# HAC T-Coil Test Report

| | | |
|---|---|---|
| **Report No.** | : | **HF191211C18A** |
| **Applicant** | : | **Kyocera Corporation c/o Kyocera International, Inc.** |
| **Address** | : | **8611 Balboa Avenue, San Diego, CA 92123** |
| **Product** | : | **Feature Phone** |
| **FCC ID** | : | **V65E4810** |
| **Brand** | : | **Kyocera** |
| **Model No.** | : | **E4810, E4810NC** |
| **Standards** | : | **FCC 47 CFR Part 20.19, ANSI C63.19-2011**<br>**KDB 285076 D01 v05, KDB 285076 D02 v03, KDB 285076 D03 v01** |
| **Sample Received Date** | : | **Dec. 12, 2019** |
| **Date of Testing** | : | **Jan. 8 ~ Feb. 13, 2020** |
| **Summary T-Rating** | : | **T4** |
| **Lab Address** | : | **No. 47-2, 14th Ling, Chia Pau Vil., Lin Kou Dist., New Taipei City, Taiwan** |
| **Test Location** | : | **No. 19, Hwa Ya 2nd Rd., Wen Hwa Vil., Kwei Shan Dist., Taoyuan City, Taiwan** |

**CERTIFICATION:** The above equipment have been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch – Lin Kou Laboratories**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's HAC characteristics under the conditions specified in this report. It should not be reproduced except in full, without the written approval of our laboratory. The client should not use it to claim product certification, approval, or endorsement by TAF or any government agencies.

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Gina Liu / Specialist

**Approved By :** Gordon Lin

Gordon Lin / Manager

Testing Laboratory
2021

**FCC Accredited No.: TW0003**

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# Release Control Record

| Report No. | Reason for Change | Date Issued |
|---|---|---|
| HF191211C18A | Initial release | Feb. 15, 2020 |
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# 1. Summary of Maximum T-Rating

<table>
<tr><th>Mode</th><th>Band</th><th>CMRS Voice<br>T-Rating</th><th>VoLTE<br>T-Rating</th><th>VoWiFi<br>T-Rating</th></tr>
<tr><td rowspan="2">WCDMA</td><td>Band II</td><td>T4</td><td rowspan="2">N/A</td><td rowspan="2">N/A</td></tr>
<tr><td>Band V</td><td>T4</td></tr>
<tr><td rowspan="5">FDD-LTE</td><td>Band 2</td><td rowspan="5">N/A</td><td>T4</td><td rowspan="5">N/A</td></tr>
<tr><td>Band 4</td><td>T4</td></tr>
<tr><td>Band 5</td><td>T4</td></tr>
<tr><td>Band 12</td><td>T4</td></tr>
<tr><td>Band 13</td><td>T4</td></tr>
<tr><td rowspan="5">WLAN</td><td>2.4G</td><td rowspan="5">N/A</td><td rowspan="5">N/A</td><td>T4</td></tr>
<tr><td>5.2G</td><td>T4</td></tr>
<tr><td>5.3G</td><td>T4</td></tr>
<tr><td>5.6G</td><td>T4</td></tr>
<tr><td>5.8G</td><td>T4</td></tr>
<tr><td colspan="2">Summary</td><td colspan="3">T4</td></tr>
</table>

**Note:**

1. The HAC T-Coil limit (T-Rating Category T3) is specified in FCC 47 CFR part 20.19 and ANSI C63.19.
2. The device T-Coil rating is determined by the minimum rating.
3. The device do not support third-party calling applications.

## 2. Description of Equipment Under Test

| | |
|---|---|
| **EUT Type** | Feature Phone |
| **FCC ID** | V65E4810 |
| **Brand Name** | Kyocera |
| **Model Name** | E4810, E4810NC |
| **Tx Frequency Bands (Unit: MHz)** | **WCDMA**<br>Band II : 1852.4 ~ 1907.6<br>Band V : 826.4 ~ 846.6<br>**FDD-LTE**<br>Band 2 : 1850.7 ~ 1909.3 (BW: 1.4M, 3M, 5M, 10M, 15M, 20M)<br>Band 4 : 1710.7 ~ 1754.3 (BW: 1.4M, 3M, 5M, 10M, 15M, 20M)<br>Band 5 : 824.7 ~ 848.3 (BW: 1.4M, 3M, 5M, 10M)<br>Band 12 : 699.7 ~ 715.3 (BW: 1.4M, 3M, 5M, 10M)<br>Band 13 : 779.5 ~ 784.5 (BW: 5M, 10M)<br>**WLAN**<br>2412 ~ 2462, 5180 ~ 5240, 5260 ~ 5320, 5500 ~ 5700, 5745 ~ 5825<br>**Bluetooth**<br>2402 ~ 2480 |
| **Modulations Supported in Uplink** | WCDMA : QPSK<br>LTE : QPSK, 16QAM<br>802.11b : DSSS<br>802.11a/g/n : OFDM<br>Bluetooth : GFSK, π/4-DQPSK, 8-DPSK |
| **Antenna Type** | Fixed Internal Antenna |
| **EUT Stage** | Identical Prototype |

**Note:**

1. All models are listed as below.

| Sample | Brand | Model | Description |
|---|---|---|---|
| 1 | Kyocera | E4810 | With Camera function |
| 2 | | E4810NC | Without Camera function |

2. The above EUT information is declared by manufacturer and for more detailed features description please refers to the manufacturer's specifications or User's Manual.

**List of Accessory:**

| | | |
|---|---|---|
| Battery | **Brand Name** | Kyocera |
| | **Model Name** | SCP-73LBPS |
| | **Power Rating** | 3.8Vdc, 1770mAh, 6.8 Wh |
| | **Type** | Li-ion |

## Air Interface and Operational Mode:

<table>
<tr><th>Air Interface</th><th>Bands</th><th>Transport Type</th><th>ANSI C63.19 Tested</th><th>Simultaneous But Not Tested</th><th>Name of Voice Service</th><th>Power Reduction</th></tr>
<tr><td rowspan="3">WCDMA</td><td>II</td><td rowspan="2">VO</td><td rowspan="2">YES</td><td rowspan="2">WLAN or BT</td><td rowspan="2">CMRS Voice(1)</td><td>No</td></tr>
<tr><td>V</td><td>No</td></tr>
<tr><td>HSPA</td><td>VD</td><td>No</td><td>WLAN or BT</td><td>N/A</td><td>No</td></tr>
<tr><td rowspan="5">FDD-LTE</td><td>2</td><td rowspan="5">VD</td><td rowspan="5">YES</td><td rowspan="5">WLAN or BT</td><td rowspan="5">N/A</td><td>No</td></tr>
<tr><td>4</td><td>No</td></tr>
<tr><td>5</td><td>No</td></tr>
<tr><td>12</td><td>No</td></tr>
<tr><td>13</td><td>No</td></tr>
<tr><td rowspan="5">WLAN</td><td>2.4G</td><td>VD</td><td>YES</td><td rowspan="5">WWAN</td><td>N/A</td><td>No</td></tr>
<tr><td>5.2G</td><td rowspan="4">VD</td><td rowspan="4">Yes</td><td rowspan="4">N/A</td><td>No</td></tr>
<tr><td>5.3G</td><td>No</td></tr>
<tr><td>5.6G</td><td>No</td></tr>
<tr><td>5.8G</td><td>No</td></tr>
<tr><td>Bluetooth</td><td>2.4G</td><td>DT</td><td>No</td><td>WWAN</td><td>N/A</td><td>No</td></tr>
<tr><td colspan="3">Transport Type<br>VO = Legacy Cellular Voice Service<br>DT = Digital Transport Only (No Voice)<br>VD = IP Voice Service over Digital Transport</td><td colspan="4">Note<br>1. Reference level in accordance with 7.4.2.1 of ANSI C63.19-2011 and the July 2012 VoLTE interpretation.<br>2. Reference level is −20 dBm0 in accordance with FCC KDB 285076</td></tr>
</table>

# 3. HAC T-Coil Measurement System

## 3.1 SPEAG DASY6 System

The SPEAG DASY6 system consists of high precision robot, probe alignment sensor, phantom, robot controller, controlled measurement server and near-field probe. The robot includes six axes that can move to the precision position of the DASY6 software defined. The DASY6 software can define the area that is detected by the probe. The robot is connected to controlled box. Controlled measurement server is connected to the controlled robot box. The DAE includes amplifier, signal multiplexing, AD converter, offset measurement and surface detection. It is connected to the Electro-optical coupler (ECO). The ECO performs the conversion form the optical into digital electric signal of the DAE and transfers data to the PC.

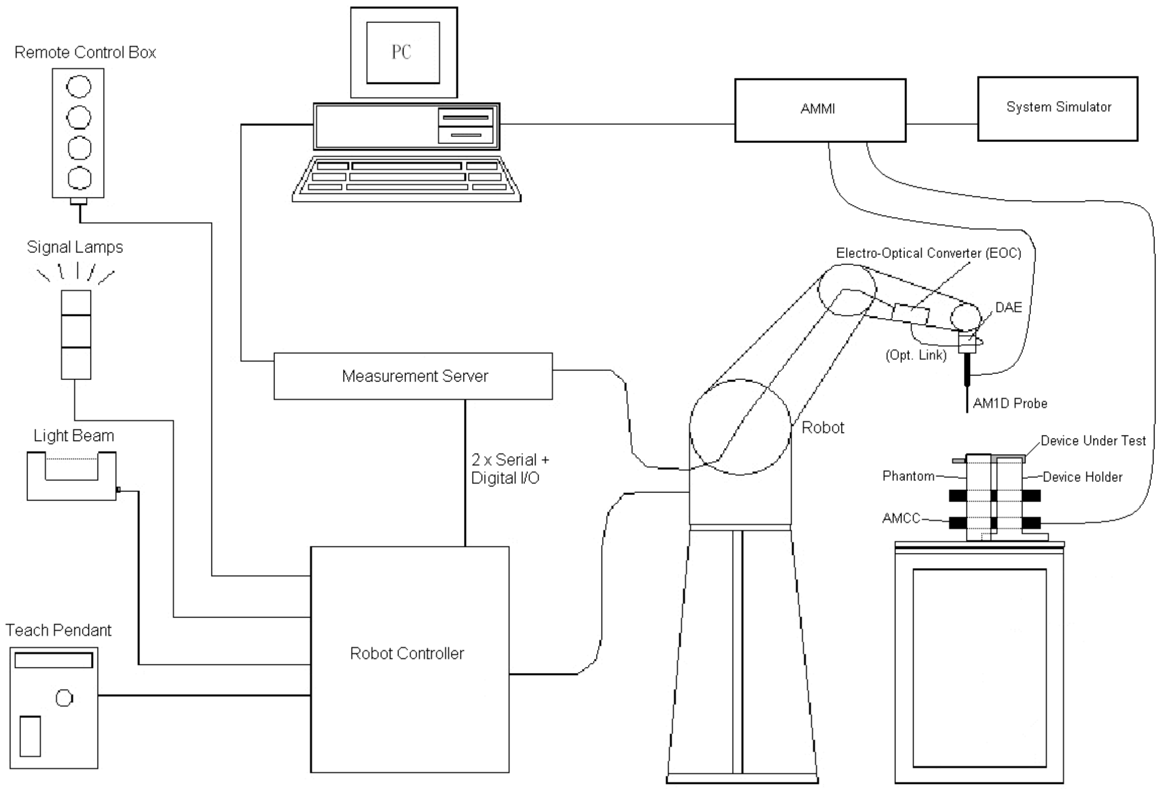



**Fig-3.1 DASY6 System Setup**

### 3.1.1 Robot

The DASY6 system uses the high precision robots from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY6: 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)

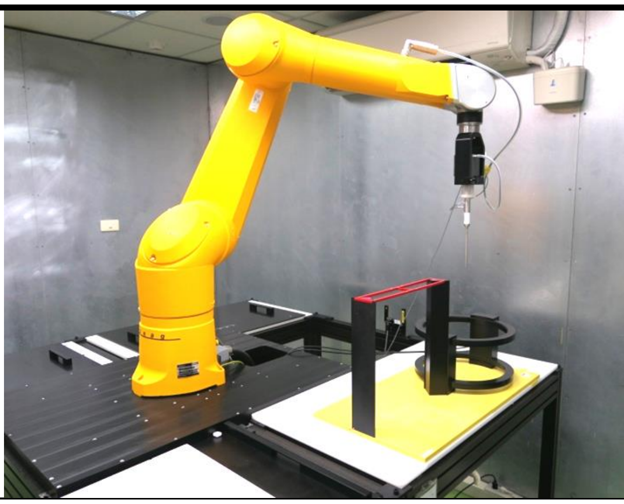
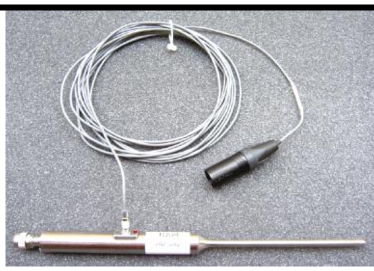


**Fig-3.3 DASY6 Measurement System**

### 3.1.2 AM1D Probe

The AM1D probe is an active probe with a single sensor. It is fully RF-shielded and has a rounded tip 6 mm in diameter incorporating a pickup coil with its center offset 3 mm 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 degrees from the vertical, the sensor is approximately vertical when the signal connector is at the underside of the probe (cable hanging downwards).

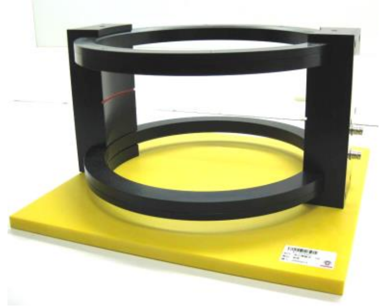
| | |
|---|---|
| **Model** | AM1DV3 |
| **Sampling Rate** | 0.1 kHz to 20 kHz<br>RF sensitivity < -100 dB |
| **Preamplifier** | Symmetric, 40 dB |
| **Dynamic Range** | -60 to 40 dB A/m |
| **Calibration** | at 1kHz |
| **Dimensions** | Tip diameter : 6 mm<br>Length : 290 mm |



### 3.1.3 Audio Magnetic Calibration Coil (AMCC)

The AMCC 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 50 Ohm, and a shunt resistor of 10 Ohm permits monitoring the current with a scale of 1:10.

| Signal | Connector | Resistance |
|---|---|---|
| Coil In | BNC | Typically 50 Ohm |
| Coil Monitor | BNO | 10 Ohm ±1%<br>(100mV corresponding to 1 A/m) |
| **Dimensions** | 370 x 370 x 196 mm | |



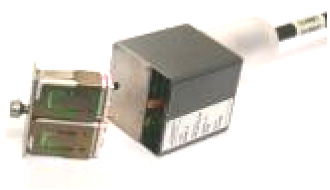
### 3.1.4 Audio Magnetic Measuring Instrument (AMMI)

The AMMI is a desktop 19-inch unit containing a sampling unit, a waveform generator for test and calibration signals, and a USB interface.

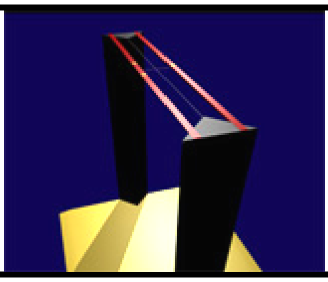
| | |
|---|---|
| **Sampling Rate** | 48 kHz / 24 bit |
| **Dynamic Range** | 100 dB (with AM1DV3 probe) |
| **Test Signal Generation** | User selectable and predefined (via PC) |
| **Calibration** | Auto-calibration / full system calibration using AMCC with monitor output |
| **Dimensions** | 482 x 65 x 270 mm |


### 3.1.5 Data Acquisition Electronics (DAE)

| | |
|---|---|
| **Model** | DAE3, DAE4 |
| **Construction** | Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop. |
| **Measurement Range** | -100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV) |
| **Input Offset Voltage** | < 5µV (with auto zero) |
| **Input Bias Current** | < 50 fA |
| **Dimensions** | 60 x 60 x 68 mm |



### 3.1.6 Phantoms

| | | |
|---|---|---|
| **Model** | Test Arch |  |
| **Construction** | Enables easy and well defined positioning of the phone and validation dipoles as well as simple teaching of the robot. | |
| **Dimensions** | Length : 370 mm<br>Width : 370 mm<br>Height : 370 mm | |

### 3.1.7 Device Holder

| | | |
|---|---|---|
| **Model** | Mounting Device |  |
| **Construction** | The Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Rotation point is the ear opening point. Transmitter devices can be easily and accurately positioned according to ANSI C63.19. | |
| **Material** | POM | |

## 3.2 System Calibration

For correct and calibrated measurement of the voltages and ABM field, DASY6 will perform a calibration job as below.
In phase 1, the audio output is switched off, and a 200 $mV_{pp}$ symmetric rectangular signal of 1 kHz is generated and internally connected directly to both channels of the sampling unit (Coil in, Probe in).

In phase 2, the audio output is off, and a 20 $mV_{pp}$ symmetric 100 Hz signal is internally connected. The signals during phases 1 and 2 are available at the output on the rear panel of the AMMI. However, the output must not be loaded, in order to avoid influencing the calibration. An RMS voltmeter would indicate 100 $mV_{RMS}$ during the first phase and 10 $mV_{RMS}$ during the second phase. After the first two phases, the two input channels are both calibrated for absolute measurements of voltages. The resulting factors are displayed above the multi-meter window.

After phases 1 and 2, the input channels are calibrated to measure exact voltages. This is required to use the inputs for measuring voltages with their peak and RMS value.

In phase 3, a multi-sine signal covering each third-octave band from 50 Hz to 10 kHz is generated and applied to both audio outputs. The probe should be positioned in the center of the AMCC and aligned in the z-direction, the field orientation of the AMCC. The “Coil In” channel is measuring the voltage over the AMCC internal shunt, which is proportional to the magnetic field in the AMCC. At the same time, the “Probe In" channel samples the amplified signal picked up by the probe coil and provides it to a numerical integrator. The ratio of the two voltages in each third-octave filter leads to the spectral representation over the frequency band of interest. The Coil signal is scaled in dBV, and the Probe signal is first integrated and normalized to show dB A/m. The ratio probe-to-coil at the frequency of 1 kHz is the sensitivity which will be used in the consecutive T-Coil jobs.

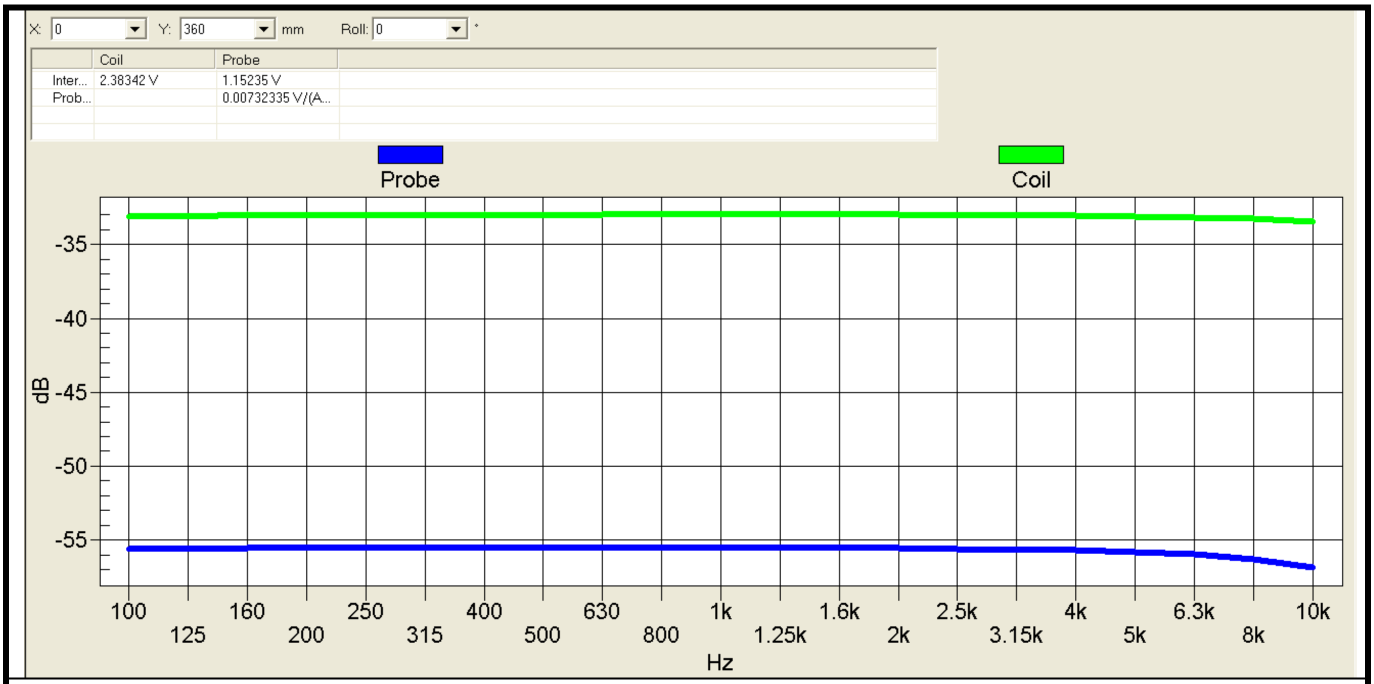



**Fig-3.4 Frequency Response and Sensitivity of AM1D Probe**

## 3.3 EUT Measurements Reference and Plane

The EUT is mounted in the device holder. The acoustic output of the EUT will coincide with the center point of the area formed by the dielectric wire and the middle bar of the arch's top frame. Then EUT will be moved vertically upwards until it touches the frame.

