384

**Date: 2016-1-1**
Electronics: DAE4 Sn771
Medium: Air
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature:22.8$^o$C
Communication System: CDMA BC0; Frequency: 836.52 MHz; Duty Cycle: 1:1
Probe: AM1DV2 - 1064;

**Perpendicular 4.2mm 50 x 50/ABM Interpolated Signal(x,y,z) (121x121x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 37.15
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.15 dB
Device Reference Point: 0, 0, -6.3 mm

**Cursor:**
ABM1 = 4.96 dBA/m
BWC Factor = 0.15 dB
Location: 4.2, -7.9, 3.7 mm

**Perpendicular 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 37.15
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.15 dB
Device Reference Point: 0, 0, -6.3 mm

**Cursor:**
ABM1/ABM2 = 49.12 dB
ABM1 comp = 4.21 dBA/m
BWC Factor = 0.15 dB
Location: 7.5, -7.9, 3.7 mm

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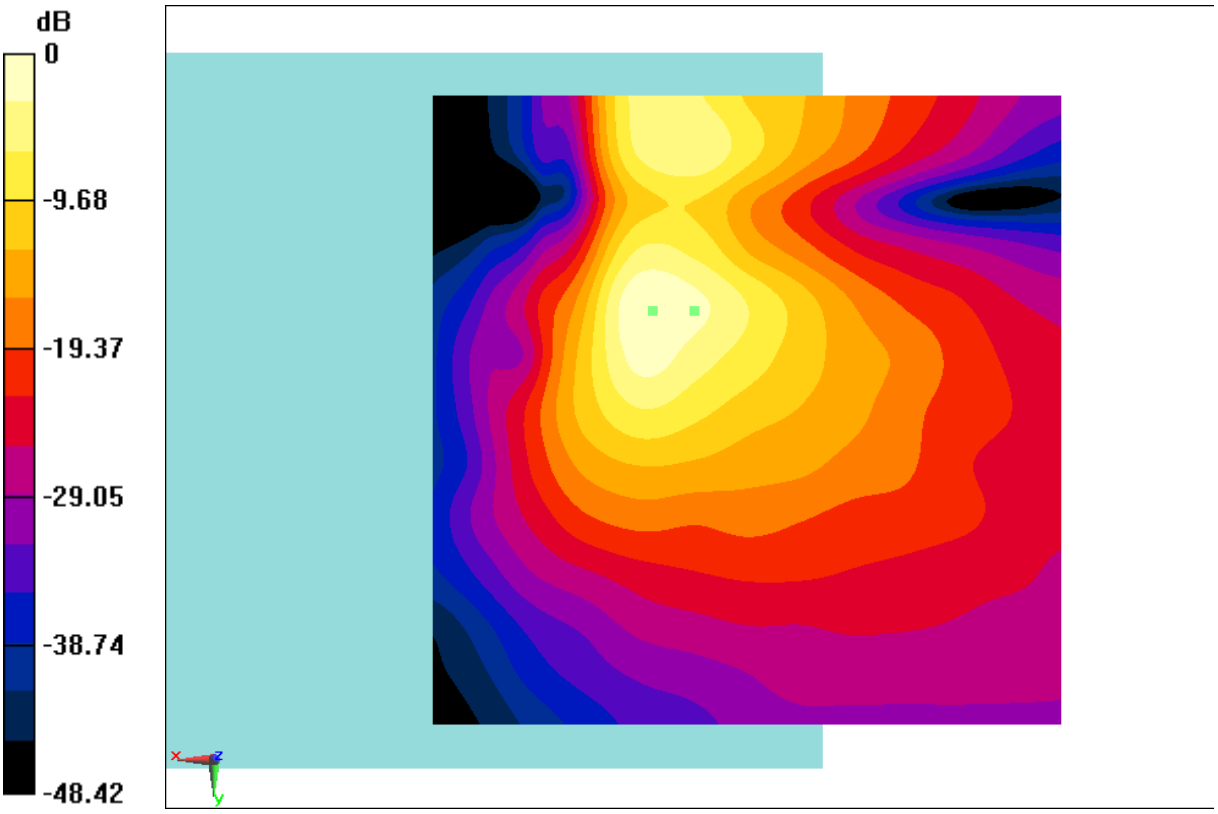