Figure 3.5 illustrates the three standard probe orientations. Position 1 is the perpendicular (axial) orientation of the probe coil. Orientation 2 is the transverse (radial) orientation. The space between the measurement positions is not fixed. It is recommended that a scan of the EUT 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.

(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 EUT handset that, 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 it may be centered on a secondary inductive source.

(4) The measurement points may be located where the perpendicular (axial) and transverse (radial) field intensity measurements are optimum with regard to the requirements. However, the measurement points should be near the acoustic output of the EUT and shall be located in the same half of the phone as the EUT receiver. In a EUT 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 orientations is not fixed. The perpendicular (axial) and transverse (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.

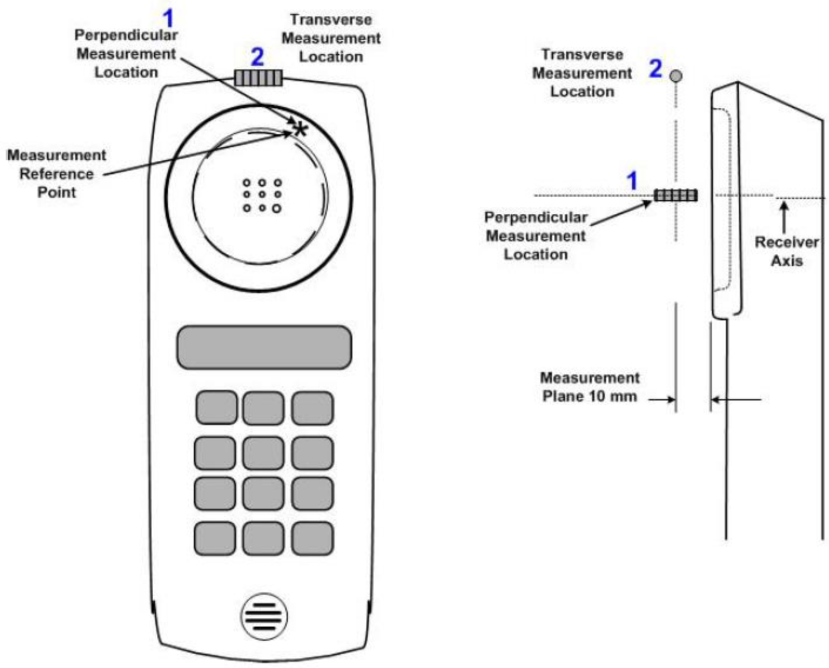



**Fig-3.5 Axis and Planes**

## 3.4 HAC T-Coil Measurement Procedure

According to ANSI C63.19-2011, the T-Coil test procedure for wireless communications device is as below.

1. Position the EUT in the test setup and connect the EUT RF connector to a base station simulator.
2. The drive level to the EUT is set such that the reference input level specified in Table 7.1 is input to the base station simulator in the 1 kHz, 1/3 octave band. This drive level shall be used for the T-Coil signal test (ABM1) at f = 1 kHz. Either a sine wave at 1025 Hz or a voice-like signal, band-limited to the 1 kHz 1/3 octave, as defined in 7.4.2, shall be used for the reference audio signal. If interference is found at 1025 Hz, an alternate nearby reference audio signal frequency may be used. The same drive level will be used for the ABM1 frequency response measurements at each 1/3 octave band center frequency. The EUT volume control may be set at any level up to maximum, provided that a signal at any frequency at maximum modulation would not result in clipping or signal overload.
3. Determine the magnetic measurement locations for the EUT, if not already specified by the manufacturer, as described in 7.4.4.1.1 and 7.4.4.2.
4. At each measurement location, measure and record the desired T-Coil magnetic signals (ABM1 at $f_i$) as described in 7.4.4.2 in each individual ISO 266-1975 R10 standard 1/3 octave band. The desired audio band input frequency ($f_i$) shall be centered in each 1/3 octave band maintaining the same drive level as determined in Step 2 and the reading taken for that band. Equivalent methods of determining the frequency response may also be employed, such as fast Fourier transform (FFT) analysis using noise excitation or input–output comparison using simulated speech. The full-band integrated or half-band integrated probe output, as described in D.9, may be used, as long as the appropriate calibration curve is applied to the measured result, so as to yield an accurate measurement of the field magnitude. (The resulting measurement shall be an accurate measurement in dB A/m.) All measurements of the desired signal shall be shown to be of the desired signal and not of an undesired signal. This may be shown by turning the desired signal on and off with the probe measuring the same location. If the scanning method is used, the scans shall show that all measurement points selected for the ABM1 measurement meet the ambient and test system noise criterion in 7.3.1.
5. At the measurement location for each orientation, measure and record the undesired broadband audio magnetic signal (ABM2) as described in 7.4.4.4 with no audio signal applied (or digital zero applied, if appropriate) using A-weighting, and the half-band integrator. Calculate the ratio of the desired to undesired signal strength (i.e., signal quality).
6. Determine the category that properly classifies the signal quality based on Table 8.5.

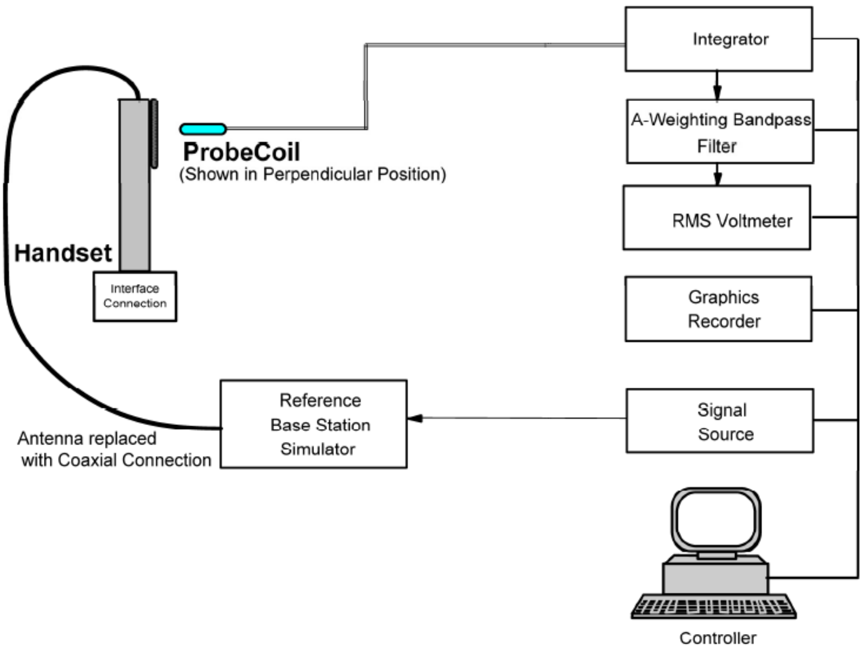



**Fig-3.6 T-Coil Measurement Test Setup**

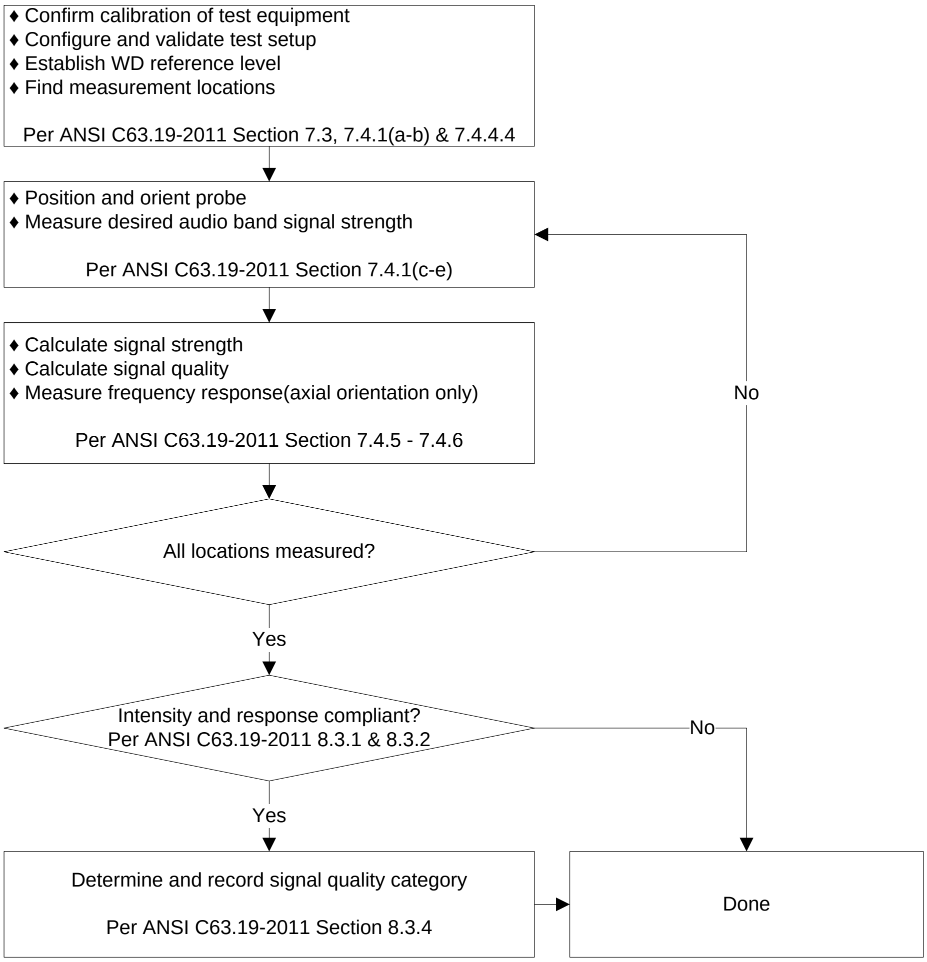



**Fig-3.7 T-Coil Signal Test Flowchart**

## 3.5 Test System Setup and Audio Input Level

The test setup shown in below is to extend DASY6 system with the capability of Audio Band Magnetic (ABM) measurements according to standard ANSI C63.19-2011. Together with the HAC RF extension, it permits complete characterization of the emissions of a wireless device (WD). The signals measured during these tests represent the field picked up by the T-Coil of a hearing aid. Using DASY52 software, these orthogonal axes can be scanned with a probe incorporating a single sensor coil. The WD is mounted on the Test Arch Phantom. The acoustic center of the WD is mounted in such a way that it is centered, and this represents the reference for the combination of ABM and RF field evaluation. The ABM fields of the WD (frequency range <20 kHz) are scanned with a fully RF-shielded active 1-D probe. The probe axis is oriented in the space diagonal to the three orthogonal axes, and its single sensor can be oriented to the axes by 120 degree rotation. The probe signal is evaluated by an Audio Magnetic Measurement Instrument (AMMI) which is interfaced to the DASY52 computer via USB. The AMMI also provides test and calibration signals and interfaces to the Helmholtz Audio Magnetic Calibration Coil (AMCC). Through the connector at the AMMI, predefined or user-definable audio signals are available for injection into the WD during the test.

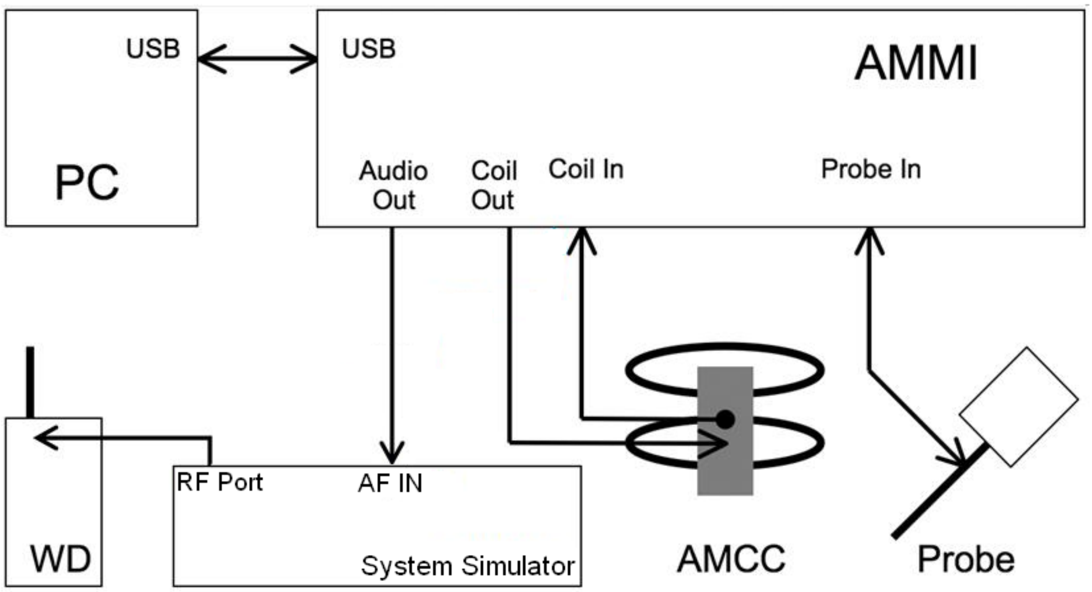



**Fig-3.8 System Setup for T-Coil Testing**

According to KDB 285076 D02, T-Coil testing for VoLTE and VoWiFi requires test instrumentation that can (1) for the system to be able to establish an IP call from/to the handset under test, (2) through an IMS (IP Multimedia Subsystem) and SIP/IP server, (3) to an analog audio adapter containing the permissible set of codecs used by the device under test, and (4) inject the necessary C63.19 test tones at the average speech level for the measurement. The test setup is illustrated in Figure 3.9. The R&S CMW500 was used as system simulator for VoLTE and VoWiFi T-Coil testing. The DAU (Data Application Unit) in CMW500 integrates IMS and SIP/IP server that can establish VoLTE and Wi-Fi calling, and transport the test tones from AMMI (Audio Magnetic Measuring Instrument) to EUT.

The test setup for OTT Voice Calling is using the R&S CMW500 as base station simulator. The CMW500's data application unit was connected to the internet and allowed for an IP data connection on the EUT. An auxiliary VoIP unit installed the same OTT application was used to initiate an OTT calling to the EUT. The auxiliary VoIP unit can allow for configure and monitor the codec bit rate during the OTT calling.

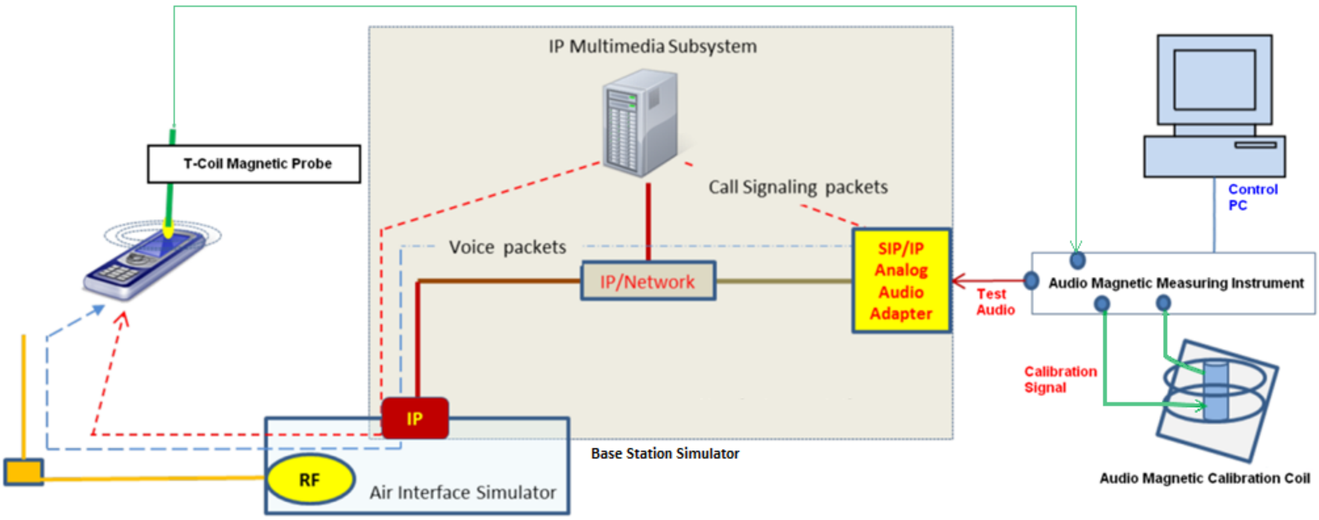



**Fig-3.9 Testing Setup for VoLTE, VoWiFi and OTT Calling**

According to KDB 285076 D02 and ANSI C63.19-2011, the applied reference input level applied at the calibrated reference point for legacy protocols fixed to specific air-interfaces are defined in 7.4.2.1 Table 7.1 of ANSI C63.19-2011 or the ANSI C63.19-2011 VoLTE interpretation of July 2012 with −16 dBm0. The normal speech input level for HAC T-coil tests shall be set to -16 dBm0 for GSM, WCDMA and VoLTE, and -18 dBm0 for CDMA. The technical description below shows a possibility to evaluate and set the correct level with the HAC T-Coil setup with an R&S communication tester with codec.

For protocols not listed in Table 7.1 of ANSI C63.19-2011 or the ANSI C63.19-2011 VoLTE interpretation, the average speech level of −20 dBm0 should be used. For VoWiFi and OTT Calling, the average speech level of -20 dBm0 was used for testing.

Reference Audio Input Level:
-16 dBm0 is used for GSM, WCDMA, and VoLTE
-18 dBm0 is used for CDMA
-20 dBm0 is used for VoWiFi, and OTT Calling

The speech levels with the settings at the AF connector of R&S CMW500 have been calibrated, and it can be set manually to ensure the specific full-scale speech level during T-Coil testing. For an example, the gain setting for -16 dBm0 has been calculated through below formula.

3.14 dBm0 = ***X*** dBV = -3.01 dBV
-16 dBm0 = $\boldsymbol{L_{-16dBm0}}$ dBV = -22.00 dBV
Gain 100 = ***G*** dBV = 3.13 dBV
Difference for -16 dBm0 = $\boldsymbol{D_{-16dBm0}}$ = $\boldsymbol{L_{-16dBm0}}$ – ***G*** = -22 – 3.13 = -25.13 dBV
Resulting Gain for -16 dBm0 = 10 ^ ($\boldsymbol{D_{-16dBm0}}$ / 20) x 100 = 5.54
Gain Setting = Resulting Gain x Required Gain Factor
Gain setting for voice 1kHz = 5.54 x 4.33 = 23.99
Gain setting for voice 300-3kHz = 5.54 x 8.48 = 46.98

The gain setting for other signal types need to be adjusted to achieve the same average level. Those signal types have the following differences/factors compared to the 1 kHz sine signal:

| Signal Type | Duration (s) | BWC (dB) | Required Gain Factor |
|---|---|---|---|
| 1 kHz sine | - | 0.0 | 1.00 |
| 48k_voice_1kHz | 1 | 0.16 | 4.33 |
| 48k_voice_300-3000 | 2 | 10.8 | 8.48 |

# 4. HAC Measurement Evaluation

## 4.1 Measurement Criteria

The HAC Standard ANSI C63.19-2011 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.

### 4.1.1 Field Intensity

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

### 4.1.2 Frequency Response

The frequency response of the axial component of the magnetic field, measured in 1/3 octave bands, shall follow the below response curve, over the frequency range 300 Hz to 3000 Hz. Figure 4.1 and Figure 4.2 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.