0 dB = 1.770 A/m = 4.96 dBA/m

**Fig B.2 T-Coil CDMA BC0_Channel 384**

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## T-Coil CDMA BC1 Transverse – Channel 600

**Date: 2016-1-1**
Electronics: DAE4 Sn771
Medium: Air
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature:22.8$^o$C
Communication System: CDMA BC1; Frequency: 1880 MHz; Duty Cycle: 1:1
Probe: AM1DV2 - 1064;

**Transverse 4.2mm 50 x 50/ABM Interpolated Signal(x,y,z) (121x121x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 37.15
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

**Cursor:**
ABM1 = 5.12 dBA/m
BWC Factor = 0.16 dB
Location: 5.8, -15, 3.7 mm

**Transverse 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 37.15
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

**Cursor:**
ABM1/ABM2 = 49.74 dB
ABM1 comp = 4.10 dBA/m
BWC Factor = 0.16 dB
Location: 8.3, -12.5, 3.7 mm

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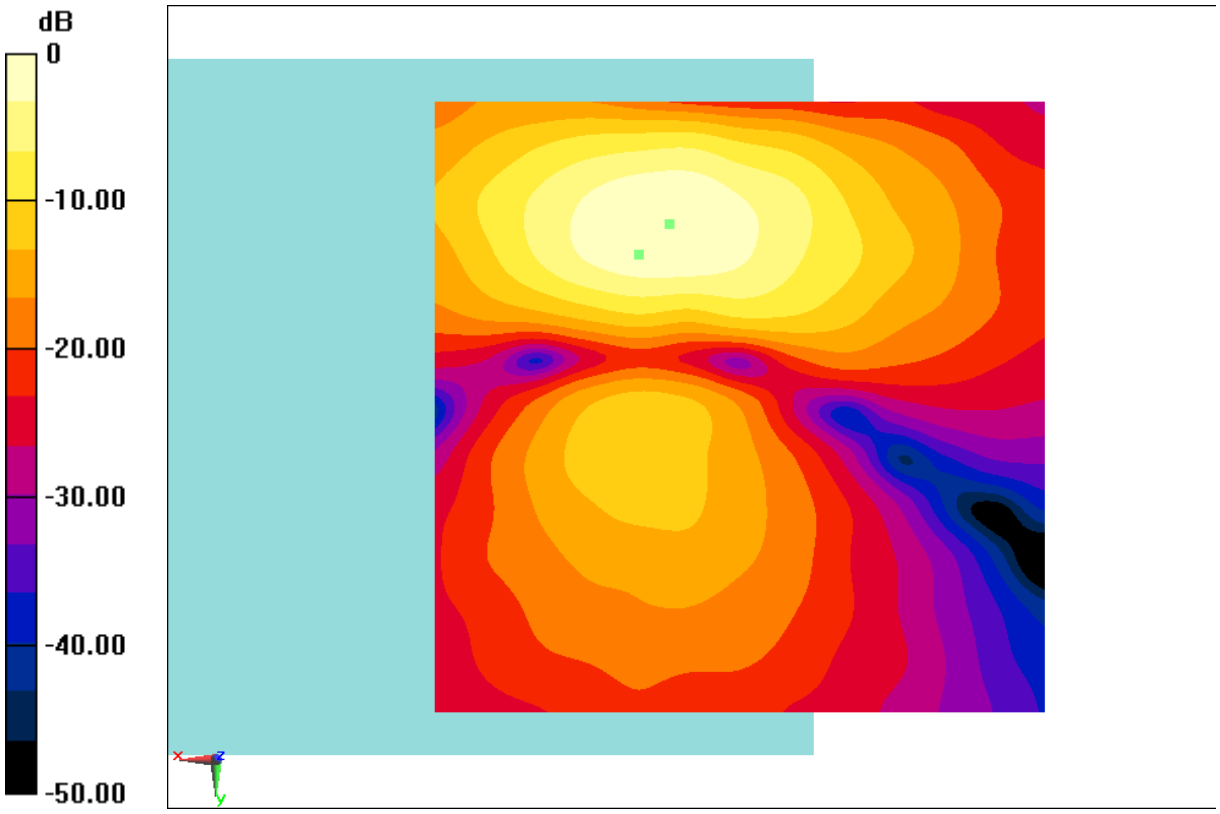


0 dB = 1.803 A/m = 5.12 dBA/m

**Fig B.3 T-Coil CDMA BC1_Channel 600**

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## T-Coil CDMA BC1 Perpendicular – Channel 600