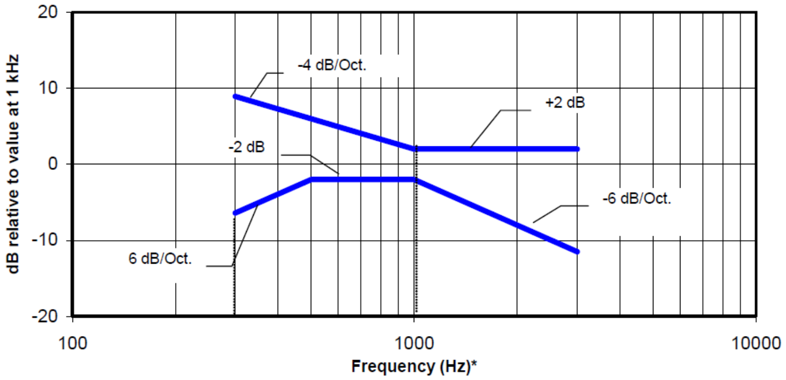



**Fig-4.1 Boundaries for EUT with a field ≤ -15 dB (A/m) at 1 kHz**

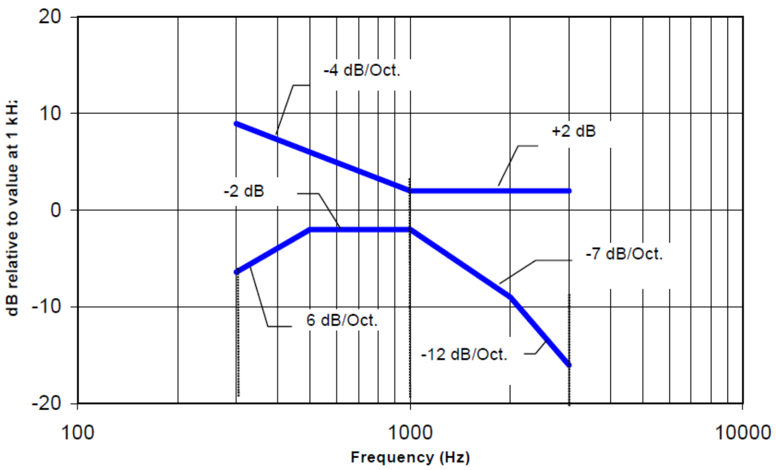



**Fig-4.2 Boundaries for EUT with a field > -15 dB (A/m) at 1 kHz**

### 4.1.3 Signal Quality

The worst signal quality of the three T-Coil signal measurements shall be used to determine the T-Coil mode category per below table.

| Category | Telephone Parameters WD Signal Quality (Signal to Noise Ratio, in dB) |
|---|---|
| Category T1 | 0 – 10 |
| Category T2 | 10 – 20 |
| Category T3 | 20 – 30 |
| Category T4 | > 30 |

## 4.2 EUT Configuration and Setting

For HAC T-Coil testing, the EUT was linked and controlled by base station emulator. Communication between the EUT and the emulator was established by coaxial connection. The EUT was set from the emulator to radiate maximum output power during HAC testing. Also EUT was set to mute on, maximum volume, and backlight off during T-Coil testing.

## 4.3 HAC T-Coil Testing Results

### 4.3.1 WCDMA CMRS Voice Testing Results

**Codec Investigation**

| Band | Channel | Codec Setting | Probe Orientation | ABM1 (dB A/m) | ABM2 (dB A/m) | Frequency Response Margin (dB) | Frequency Response | SNR (dB) |
|---|---|---|---|---|---|---|---|---|
| WCDMA V | 4182 | AMR 4.75kbps | Axial (Z) | -1.18 | -50.32 | 1.57 | Pass | 49.14 |
| WCDMA V | 4182 | AMR 7.95kbps | Axial (Z) | -0.27 | -51.5 | 2 | Pass | 51.23 |
| WCDMA V | 4182 | AMR 12.2kbps | Axial (Z) | 0.13 | -50.63 | 2 | Pass | 50.76 |

**Test Summary**

| Plot No. | Band | Channel | Codec Setting | Probe Orientation | ABM1 (dB A/m) | ABM2 (dB A/m) | Ambient Noise (dB A/m) | Frequency Response Margin (dB) | Frequency Response | SNR (dB) | FCC Limit (dB) | FCC Margin (dB) | T-Rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | WCDMA II | 9400 | AMR 4.75kbps | Axial (Z) | -1.04 | -50.94 | -51.76 | 2 | Pass | 49.9 | 20 | -29.9 | T4 |
| 01 | WCDMA II | 9400 | AMR 4.75kbps | Radial (Y) | -9.75 | -54.57 | -54.8 | N/A | N/A | 44.82 | 20 | -24.82 | T4 |
| 02 | WCDMA V | 4182 | AMR 4.75kbps | Axial (Z) | -1.18 | -50.32 | -51.76 | 1.57 | Pass | 49.14 | 20 | -29.14 | T4 |
| 02 | WCDMA V | 4182 | AMR 4.75kbps | Radial (Y) | -9.78 | -54.46 | -54.8 | N/A | N/A | 44.68 | 20 | -24.68 | T4 |

### 4.3.2 VoLTE Testing Results

## Radio Configuration Investigation

| Air Interface | Band | Bandwidth (MHz) | Modulation | RB Size | RB Offset | Channel | UL-DL Configuration | Probe Orientation | ABM1 (dB A/m) | ABM2 (dB A/m) | SNR (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FDD-LTE | LTE B2 | 20 | QPSK | 1 | 0 | 18900 | N/A | Axial (Z) | -2.64 | -46.26 | 43.62 |
| FDD-LTE | LTE B2 | 20 | QPSK | 1 | 50 | 18900 | N/A | Axial (Z) | -3.16 | -48.09 | 44.93 |
| FDD-LTE | LTE B2 | 20 | QPSK | 1 | 99 | 18900 | N/A | Axial (Z) | -1.4 | -46.8 | 45.4 |
| FDD-LTE | LTE B2 | 20 | QPSK | 50 | 0 | 18900 | N/A | Axial (Z) | -2.25 | -46.58 | 44.33 |
| FDD-LTE | LTE B2 | 20 | QPSK | 50 | 25 | 18900 | N/A | Axial (Z) | -1.84 | -46.21 | 44.37 |
| FDD-LTE | LTE B2 | 20 | QPSK | 50 | 50 | 18900 | N/A | Axial (Z) | -1.9 | -46.87 | 44.97 |
| FDD-LTE | LTE B2 | 20 | QPSK | 100 | 0 | 18900 | N/A | Axial (Z) | -3.93 | -48.76 | 44.83 |
| FDD-LTE | LTE B2 | 20 | 16QAM | 1 | 0 | 18900 | N/A | Axial (Z) | -4.14 | -48.68 | 44.54 |
| FDD-LTE | LTE B2 | 20 | 64QAM | 1 | 0 | 18900 | N/A | Axial (Z) | -4.11 | -48.23 | 44.12 |
| FDD-LTE | LTE B2 | 15 | QPSK | 1 | 0 | 18900 | N/A | Axial (Z) | -4.23 | -48.22 | 43.99 |
| FDD-LTE | LTE B2 | 10 | QPSK | 1 | 0 | 18900 | N/A | Axial (Z) | -1.68 | -47.51 | 45.83 |
| FDD-LTE | LTE B2 | 5 | QPSK | 1 | 0 | 18900 | N/A | Axial (Z) | -2.04 | -45.98 | 43.94 |
| FDD-LTE | LTE B2 | 3 | QPSK | 1 | 0 | 18900 | N/A | Axial (Z) | -3.08 | -47.41 | 44.33 |
| FDD-LTE | LTE B2 | 1.4 | QPSK | 1 | 0 | 18900 | N/A | Axial (Z) | -2.74 | -46.92 | 44.18 |

## Codec Investigation

| Band | Bandwidth (MHz) | Modulation | RB Size | RB Offset | Channel | Codec Setting | Probe Orientation | ABM1 (dB A/m) | ABM2 (dB A/m) | Frequency Response Margin (dB) | Frequency Response | SNR (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LTE B2 | 20 | QPSK | 1 | 0 | 18900 | AMR NB 4.75kbps | Axial (Z) | -2.23 | -46.7 | 2 | Pass | 44.47 |
| LTE B2 | 20 | QPSK | 1 | 0 | 18900 | AMR NB 12.2kbps | Axial (Z) | -1.73 | -46.83 | 2 | Pass | 45.1 |
| LTE B2 | 20 | QPSK | 1 | 0 | 18900 | AMR WB 6.6kbps | Axial (Z) | -2.64 | -46.26 | 1.8 | Pass | 43.62 |
| LTE B2 | 20 | QPSK | 1 | 0 | 18900 | AMR WB 23.85kbps | Axial (Z) | -0.39 | -46.15 | 2 | Pass | 45.76 |

## Test Summary

| Plot No. | Band | Bandwidth (MHz) | Modulation | RB Size | RB Offset | Channel | UL-DL Configuration | Codec Setting | Probe Orientation | ABM1 (dB A/m) | ABM2 (dB A/m) | Ambient Noise (dB A/m) | Frequency Response Margin (dB) | Frequency Response | SNR (dB) | FCC Limit (dB) | FCC Margin (dB) | T-Rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 03 | LTE B2 | 20 | QPSK | 1 | 0 | 18900 | N/A | AMR WB 6.6kbps | Axial (Z) | -2.64 | -46.26 | -47.31 | 1.8 | Pass | 43.62 | 20 | -23.62 | T4 |
| 03 | LTE B2 | 20 | QPSK | 1 | 0 | 18900 | N/A | AMR WB 6.6kbps | Radial (Y) | -11.21 | -53.34 | -54.07 | N/A | N/A | 42.13 | 20 | -22.13 | T4 |
| 04 | LTE B4 | 20 | QPSK | 1 | 0 | 20175 | N/A | AMR WB 6.6kbps | Axial (Z) | -2.79 | -45.04 | -47.31 | 1.35 | Pass | 42.25 | 20 | -22.25 | T4 |
| 04 | LTE B4 | 20 | QPSK | 1 | 0 | 20175 | N/A | AMR WB 6.6kbps | Radial (Y) | -10.51 | -53.23 | -54.07 | N/A | N/A | 42.72 | 20 | -22.72 | T4 |
| 05 | LTE B5 | 10 | QPSK | 1 | 0 | 20525 | N/A | AMR WB 6.6kbps | Axial (Z) | -2.65 | -45.23 | -47.31 | 1.59 | Pass | 42.58 | 20 | -22.58 | T4 |
| 05 | LTE B5 | 10 | QPSK | 1 | 0 | 20525 | N/A | AMR WB 6.6kbps | Radial (Y) | -10.55 | -53.6 | -54.07 | N/A | N/A | 43.05 | 20 | -23.05 | T4 |
| 06 | LTE B12 | 10 | QPSK | 1 | 0 | 23095 | N/A | AMR WB 6.6kbps | Axial (Z) | -3.12 | -46.52 | -47.31 | 1.06 | Pass | 43.40 | 20 | -23.4 | T4 |
| 06 | LTE B12 | 10 | QPSK | 1 | 0 | 23095 | N/A | AMR WB 6.6kbps | Radial (Y) | -11.39 | -53.74 | -54.07 | N/A | N/A | 42.35 | 20 | -22.35 | T4 |
| 07 | LTE B13 | 10 | QPSK | 1 | 0 | 23230 | N/A | AMR WB 6.6kbps | Axial (Z) | -3.18 | -46.06 | -47.31 | 1.86 | Pass | 42.88 | 20 | -22.88 | T4 |
| 07 | LTE B13 | 10 | QPSK | 1 | 0 | 23230 | N/A | AMR WB 6.6kbps | Radial (Y) | -11.29 | -53.65 | -54.07 | N/A | N/A | 42.36 | 20 | -22.36 | T4 |

### 4.3.3 VoWiFi Testing Results

## Radio Configuration Investigation

| Band | Mode | Data Rate | Channel | Probe Orientation | ABM1 (dB A/m) | ABM2 (dB A/m) | SNR (dB) |
|---|---|---|---|---|---|---|---|
| WLAN 2.4G | 802.11b | 1Mbps | 6 | Axial (Z) | 3.02 | -46.52 | 49.54 |
| WLAN 2.4G | 802.11b | 11Mbps | 6 | Axial (Z) | 3.21 | -46.43 | 49.64 |
| WLAN 2.4G | 802.11g | 6Mbps | 6 | Axial (Z) | 2.64 | -46.96 | 49.6 |
| WLAN 2.4G | 802.11g | 54Mbps | 6 | Axial (Z) | 2.67 | -47.24 | 49.91 |
| WLAN 2.4G | 802.11n HT20 | MCS0 | 6 | Axial (Z) | 2.87 | -46.8 | 49.67 |
| WLAN 2.4G | 802.11n HT20 | MCS8 | 6 | Axial (Z) | 2.63 | -47.48 | 50.11 |
| WLAN 5G | 802.11a | 6Mbps | 40 | Axial (Z) | 2.59 | -45.97 | 48.56 |
| WLAN 5G | 802.11a | 54Mbps | 40 | Axial (Z) | 2.65 | -46.98 | 49.63 |
| WLAN 5G | 802.11n HT20 | MCS0 | 40 | Axial (Z) | 2.68 | -46.36 | 49.04 |
| WLAN 5G | 802.11n HT20 | MCS8 | 40 | Axial (Z) | 2.79 | -46.69 | 49.48 |
| WLAN 5G | 802.11n HT40 | MCS0 | 38 | Axial (Z) | 2.69 | -47.09 | 49.78 |
| WLAN 5G | 802.11n HT40 | MCS8 | 38 | Axial (Z) | 2.87 | -46.24 | 49.11 |

## Codec Investigation

| Band | Mode | Data Rate | Channel | Codec Setting | Probe Orientation | ABM1 (dB A/m) | ABM2 (dB A/m) | Frequency Response Margin (dB) | Frequency Response | SNR (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| WLAN 5.2G | 802.11a | 6Mbps | 40 | AMR NB 4.75kbps | Axial (Z) | 2.78 | -46.21 | 0.8 | Pass | 48.99 |
| WLAN 5.2G | 802.11a | 6Mbps | 40 | AMR NB 12.2kbps | Axial (Z) | 3.81 | -46.59 | 2 | Pass | 50.4 |
| WLAN 5.2G | 802.11a | 6Mbps | 40 | AMR WB 6.6kbps | Axial (Z) | 2.59 | -45.97 | 1.93 | Pass | 48.56 |
| WLAN 5.2G | 802.11a | 6Mbps | 40 | AMR WB 23.85kbps | Axial (Z) | 3.42 | -46.29 | 2 | Pass | 49.71 |

## Test Summary

| Plot No. | Band | Mode | Data Rate | Channel | Codec Setting | Probe Orientation | ABM1 (dB A/m) | ABM2 (dB A/m) | Ambient Noise (dB A/m) | Frequency Response Margin (dB) | Frequency Response | SNR (dB) | FCC Limit (dB) | FCC Margin (dB) | T-Rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 08 | WLAN 2.4G | 802.11b | 1Mbps | 6 | AMR WB 6.6kbps | Axial (Z) | 3.02 | -46.52 | -47.91 | 1.7 | Pass | 49.54 | 20 | -29.54 | T4 |
| 08 | WLAN 2.4G | 802.11b | 1Mbps | 6 | AMR WB 6.6kbps | Radial (Y) | -5.54 | -52.87 | -53.68 | N/A | N/A | 47.33 | 20 | -27.33 | T4 |
| 09 | WLAN 5.2G | 802.11a | 6Mbps | 40 | AMR WB 6.6kbps | Axial (Z) | 2.59 | -45.97 | -47.91 | 1.93 | Pass | 48.56 | 20 | -28.56 | T4 |
| 09 | WLAN 5.2G | 802.11a | 6Mbps | 40 | AMR WB 6.6kbps | Radial (Y) | -6.08 | -52.54 | -53.68 | N/A | N/A | 46.46 | 20 | -26.46 | T4 |
| 10 | WLAN 5.3G | 802.11a | 6Mbps | 52 | AMR WB 6.6kbps | Axial (Z) | 2.33 | -45.75 | -47.91 | 1.87 | Pass | 48.08 | 20 | -28.08 | T4 |
| 10 | WLAN 5.3G | 802.11a | 6Mbps | 52 | AMR WB 6.6kbps | Radial (Y) | -6.18 | -52.65 | -53.68 | N/A | N/A | 46.47 | 20 | -26.47 | T4 |
| 11 | WLAN 5.6G | 802.11a | 6Mbps | 116 | AMR WB 6.6kbps | Axial (Z) | 2.31 | -45.75 | -47.91 | 1.65 | Pass | 48.06 | 20 | -28.06 | T4 |
| 11 | WLAN 5.6G | 802.11a | 6Mbps | 116 | AMR WB 6.6kbps | Radial (Y) | -6.10 | -52.64 | -53.68 | N/A | N/A | 46.54 | 20 | -26.54 | T4 |
| 12 | WLAN 5.8G | 802.11a | 6Mbps | 157 | AMR WB 6.6kbps | Axial (Z) | 2.21 | -45.88 | -47.91 | 1.73 | Pass | 48.09 | 20 | -28.09 | T4 |
| 12 | WLAN 5.8G | 802.11a | 6Mbps | 157 | AMR WB 6.6kbps | Radial (Y) | -5.78 | -52.67 | -53.68 | N/A | N/A | 46.89 | 20 | -26.89 | T4 |

**Test Engineer：**Willy Chang, and Eric Wu

# 5. Calibration of Test Equipment

| Equipment | Manufacturer | Model | SN | Cal. Date | Cal. Interval |
|---|---|---|---|---|---|
| Audio Band Magnetic Probe | SPEAG | AM1DV3 | 3060 | Jan. 20, 2020 | 1 Year |
| Audio Band Magnetic Probe | SPEAG | AM1DV3 | 3067 | Dec. 10, 2019 | 1 Year |
| Data Acquisition Electronics | SPEAG | DAE4 | 1277 | Jan. 24, 2019 | 1 Year |
| Data Acquisition Electronics | SPEAG | DAE4 | 1431 | Mar. 25, 2019 | 1 Year |
| Data Acquisition Electronics | SPEAG | DAE4 | 1585 | Jun. 07, 2019 | 1 Year |
| Universal Radio Communication Tester | R&S | CMW500 | 164864 | Apr. 08, 2019 | 1 Year |
| Universal Radio Communication Tester | R&S | CMW500 | 152443 | Oct. 30, 2019 | 1 Year |
| Test Arch Phantom | SPEAG | Arch | N/A | N/A | N/A |

# 6. Measurement Uncertainty

| 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 Calibration | 0.07 | Rectangular | √3 | 1 | 1 | ± 0.04 % | ± 0.04 % |
| Noise Contribution | 0.02 | Rectangular | √3 | 0.0143 | 1 | ± 0.0 % | ± 0.01 % |
| Frequency Slope | 5.9 | Rectangular | √3 | 0.1 | 1 | ± 0.3 % | ± 3.4 % |
| **Probe System** | | | | | | | |
| Repeatability / Drift | 1.0 | Rectangular | √3 | 1 | 1 | ± 0.6 % | ± 0.6 % |
| Linearity / Dynamic Range | 0.6 | Rectangular | √3 | 1 | 1 | ± 0.3 % | ± 0.3 % |
| Acoustic Noise | 1.0 | Rectangular | √3 | 0.1 | 1 | ± 0.1 % | ± 0.6 % |
| Probe Angle | 2.3 | Rectangular | √3 | 1 | 1 | ± 1.3 % | ± 1.3 % |
| 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 % | ± 0.3 % |
| **Positioning** | | | | | | | |
| Probe Positioning | 1.9 | Rectangular | √3 | 1 | 1 | ± 1.1 % | ± 1.1 % |
| Phantom Thickness | 0.9 | Rectangular | √3 | 1 | 1 | ± 0.5 % | ± 0.5 % |
| EUT Positioning | 1.9 | Rectangular | √3 | 1 | 1 | ± 1.1 % | ± 1.1 % |
| **External Contributions** | | | | | | | |
| RF Interference | 0.0 | Rectangular | √3 | 1 | 0.3 | ± 0.0 % | ± 0.0 % |
| Test Signal Variation | 2.0 | Rectangular | √3 | 1 | 1 | ± 1.2 % | ± 1.2 % |
| **Combined Standard Uncertainty** | | | | | | ± 4.0 % | ± 6.1 % |
| Coverage Factor for 95 % | | | | | | K = 2 | |
| **Expanded Uncertainty** | | | | | | **± 8.0 %** | **± 12.2 %** |

**Uncertainty Budget for HAC T-Coil**

## 7. Information of the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

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The road map of all our labs can be found in our web site also.

**---END---**

# Appendix A. Plots of HAC T-Coil Measurement

The HAC plots for worst-case in each wireless mode and frequency band combination are shown as follows.

Test Laboratory: Bureau Veritas ADT SAR/HAC Testing Lab    Date: 2020/01/08

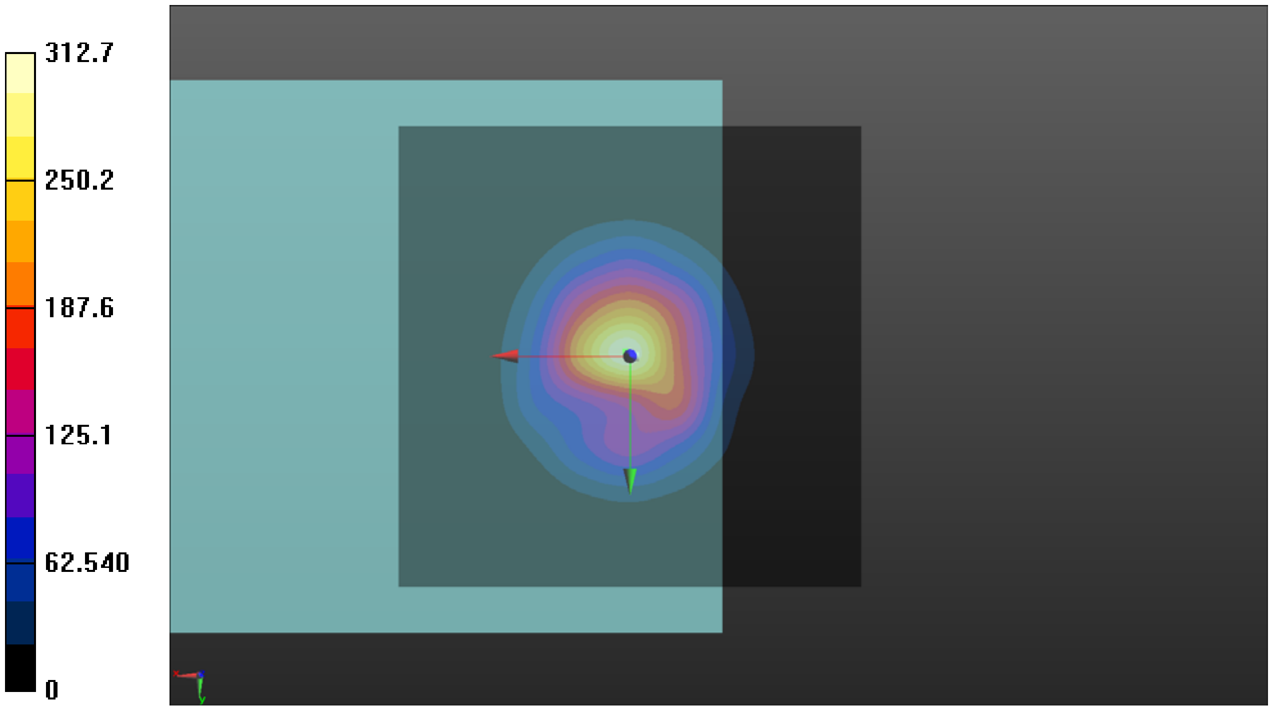
## P01 T-Coil_WCDMA II_Ch9400_AMR 4.75kbps_Sample1_Axial (Z)

**DUT: 191212C04**

Communication System: UMTS-FDD (WCDMA, AMR); Frequency: 1880 MHz;Duty Cycle: 1:1.73
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3060; ; Calibrated: 2019/01/29
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1277; Calibrated: 2019/01/24
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 49.90 dB
ABM1 comp = -1.04 dBA/m
Location: 0.5, -0.5, 3.7 mm



Test Laboratory: Bureau Veritas ADT SAR/HAC Testing Lab Date: 2020/01/08

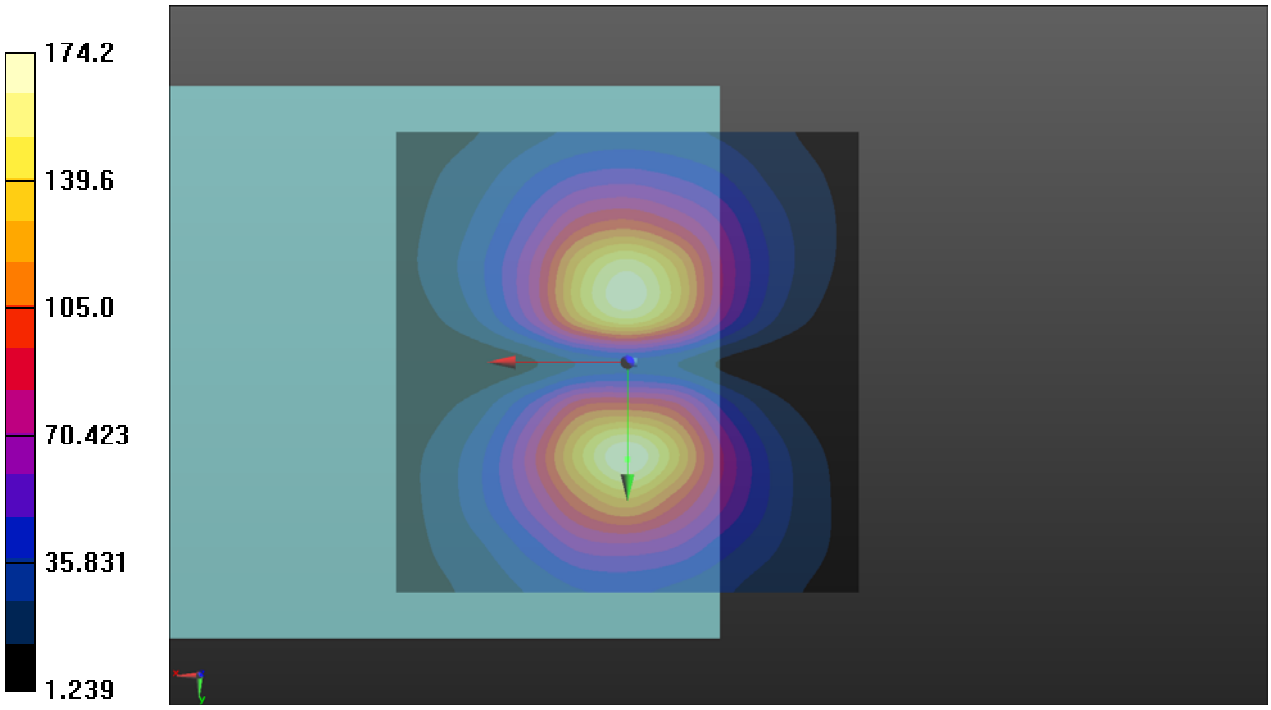
## P01 T-Coil_WCDMA II_Ch9400_AMR 4.75kbps_Sample1_Radial (Y)

**DUT: 191212C04**

Communication System: UMTS-FDD (WCDMA, AMR); Frequency: 1880 MHz;Duty Cycle: 1:1.73
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3060; ; Calibrated: 2019/01/29
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1277; Calibrated: 2019/01/24
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 44.82 dB
ABM1 comp = -9.75 dBA/m
Location: 0, 10.5, 3.7 mm



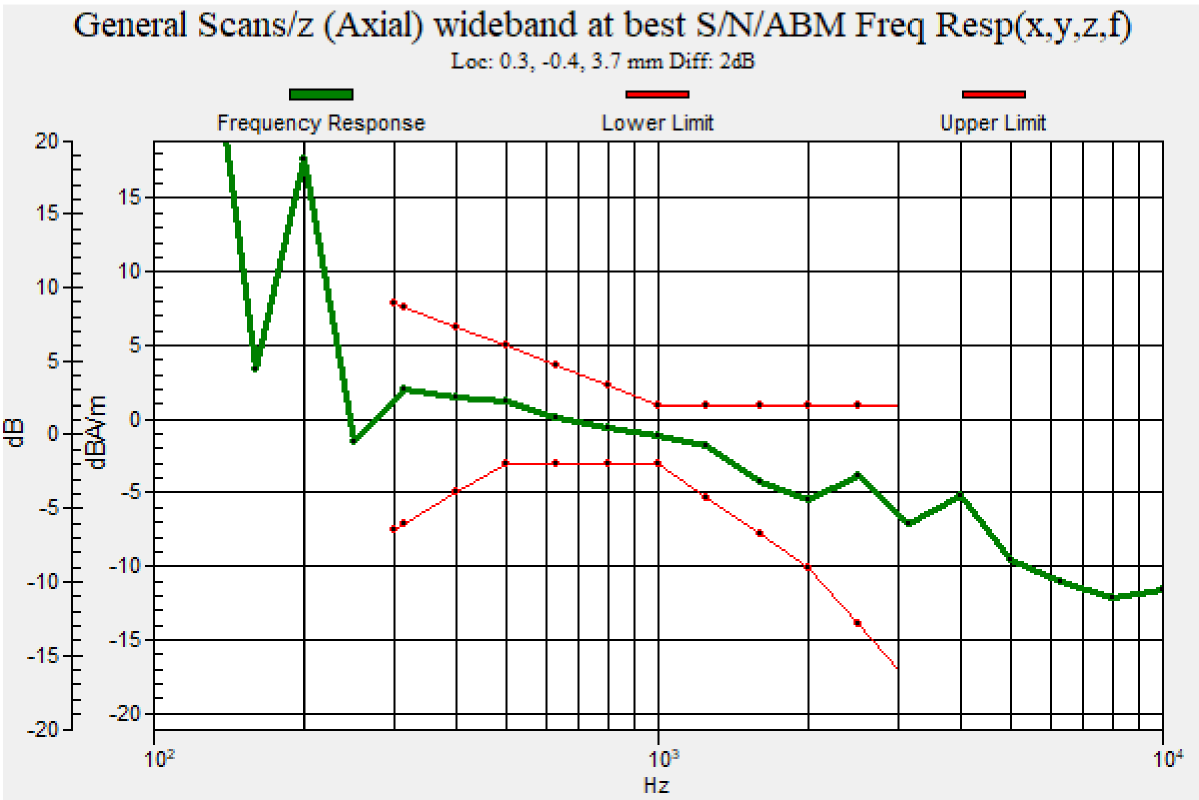
# P01 T-Coil_WCDMA II_Ch9400_AMR 4.75kbps_Sample1_Freq Resp

**DUT: 191212C04**

Communication System: UMTS-FDD (WCDMA, AMR); Frequency: 1880 MHz;Duty Cycle: 1:1.73
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3060; ; Calibrated: 2019/01/29
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1277; Calibrated: 2019/01/24
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Measurement grid: dx=10mm, dy=10mm



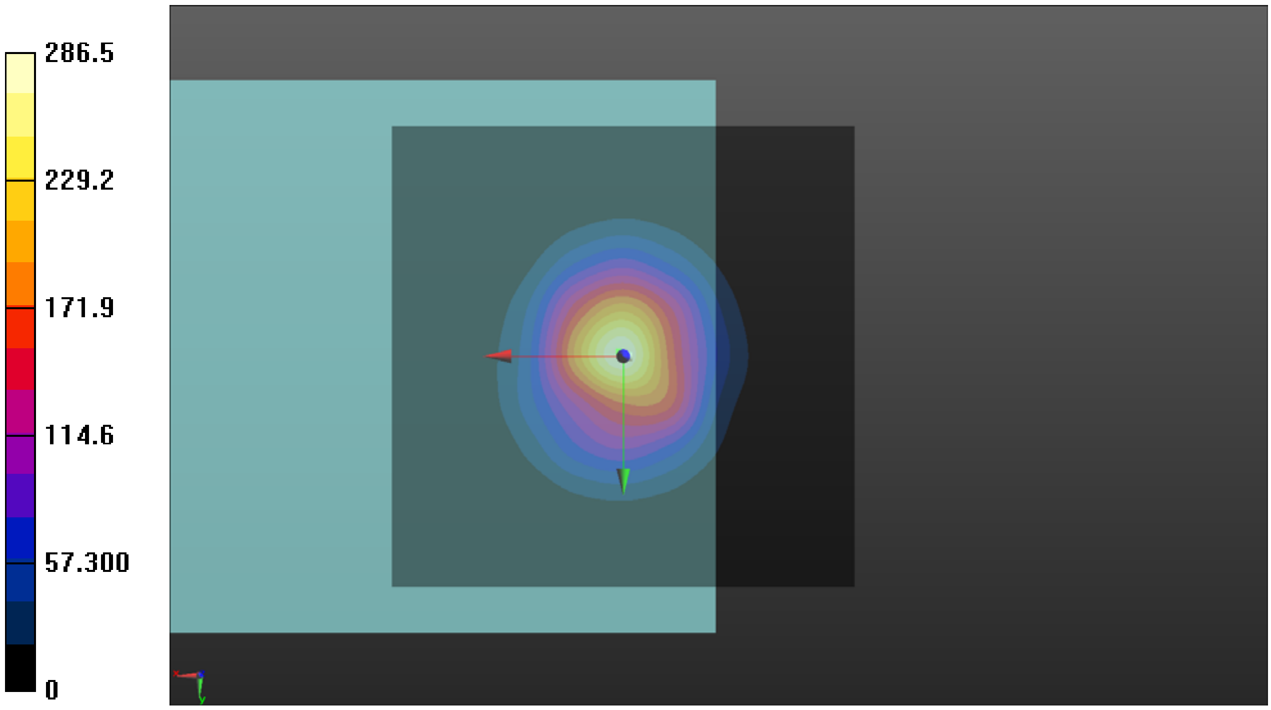
## P02 T-Coil_WCDMA V_Ch4182_AMR 4.75kbps_Sample1_Axial (Z)

**DUT: 191212C04**

Communication System: UMTS-FDD (WCDMA, AMR); Frequency: 836.4 MHz;Duty Cycle: 1:1.73
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3060; ; Calibrated: 2019/01/29
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1277; Calibrated: 2019/01/24
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 49.14 dB
ABM1 comp = -1.18 dBA/m
Location: 0.5, -0.5, 3.7 mm



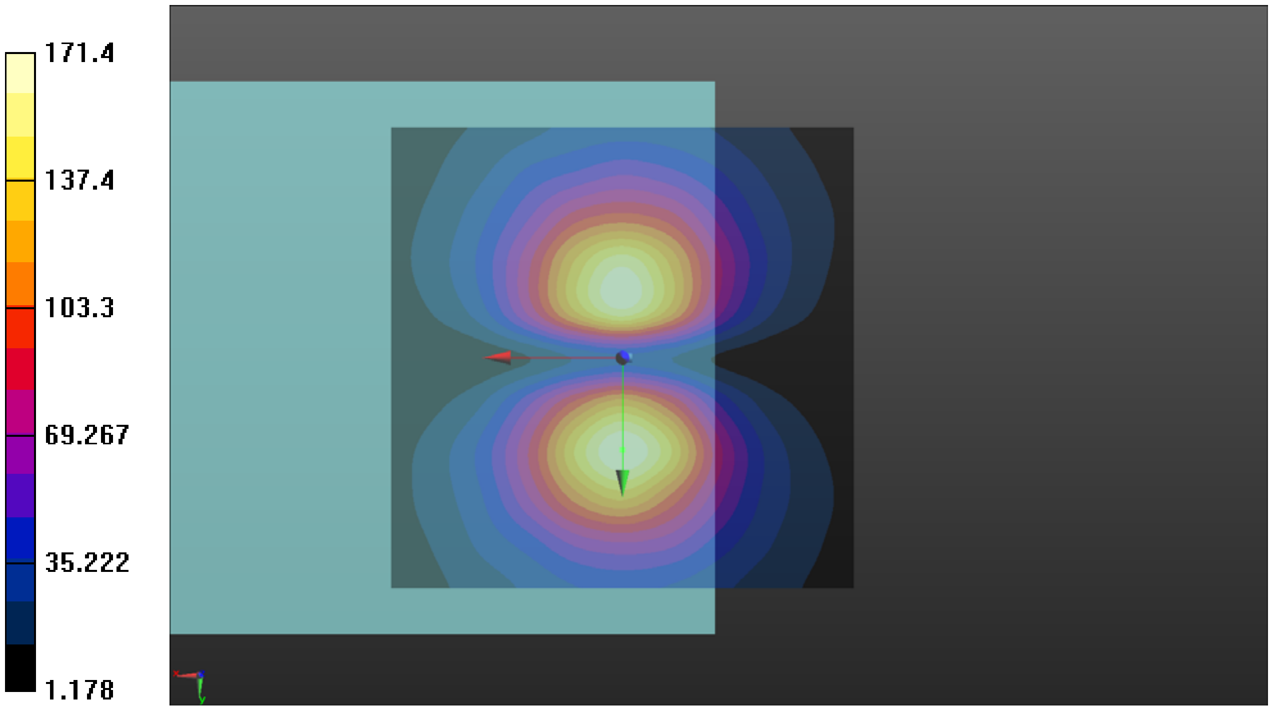
## P02 T-Coil_WCDMA V_Ch4182_AMR 4.75kbps_Sample1_Radial (Y)

**DUT: 191212C04**

Communication System: UMTS-FDD (WCDMA, AMR); Frequency: 836.4 MHz;Duty Cycle: 1:1.73
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3060; ; Calibrated: 2019/01/29
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1277; Calibrated: 2019/01/24
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 44.68 dB
ABM1 comp = -9.78 dBA/m
Location: 0, 10, 3.7 mm



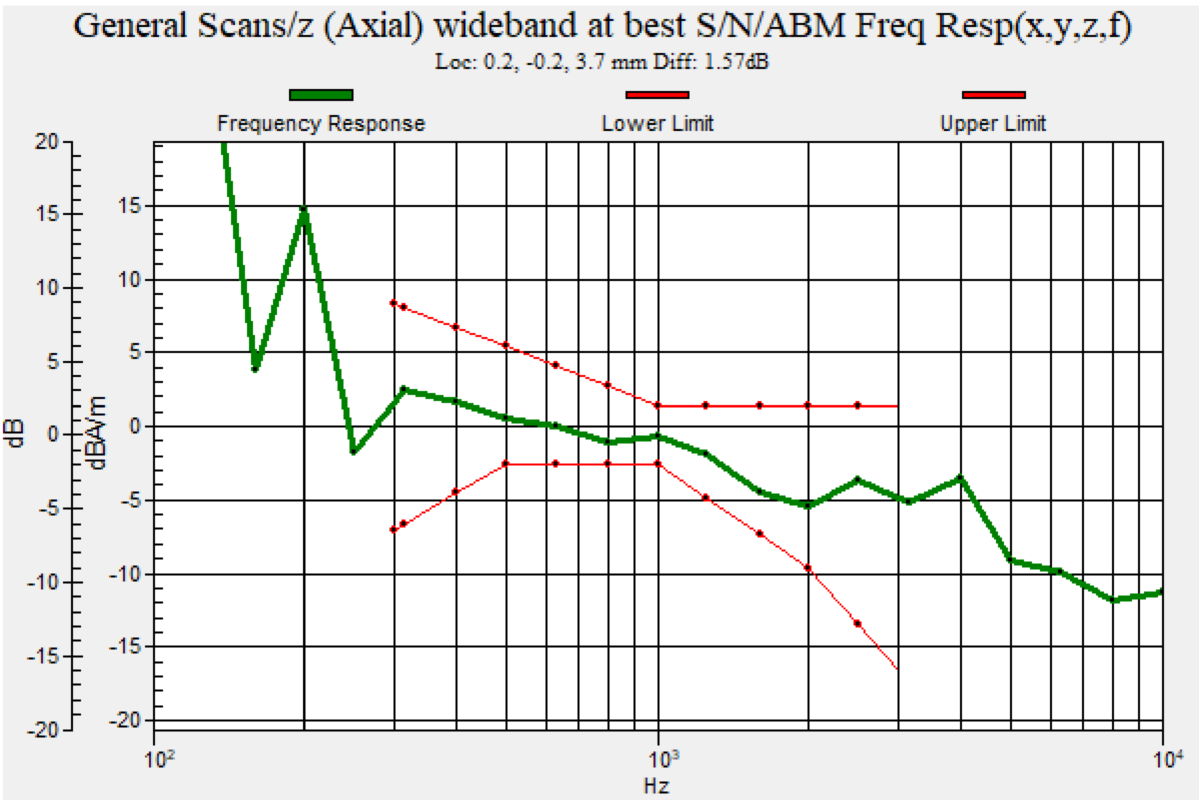
## P02 T-Coil_WCDMA V_Ch4182_AMR 4.75kbps_Sample1_Freq Resp

### DUT: 191212C04

Communication System: UMTS-FDD (WCDMA, AMR); Frequency: 836.4 MHz;Duty Cycle: 1:1.73
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3060; ; Calibrated: 2019/01/29
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1277; Calibrated: 2019/01/24
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Measurement grid: dx=10mm, dy=10mm