**Date: 2016-1-1**
Electronics: DAE4 Sn771
Medium: Air
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature:22.8$^o$C
Communication System: CDMA BC1; Frequency: 1880 MHz; Duty Cycle: 1:1
Probe: AM1DV2 - 1064;

**Perpendicular 4.2mm 50 x 50/ABM Interpolated Signal(x,y,z) (121x121x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 37.15
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

**Cursor:**
ABM1 = 5.27 dBA/m
BWC Factor = 0.16 dB
Location: 4.6, -22.1, 3.7 mm

**Perpendicular 4.2mm 50 x 50/ABM Interpolated SNR(x,y,z) (121x121x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav
Output Gain: 37.15
Measure Window Start: 300ms
Measure Window Length: 1000ms
BWC applied: 0.16 dB
Device Reference Point: 0, 0, -6.3 mm

**Cursor:**
ABM1/ABM2 = 49.24 dB
ABM1 comp = 4.50 dBA/m
BWC Factor = 0.16 dB
Location: 7.9, -7.9, 3.7 mm

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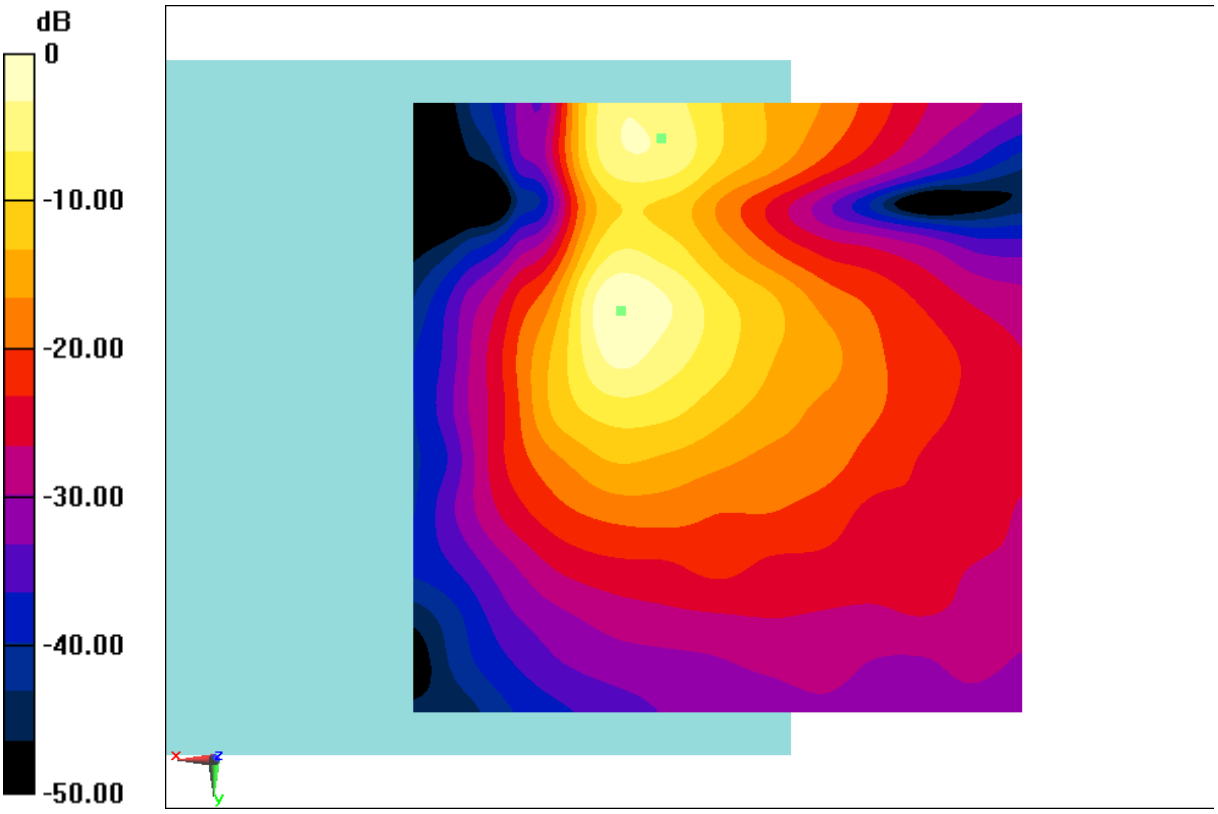