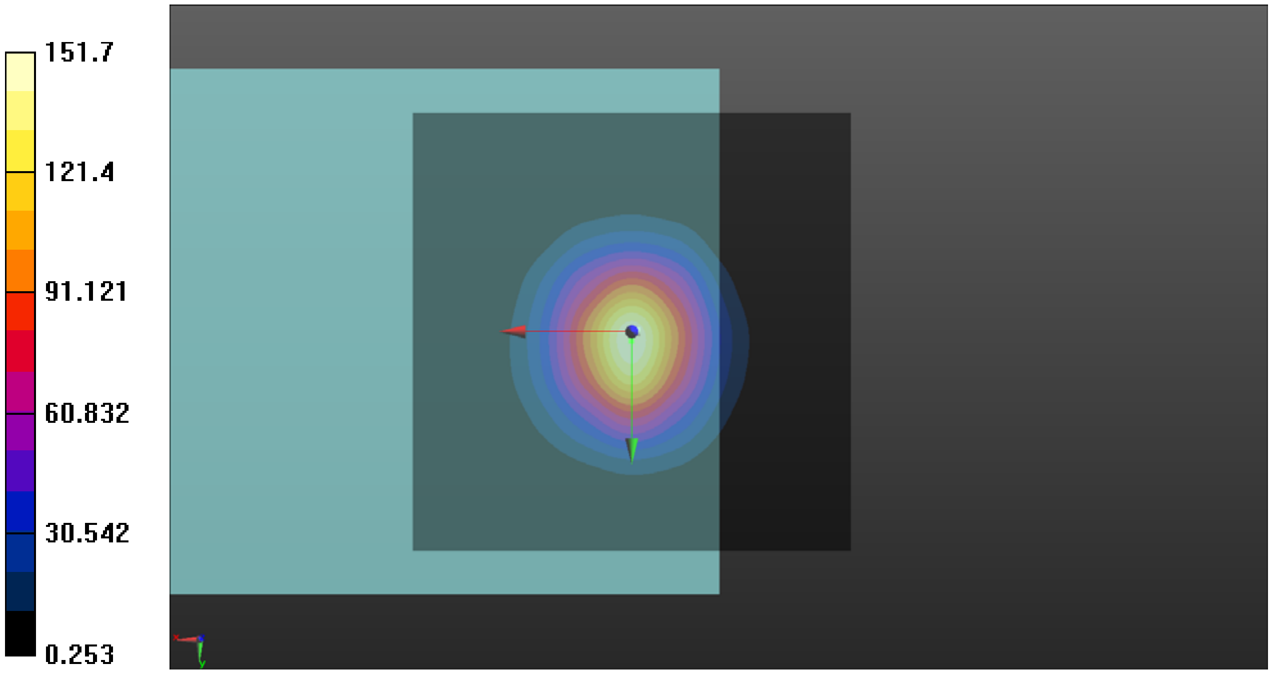
## P03 T-Coil_LTE 2_QPSK20M_Ch18900_1RB_OS0_AMR WB 6.6kbps_Sample1_Axial (Z)

**DUT: 191212C04**

Communication System: Generic LTE; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3067; ; Calibrated: 2019/12/10
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1431; Calibrated: 2019/03/25
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 43.62 dB
ABM1 comp = -2.64 dBA/m
Location: 0, 1, 3.7 mm



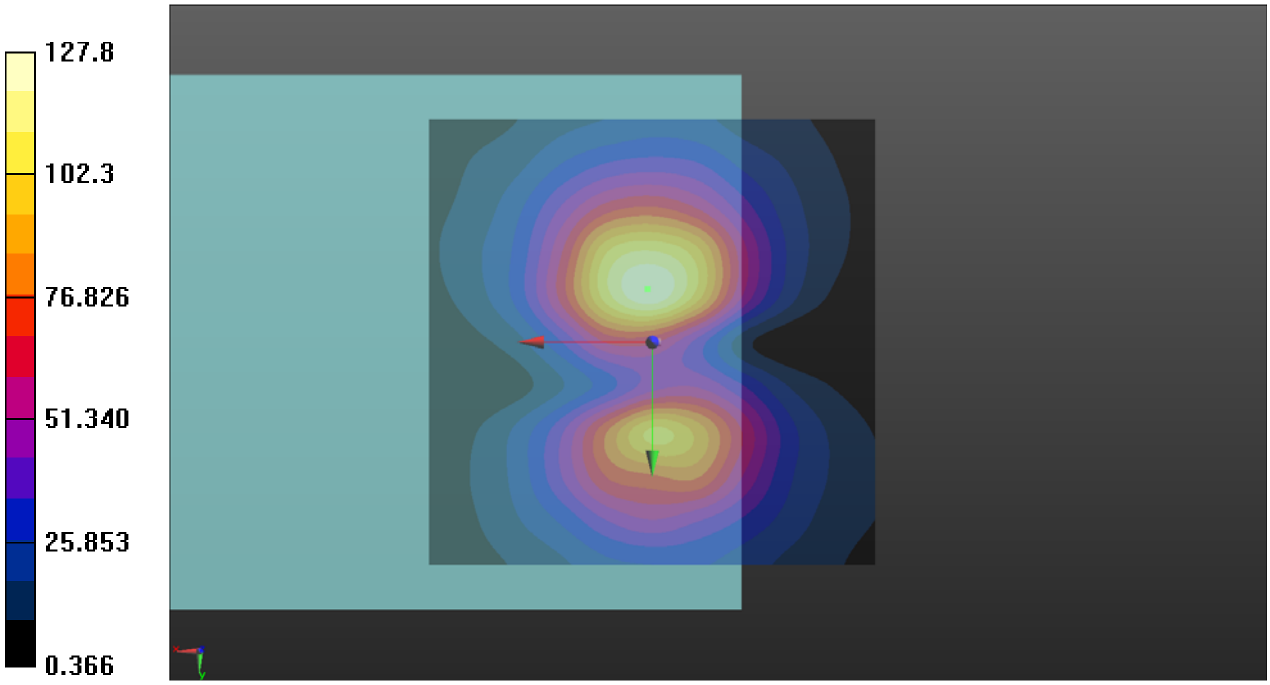
# P03 T-Coil_LTE 2_QPSK20M_Ch18900_1RB_OS0_AMR WB 6.6kbps_Sample1_Radial (Y)

**DUT: 191212C04**

Communication System: Generic LTE; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3067; ; Calibrated: 2019/12/10
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1431; Calibrated: 2019/03/25
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 42.13 dB
ABM1 comp = -11.21 dBA/m
Location: 0.5, -6, 3.7 mm



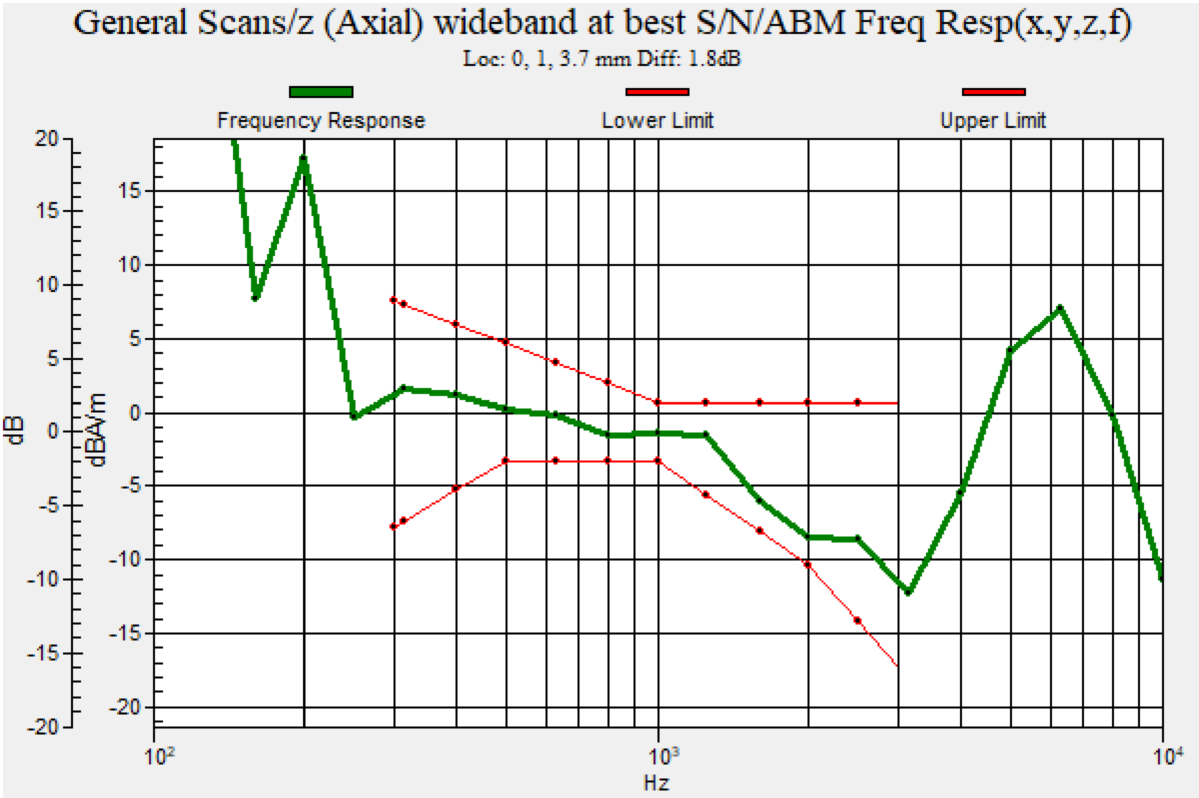
## P03 T-Coil_LTE 2_QPSK20M_Ch18900_1RB_OS0_AMR WB 6.6kbps_Sample1_Freq Resp

**DUT: 191212C04**

Communication System: Generic LTE; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3067; ; Calibrated: 2019/12/10
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1431; Calibrated: 2019/03/25
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Measurement grid: dx=10mm, dy=10mm



Test Laboratory: Bureau Veritas ADT SAR/HAC Testing Lab Date: 2020/01/15

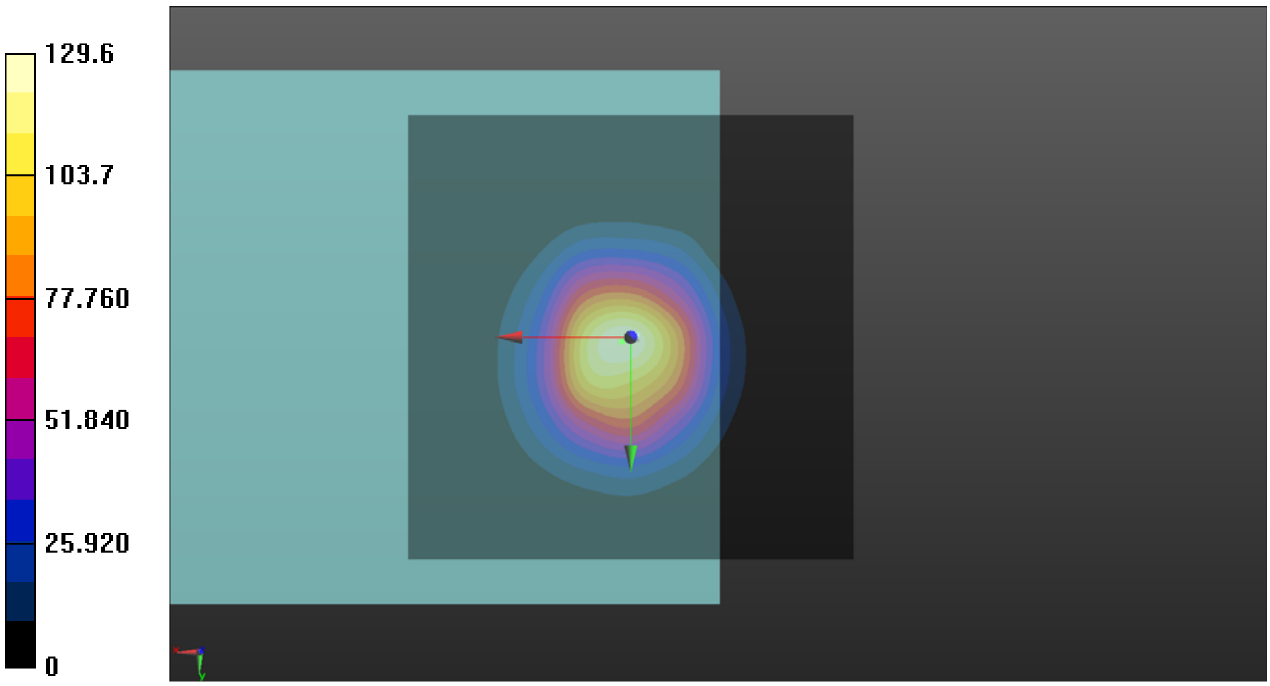
# P04 T-Coil_LTE 4_QPSK20M_Ch20175_1RB_OS0_AMR WB 6.6kbps_Sample1_Axial (Z)

**DUT: 191212C04**

Communication System: Generic LTE; Frequency: 1732.5 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3067; ; Calibrated: 2019/12/10
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1431; Calibrated: 2019/03/25
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 42.25 dB
ABM1 comp = -2.79 dBA/m
Location: 1, 0.5, 3.7 mm



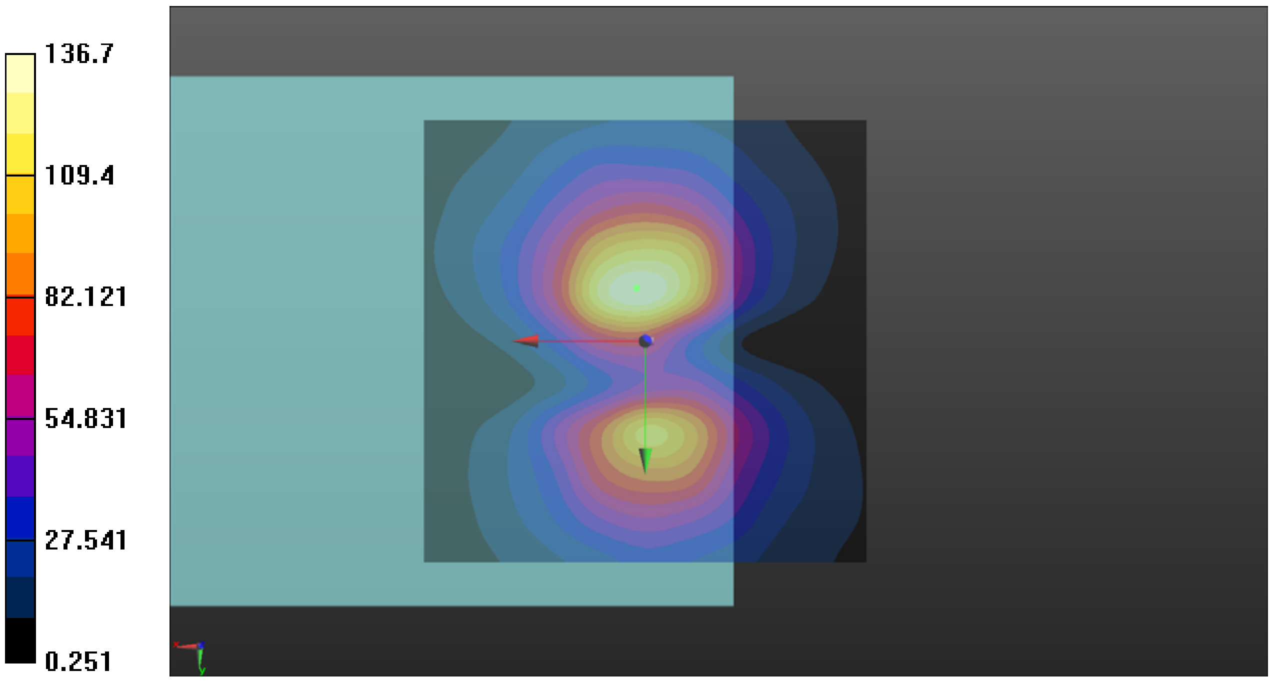
# P04 T-Coil_LTE 4_QPSK20M_Ch20175_1RB_OS0_AMR WB 6.6kbps_Sample1_Radial (Y)

**DUT: 191212C04**

Communication System: Generic LTE; Frequency: 1732.5 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3067; ; Calibrated: 2019/12/10
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1431; Calibrated: 2019/03/25
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 42.72 dB
ABM1 comp = -10.51 dBA/m
Location: 1, -6, 3.7 mm



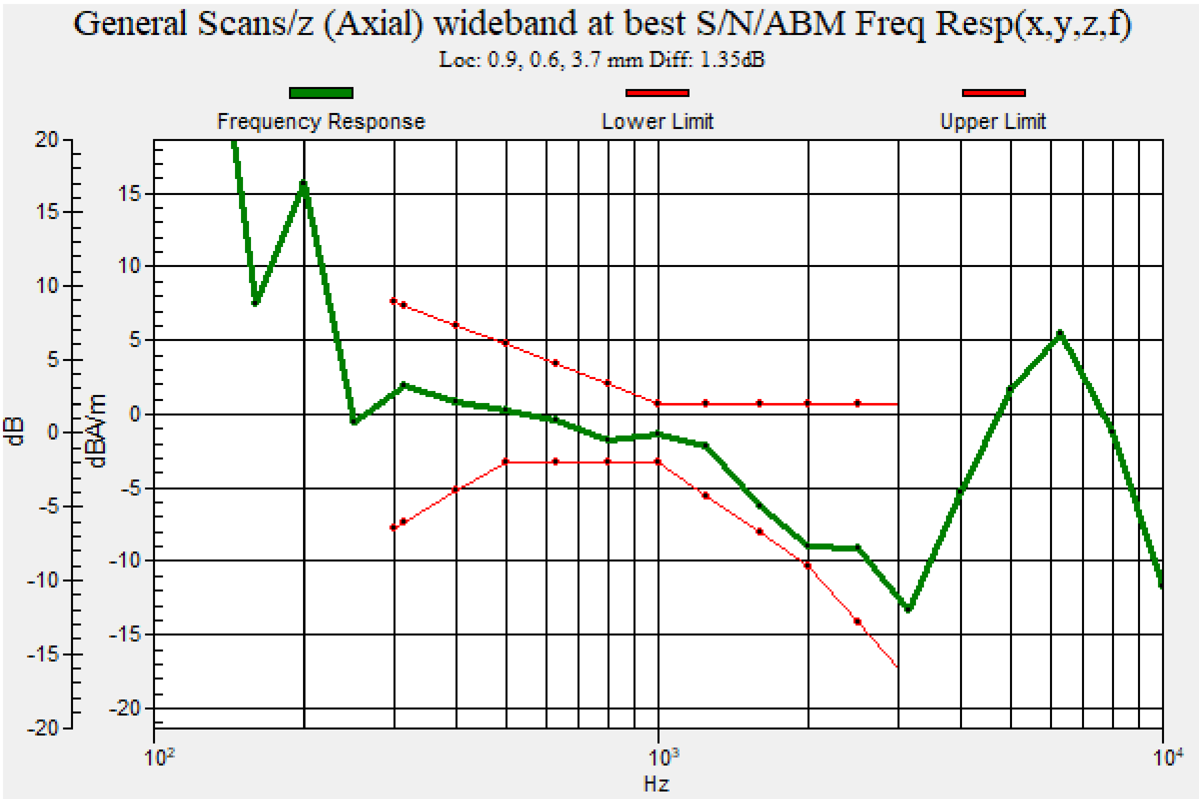
# P04 T-Coil_LTE 4_QPSK20M_Ch20175_1RB_OS0_AMR WB 6.6kbps_Sample1_Freq Resp

**DUT: 191212C04**

Communication System: Generic LTE; Frequency: 1732.5 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3067; ; Calibrated: 2019/12/10
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1431; Calibrated: 2019/03/25
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Measurement grid: dx=10mm, dy=10mm



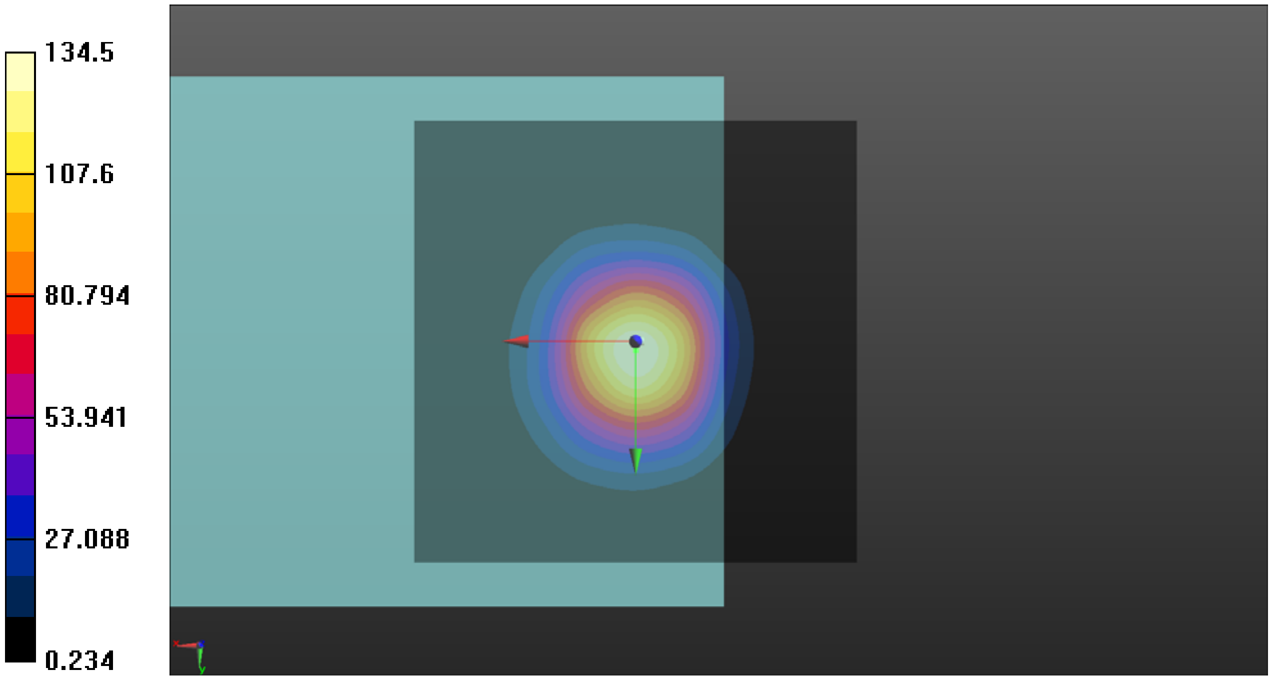
# P05 T-Coil_LTE 5_QPSK10M_Ch20525_1RB_OS0_AMR WB 6.6kbps_Sample1_Axial (Z)

**DUT: 191212C04**

Communication System: Generic LTE; Frequency: 836.5 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3067; ; Calibrated: 2019/12/10
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1431; Calibrated: 2019/03/25
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 42.58 dB
ABM1 comp = -2.65 dBA/m
Location: 0, 1, 3.7 mm



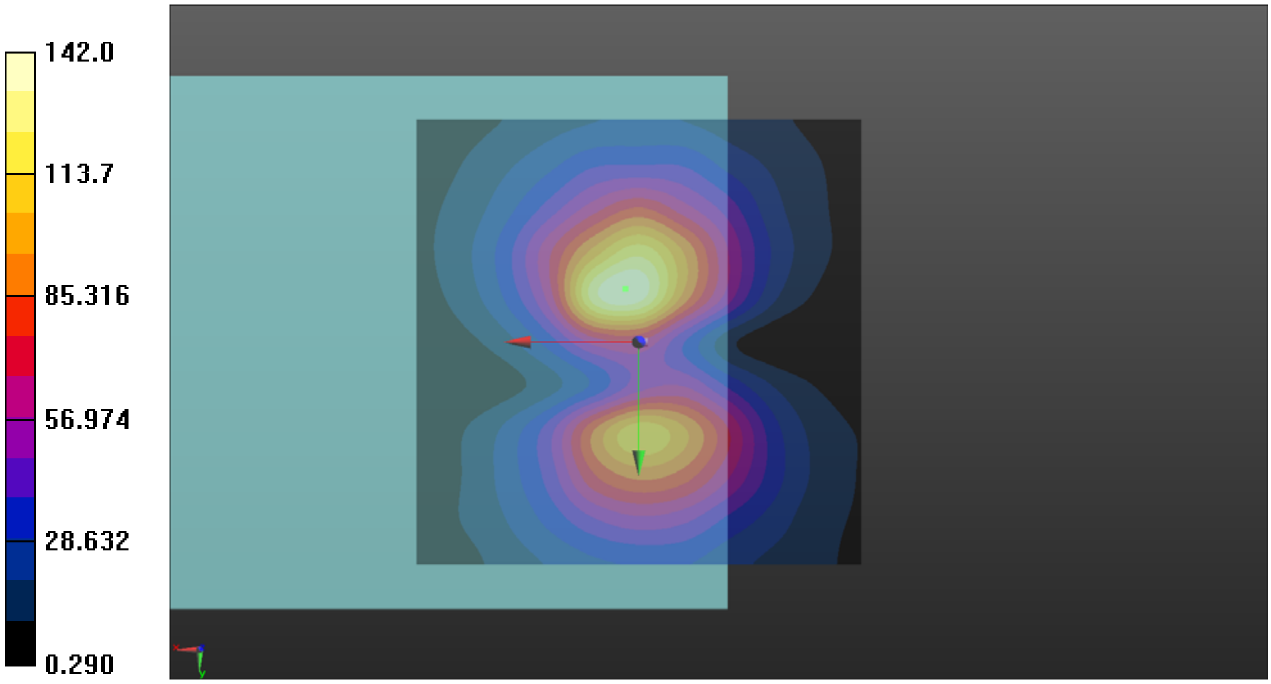
## P05 T-Coil_LTE 5_QPSK10M_Ch20525_1RB_OS0_AMR WB 6.6kbps_Sample1_Radial (Y)

**DUT: 191212C04**

Communication System: Generic LTE; Frequency: 836.5 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3067; ; Calibrated: 2019/12/10
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1431; Calibrated: 2019/03/25
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 43.05 dB
ABM1 comp = -10.55 dBA/m
Location: 1.5, -6, 3.7 mm



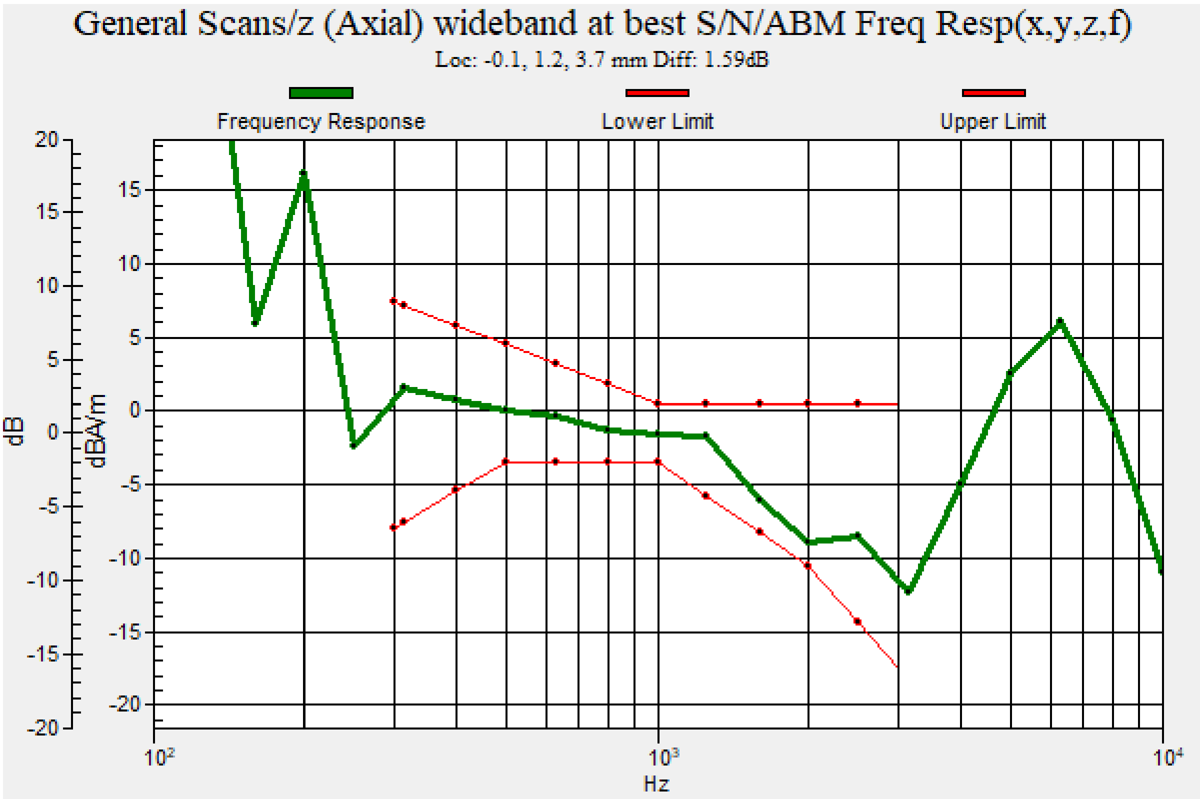
# P05 T-Coil_LTE 5_QPSK10M_Ch20525_1RB_OS0_AMR WB 6.6kbps_Sample1_Freq Resp

**DUT: 191212C04**

Communication System: Generic LTE; Frequency: 836.5 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3067; ; Calibrated: 2019/12/10
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1431; Calibrated: 2019/03/25
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Measurement grid: dx=10mm, dy=10mm



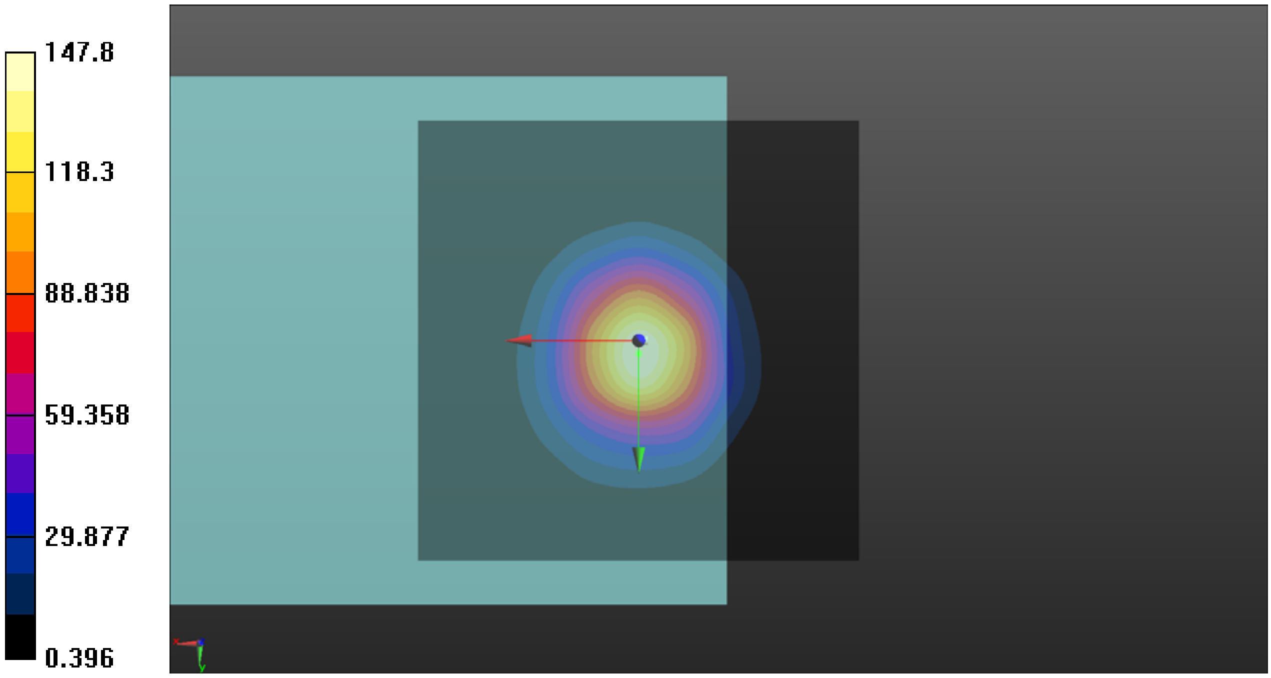
# P06 T-Coil_LTE 12_QPSK10M_Ch23095_1RB_OS0_AMR WB 6.6kbps_Sample1_Axial (Z)

**DUT: 191212C04**

Communication System: Generic LTE; Frequency: 707.5 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3067; ; Calibrated: 2019/12/10
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1431; Calibrated: 2019/03/25
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 43.40 dB
ABM1 comp = -3.12 dBA/m
Location: 0, 1.5, 3.7 mm



Test Laboratory: Bureau Veritas ADT SAR/HAC Testing Lab                                        Date: 2020/01/15

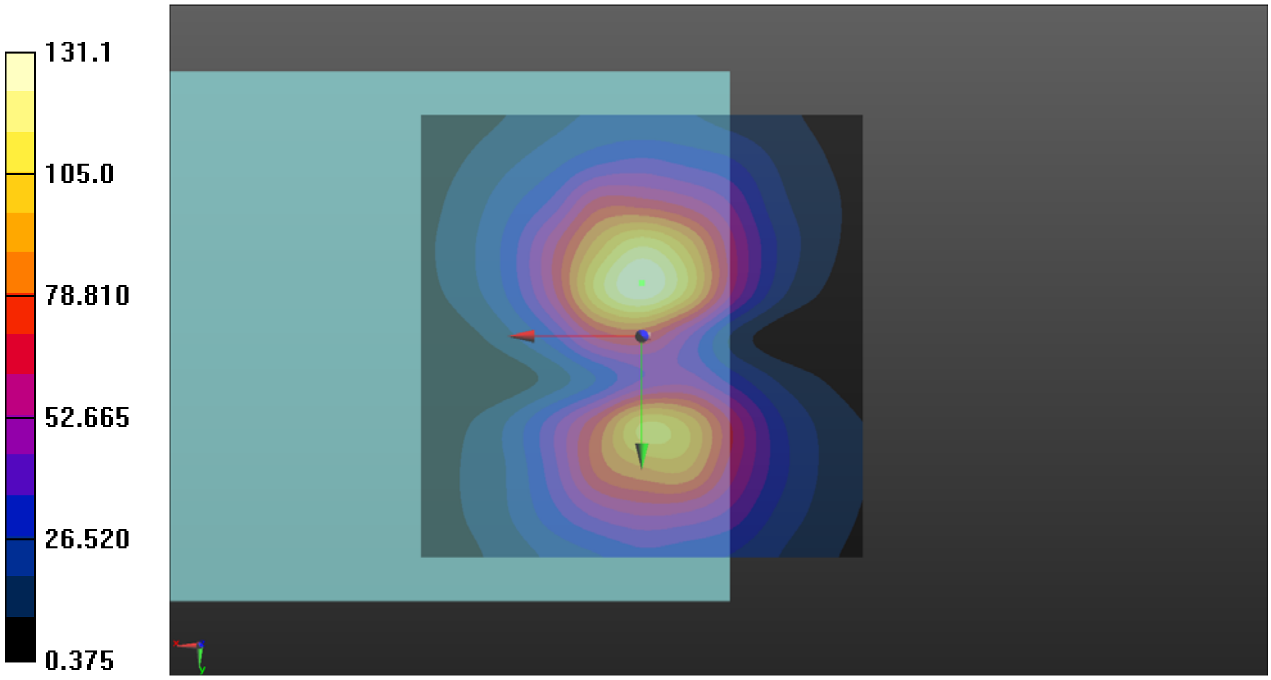
## P06 T-Coil_LTE 12_QPSK10M_Ch23095_1RB_OS0_AMR WB 6.6kbps_Sample1_Radial (Y)

**DUT: 191212C04**

Communication System: Generic LTE; Frequency: 707.5 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3067; ; Calibrated: 2019/12/10
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1431; Calibrated: 2019/03/25
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 42.35 dB
ABM1 comp = -11.39 dBA/m
Location: 0, -6, 3.7 mm



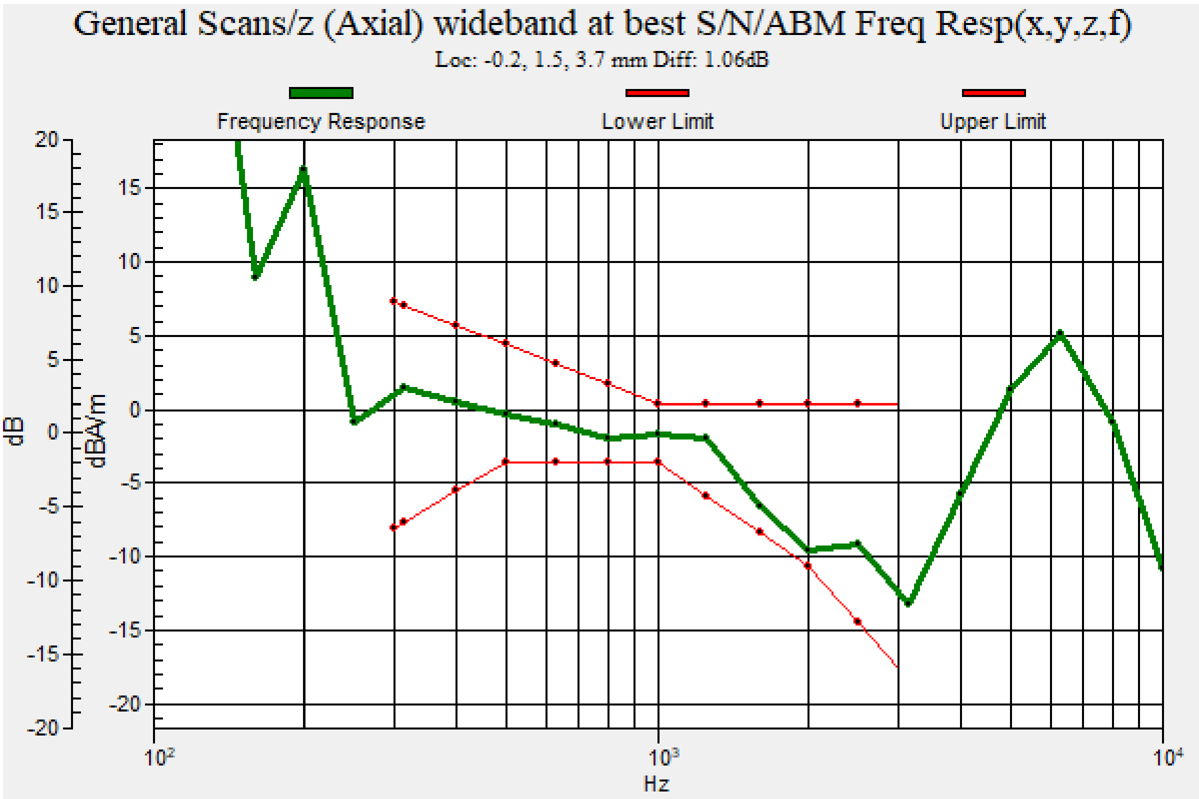
# P06 T-Coil_LTE 12_QPSK10M_Ch23095_1RB_OS0_AMR WB 6.6kbps_Sample1_Freq Resp

**DUT: 191212C04**

Communication System: Generic LTE; Frequency: 707.5 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3067; ; Calibrated: 2019/12/10
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1431; Calibrated: 2019/03/25
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Measurement grid: dx=10mm, dy=10mm



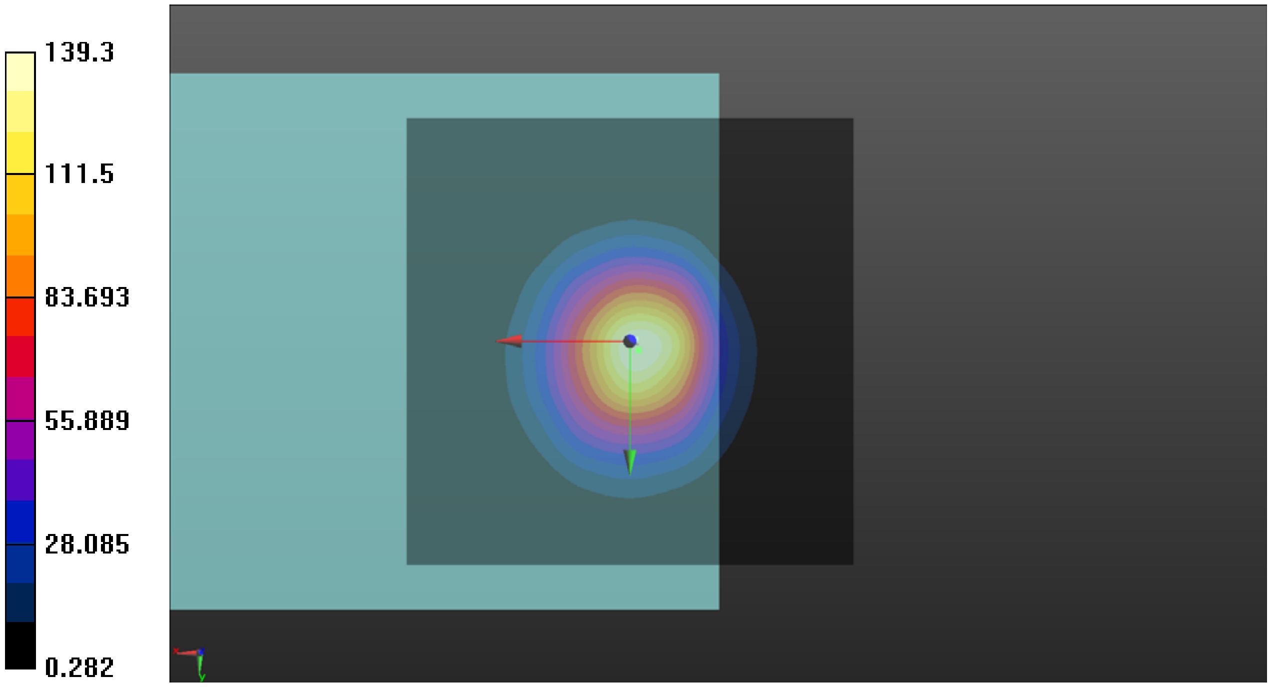
## P07 T-Coil_LTE 13_QPSK10M_Ch23230_1RB_OS0_AMR WB 6.6kbps_Sample1_Axial (Z)