0 dB = 1.835 A/m = 5.27 dBA/m

**Fig B.4 T-Coil CDMA BC1_Channel 600**

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# ANNEX C FREQUENCY REPONSE CURVES

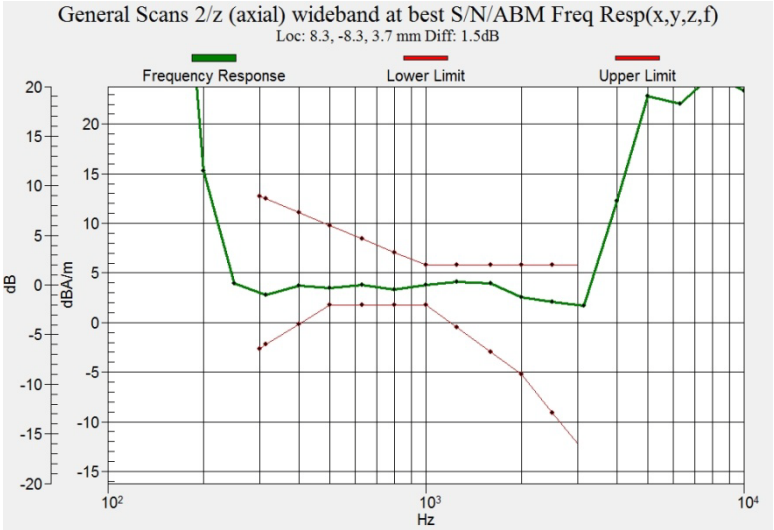


**Figure C.1 Frequency Response of CDMA BC0_Channel 384**

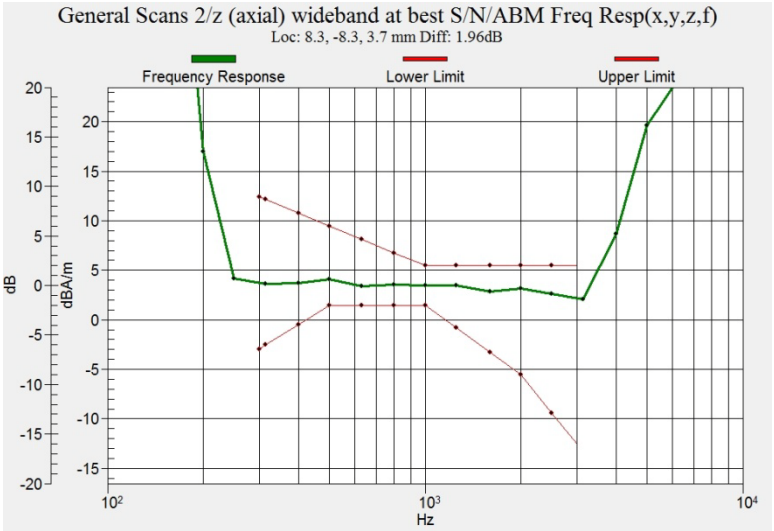


**Figure C.2 Frequency Response of CDMA BC1_Channel 600**

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# ANNEX D PROBE CALIBRATION CERTIFICATE

**Calibration Laboratory of**
Schmid & Partner
Engineering AG
**Zeughausstrasse 43, 8004 Zurich, Switzerland**

**S** Schweizerischer Kalibrierdienst
**C** Service suisse d'étalonnage
Servizio svizzero di taratura
**S** Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
**The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates**

**Accreditation No.: SCS 0108**

**Client** **Auden**

**Certificate No: AM1DV3-3128_Jan15**

## CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | AM1DV3 - SN: 3128 |
| Calibration procedure(s) | QA CAL-24.v4<br>Calibration procedure for AM1D magnetic field probes and TMFS in the audio range |
| Calibration date: | January 6, 2015 |

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Keithley Multimeter Type 2001 | SN: 0810278 | 03-Oct-14 (No:15573) | Oct-15 |
| Reference Probe AM1DV2 | SN: 1008 | 14-Jan-14 (No. AM1D-1008_Jan14) | Jan-15 |
| DAE4 | SN: 781 | 12-Sep-14 (No. DAE4-781_Sep14) | Sep-15 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| AMCC | 1050 | 01-Oct-13 (in house check Oct-13) | Oct-16 |
| AMMI Audio Measuring Instrument | 1062 | 26-Sep-12 (in house check Sep-12) | Sep-15 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Leif Klysner | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: January 6, 2015

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.