**DUT: 191212C04**

Communication System: Generic LTE; Frequency: 782 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3067; ; Calibrated: 2019/12/10
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1431; Calibrated: 2019/03/25
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 42.88 dB
ABM1 comp = -3.18 dBA/m
Location: -1, 1, 3.7 mm



Test Laboratory: Bureau Veritas ADT SAR/HAC Testing Lab Date: 2020/01/15

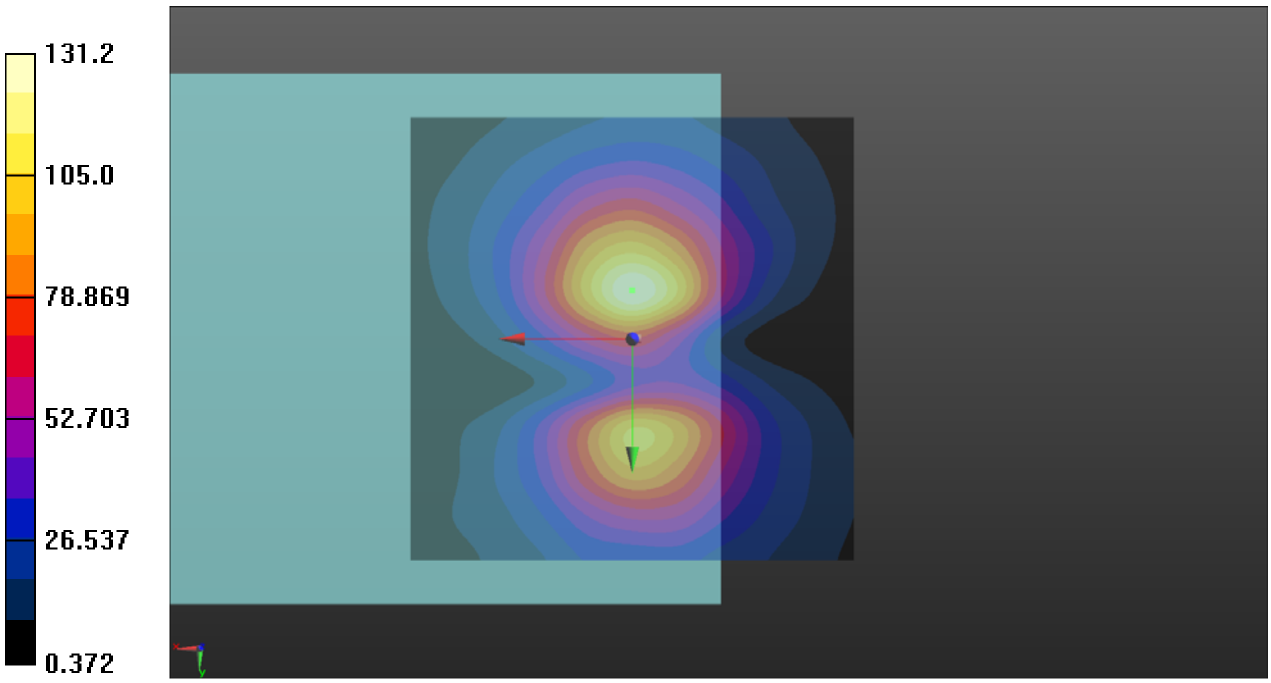
## P07 T-Coil_LTE 13_QPSK10M_Ch23230_1RB_OS0_AMR WB 6.6kbps_Sample1_Radial (Y)

**DUT: 191212C04**

Communication System: Generic LTE; Frequency: 782 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3067; ; Calibrated: 2019/12/10
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1431; Calibrated: 2019/03/25
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 42.36 dB
ABM1 comp = -11.29 dBA/m
Location: 0, -5.5, 3.7 mm



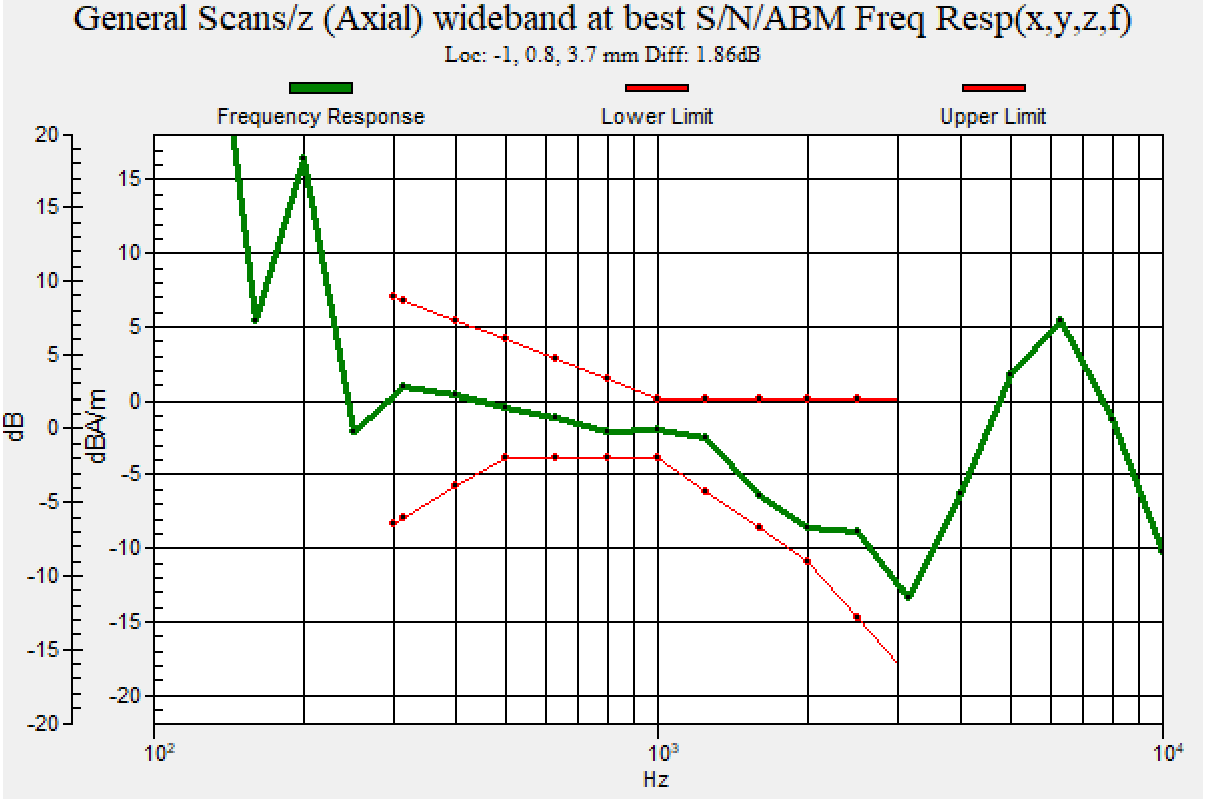
# P07 T-Coil_LTE 13_QPSK10M_Ch23230_1RB_OS0_AMR WB 6.6kbps_Sample1_Freq Resp

**DUT: 191212C04**

Communication System: Generic LTE; Frequency: 782 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3067; ; Calibrated: 2019/12/10
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1431; Calibrated: 2019/03/25
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (3); SEMCAD X Version 14.6.13 (7474)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Measurement grid: dx=10mm, dy=10mm



Test Laboratory: Bureau Veritas ADT SAR/HAC Testing Lab Date: 2020/02/13

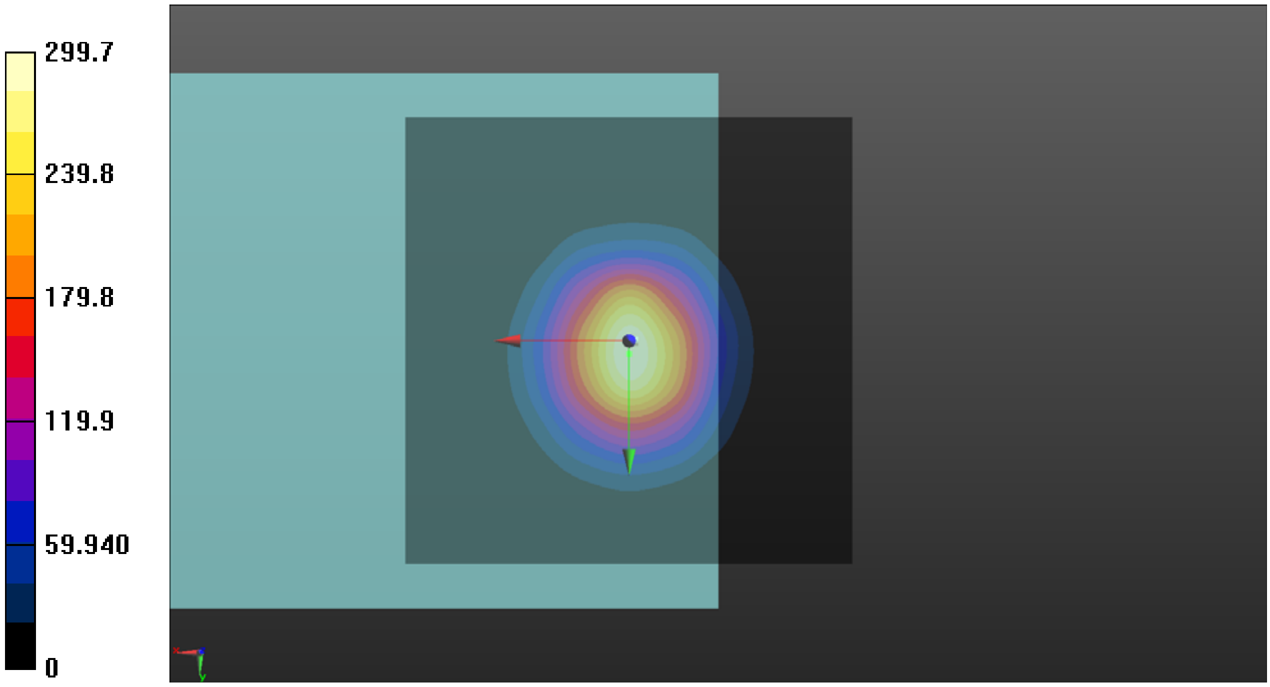
## P08 T-Coil_WLAN2.4G_802.11b_1Mbps_Ch6_AMR WB 6.6kbps_Sample1_Axial (Z)

**DUT: 191212C04**

Communication System: IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps); Frequency: 2437 MHz;Duty Cycle: 1:1.54
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3060; ; Calibrated: 2020/01/20
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 49.54 dB
ABM1 comp = 3.02 dBA/m
Location: 0, 1.5, 3.7 mm



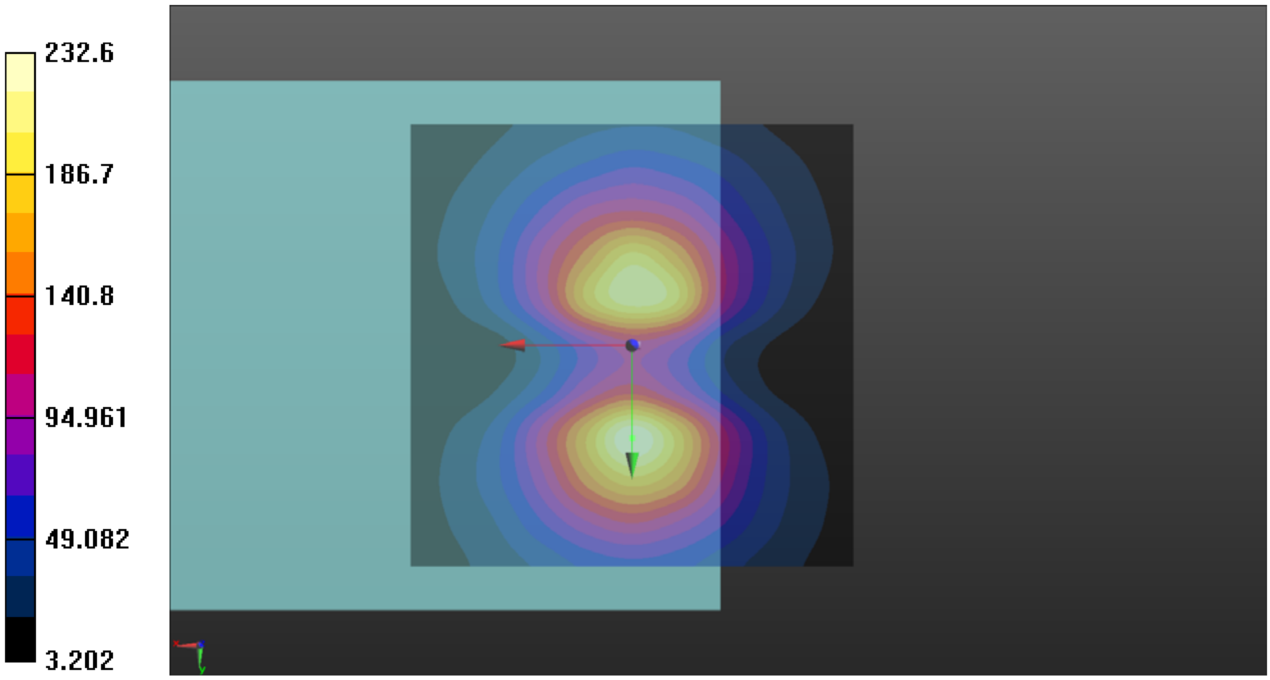
## P08 T-Coil_WLAN2.4G_802.11b_1Mbps_Ch6_AMR WB 6.6kbps_Sample1_Radial (Y)

**DUT: 191212C04**

Communication System: IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps); Frequency: 2437 MHz;Duty Cycle: 1:1.54
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3060; ; Calibrated: 2020/01/20
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 47.33 dB
ABM1 comp = -5.54 dBA/m
Location: 0, 10.5, 3.7 mm



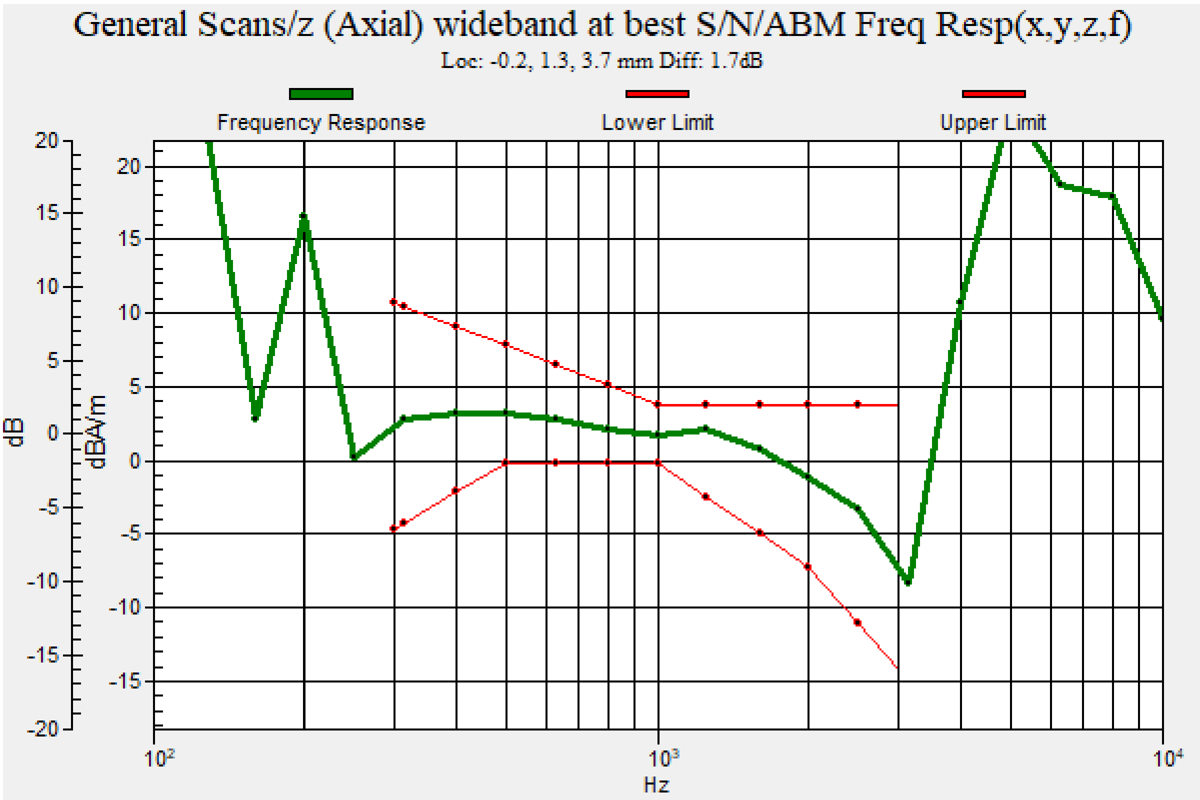
# P08 T-Coil_WLAN2.4G_802.11b_1Mbps_Ch6_AMR WB 6.6kbps_Sample1_Freq Resp

**DUT: 191212C04**

Communication System: IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps); Frequency: 2437 MHz;Duty Cycle: 1:1.54
Medium: Air Medium parameters used: σ = 0 S/m, $\varepsilon_r$ = 1; ρ = 1 kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3060; ; Calibrated: 2020/01/20
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Measurement grid: dx=10mm, dy=10mm



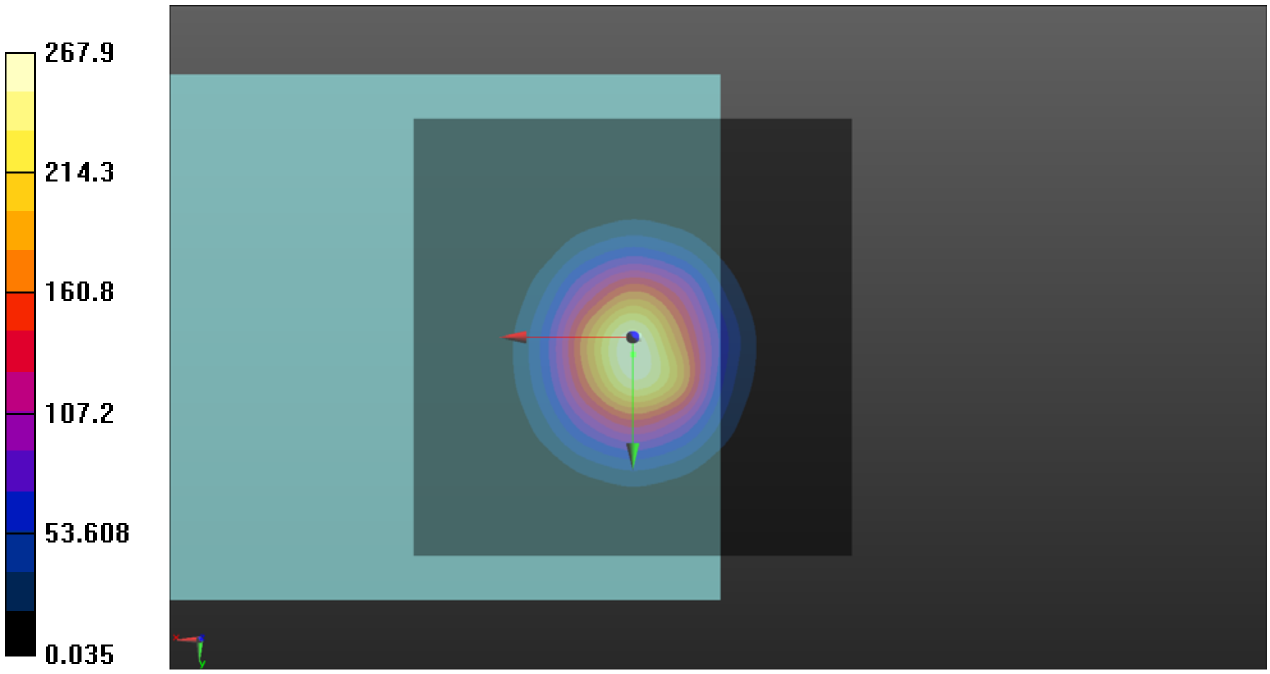
## P09 T-Coil_WLAN5.2G_802.11a_6Mbps_Ch40_AMR WB 6.6kbps_Sample1_Axial (Z)