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[**References**

[1] ANSI-C63.19-2007
American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.
[2] ANSI-C63.19-2011
American National Standard, Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.
[3] DASY5 manual, Chapter: Hearing Aid Compatibility (HAC) T-Coil Extension

**Description of the AM1D probe**

The AM1D Audio Magnetic Field Probe is a fully shielded magnetic field probe for the frequency range from 100 Hz to 20 kHz. The pickup coil is compliant with the dimensional requirements of [1+2]. The probe includes a symmetric low noise amplifier for the signal available at the shielded 3 pin connector at the side. Power is supplied via the same connector (phantom power supply) and monitored via the LED near the connector. The 7 pin connector at the end of the probe does not carry any signals, but determines the angle of the sensor when mounted on the DAE. The probe supports mechanical detection of the surface.
The single sensor in the probe is arranged in a tilt angle allowing measurement of 3 orthogonal field components when rotating the probe by 120° around its axis. It is aligned with the perpendicular component of the field, if the probe axis is tilted nominally 35.3° above the measurement plane, using the connector rotation and sensor angle stated below.
The probe is fully RF shielded when operated with the matching signal cable (shielded) and allows measurement of audio magnetic fields in the close vicinity of RF emitting wireless devices according to [1+2] without additional shielding.

**Handling of the item**

The probe is manufactured from stainless steel. In order to maintain the performance and calibration of the probe, it must not be opened. The probe is designed for operation in air and shall not be exposed to humidity or liquids. For proper operation of the surface detection and emergency stop functions in a DASY system, the probe must be operated with the special probe cup provided (larger diameter).

**Methods Applied and Interpretation of Parameters**

- *Coordinate System:* The AM1D probe is mounted in the DASY system for operation with a HAC Test Arch phantom with AMCC Helmholtz calibration coil according to [3], with the tip pointing to "southwest" orientation.
- *Functional Test:* The functional test preceding calibration includes test of
  Noise level
  RF immunity (1kHz AM modulated signal). The shield of the probe cable must be well connected.
  Frequency response verification from 100 Hz to 10 kHz.
- *Connector Rotation:* The connector at the end of the probe does not carry any signals and is used for fixation to the DAE only. The probe is operated in the center of the AMCC Helmholtz coil using a 1 kHz magnetic field signal. Its angle is determined from the two minima at nominally +120° and –120° rotation, so the sensor in the tip of the probe is aligned to the vertical plane in z-direction, corresponding to the field maximum in the AMCC Helmholtz calibration coil.
- *Sensor Angle:* The sensor tilting in the vertical plane from the ideal vertical direction is determined from the two minima at nominally +120° and –120°. DASY system uses this angle to align the sensor for radial measurements to the x and y axis in the horizontal plane.

*Sensitivity:* With the probe sensor aligned to the z-field in the AMCC, the output of the probe is compared to the magnetic field in the AMCC at 1 kHz. The field in the AMCC Helmholtz coil is given by the geometry and the current through the coil, which is monitored on the precision shunt resistor of the coil.



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**AM1D probe identification and configuration data**

| | |
|---|---|
| Item | **AM1DV3** Audio Magnetic 1D Field Probe |
| Type No | SP AM1 001 BA |
| Serial No | **3128** |

| | |
|---|---|
| Overall length | 296 mm |
| Tip diameter | 6.0 mm (at the tip) |
| Sensor offset | 3.0 mm (centre of sensor from tip) |
| Internal Amplifier | 20 dB |

| | |
|---|---|
| Manufacturer / Origin | Schmid & Partner Engineering AG, Zürich, Switzerland |
| Manufacturing date | April 26, 2012 |
| Last calibration date | n/a |

**Calibration data**

| | | | |
|---|---|---|---|
| Connector rotation angle | (in DASY system) | **155.7 °** | +/- 3.6 ° (k=2) |
| Sensor angle | (in DASY system) | **1.46 °** | +/- 0.5 ° (k=2) |
| Sensitivity at 1 kHz | (in DASY system) | **0.00780 V / (A/m)** | +/- 2.2 % (k=2) |

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.



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**The photos of HAC test are presented in the additional document:**

Appendix to test report no. I15Z43256-SEM04/05

The photos of HAC test

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