**DUT: 191212C04**

Communication System: IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps); Frequency: 5200 MHz;Duty Cycle: 1:7.38
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3060; ; Calibrated: 2020/01/20
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 48.56 dB
ABM1 comp = 2.59 dBA/m
Location: 0, 2, 3.7 mm



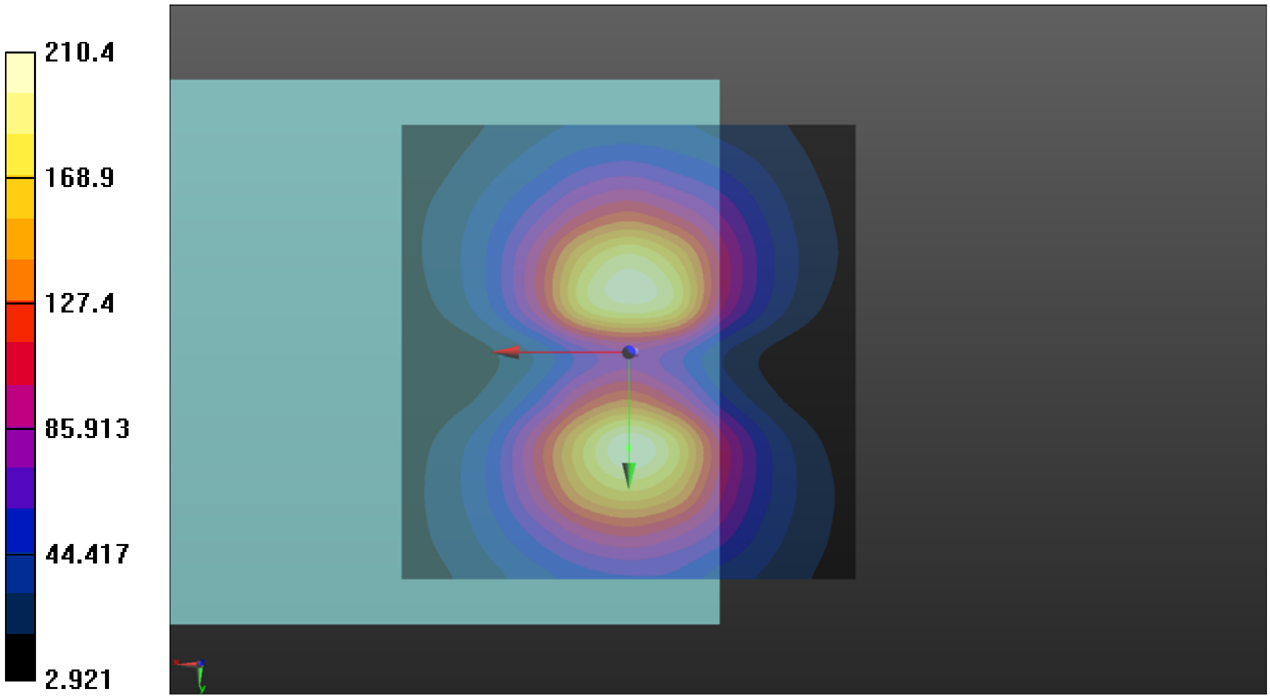
## P09 T-Coil_WLAN5.2G_802.11a_6Mbps_Ch40_AMR WB 6.6kbps_Sample1_Radial (Y)

**DUT: 191212C04**

Communication System: IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps); Frequency: 5200 MHz;Duty Cycle: 1:7.38
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3060; ; Calibrated: 2020/01/20
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 46.46 dB
ABM1 comp = -6.08 dBA/m
Location: 0, 10.5, 3.7 mm



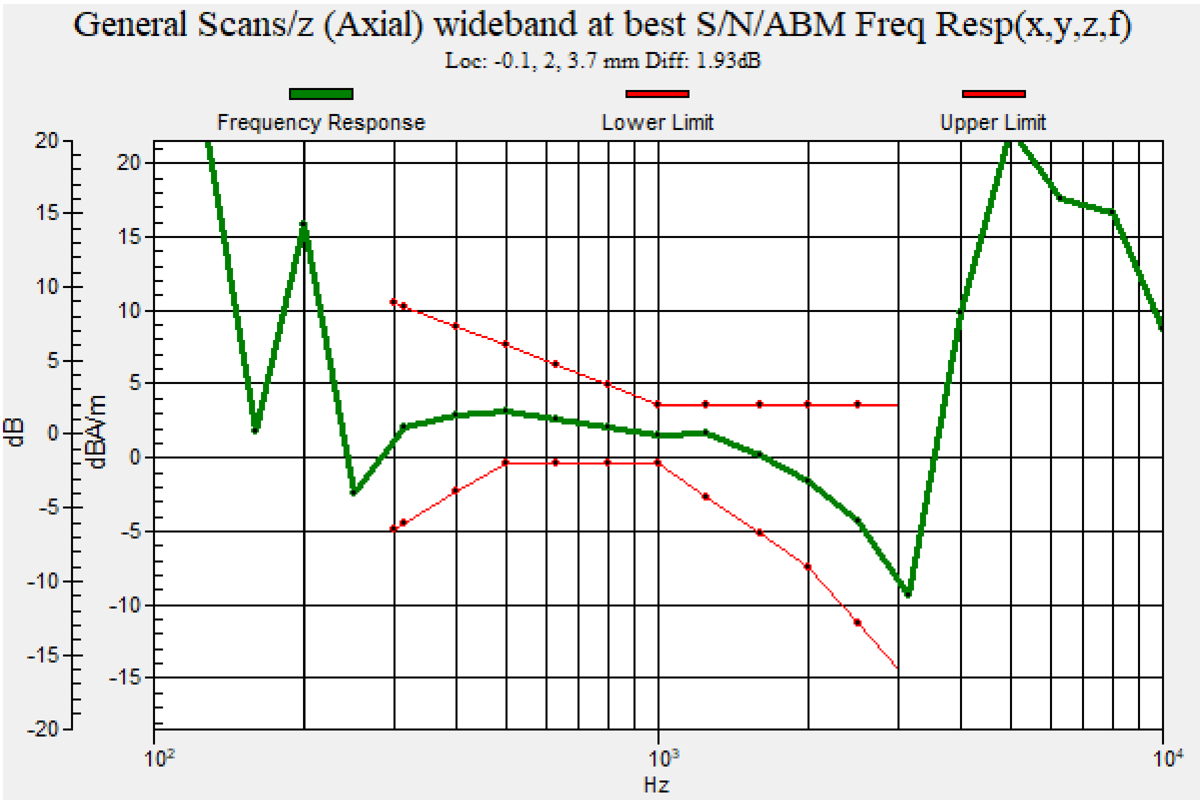
# P09 T-Coil_WLAN5.2G_802.11a_6Mbps_Ch40_AMR WB 6.6kbps_Sample1_Freq Resp

**DUT: 191212C04**

Communication System: IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps); Frequency: 5200 MHz;Duty Cycle: 1:7.38
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3060; ; Calibrated: 2020/01/20
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Measurement grid: dx=10mm, dy=10mm



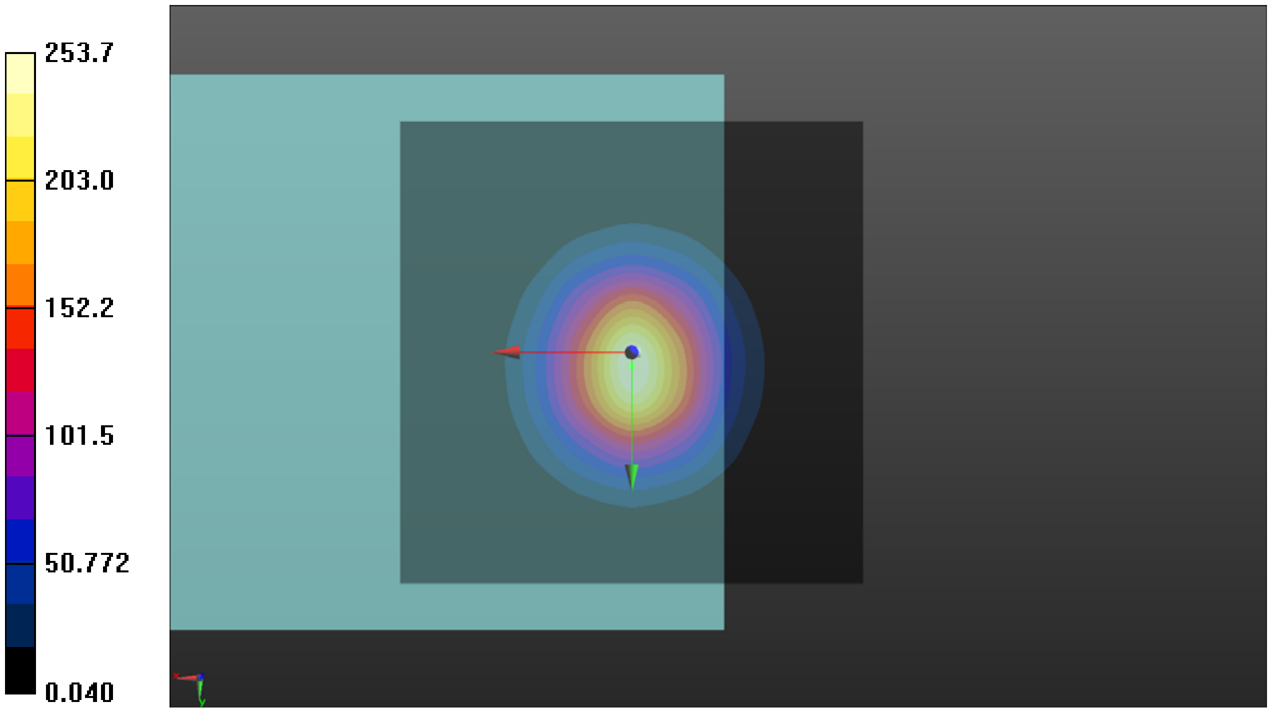
## P10 T-Coil_WLAN5.3G_802.11a_6Mbps_Ch52_AMR WB 6.6kbps_Sample1_Axial (Z)

**DUT: 191212C04**

Communication System: IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps); Frequency: 5260 MHz;Duty Cycle: 1:7.38
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3060; ; Calibrated: 2020/01/20
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 48.08 dB
ABM1 comp = 2.33 dBA/m
Location: 0, 1.5, 3.7 mm



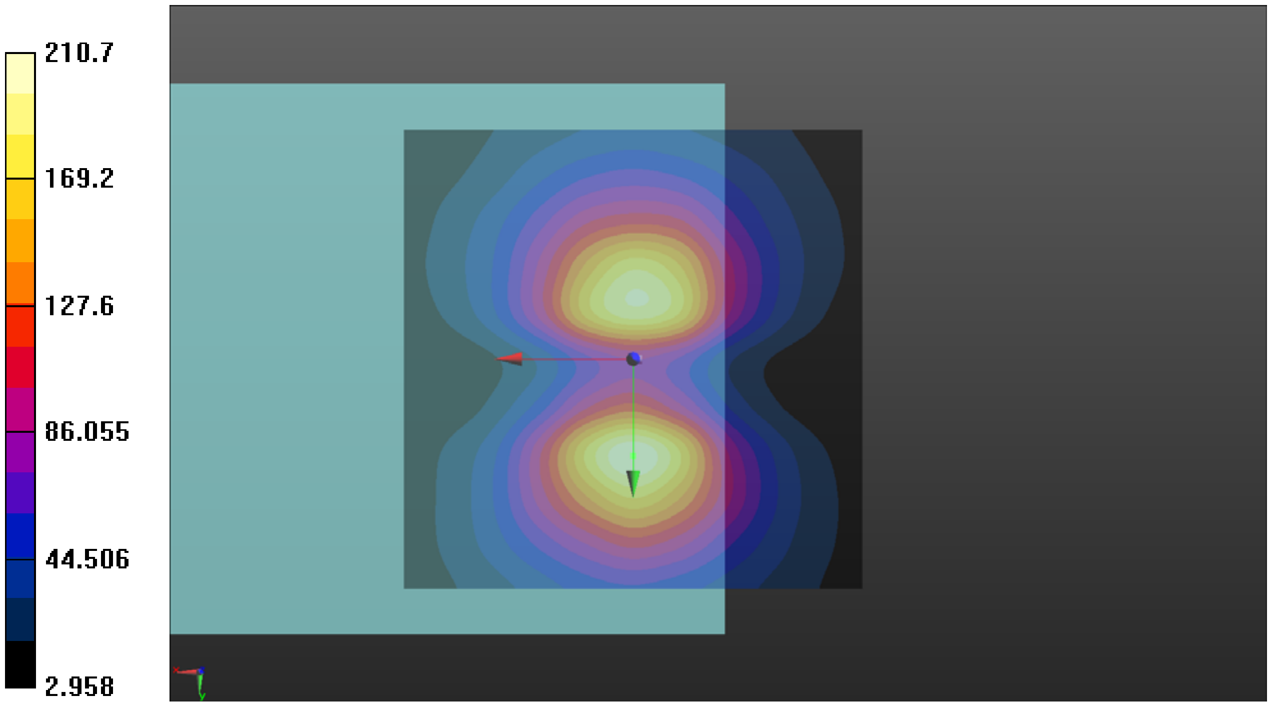
## P10 T-Coil_WLAN5.3G_802.11a_6Mbps_Ch52_AMR WB 6.6kbps_Sample1_Radial (Y)

**DUT: 191212C04**

Communication System: IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps); Frequency: 5260 MHz;Duty Cycle: 1:7.38
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3060; ; Calibrated: 2020/01/20
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 46.47 dB
ABM1 comp = -6.18 dBA/m
Location: 0, 10.5, 3.7 mm



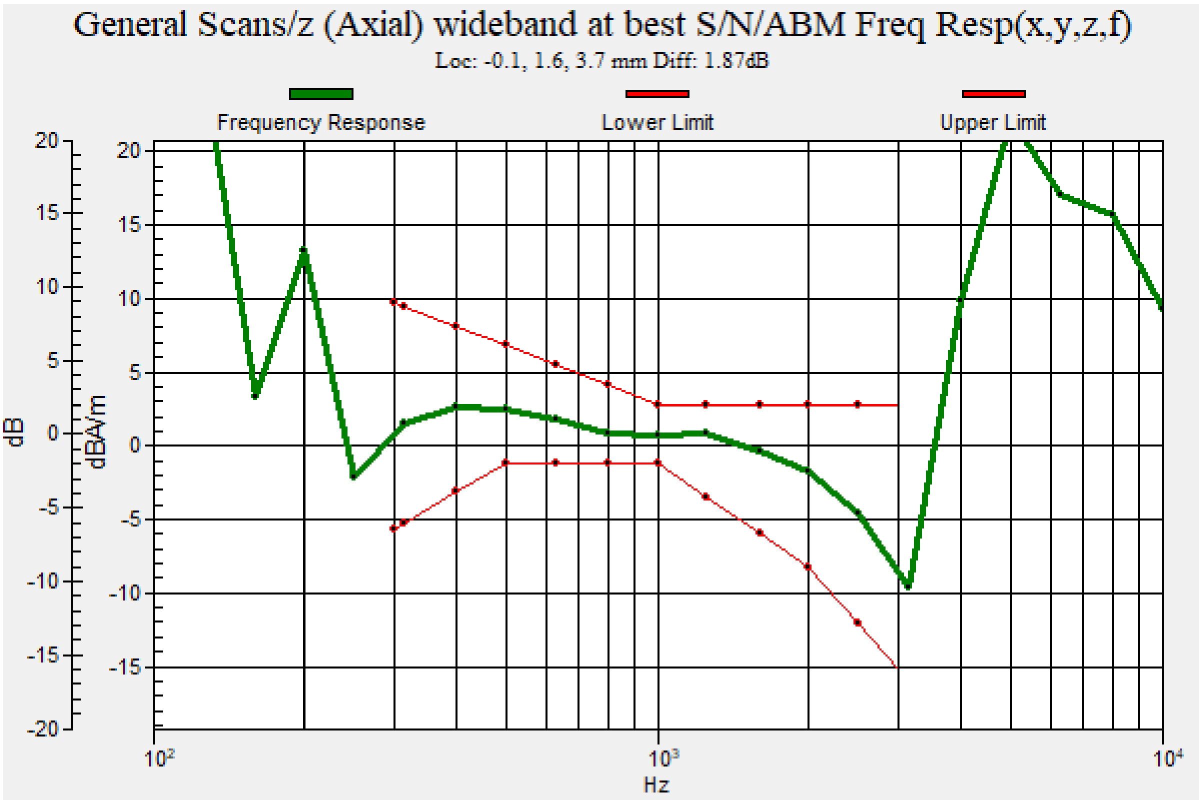
## P10 T-Coil_WLAN5.3G_802.11a_6Mbps_Ch52_AMR WB 6.6kbps_Sample1_Freq Resp

**DUT: 191212C04**

Communication System: IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps); Frequency: 5260 MHz;Duty Cycle: 1:7.38
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3060; ; Calibrated: 2020/01/20
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Measurement grid: dx=10mm, dy=10mm



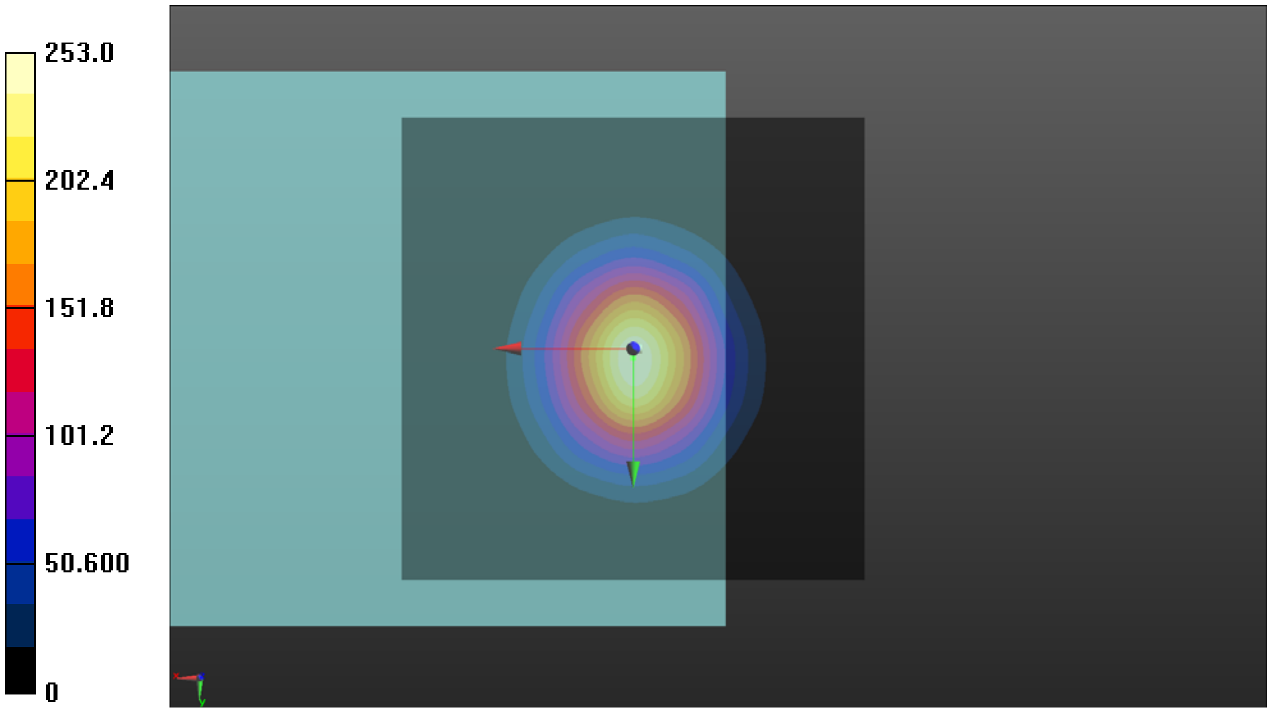
# P11 T-Coil_WLAN5.6G_802.11a_6Mbps_Ch116_AMR WB 6.6kbps_Sample1_Axial (Z)

**DUT: 191212C04**

Communication System: IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps); Frequency: 5580 MHz;Duty Cycle: 1:7.38
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3060; ; Calibrated: 2020/01/20
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 48.06 dB
ABM1 comp = 2.31 dBA/m
Location: 0, 1, 3.7 mm



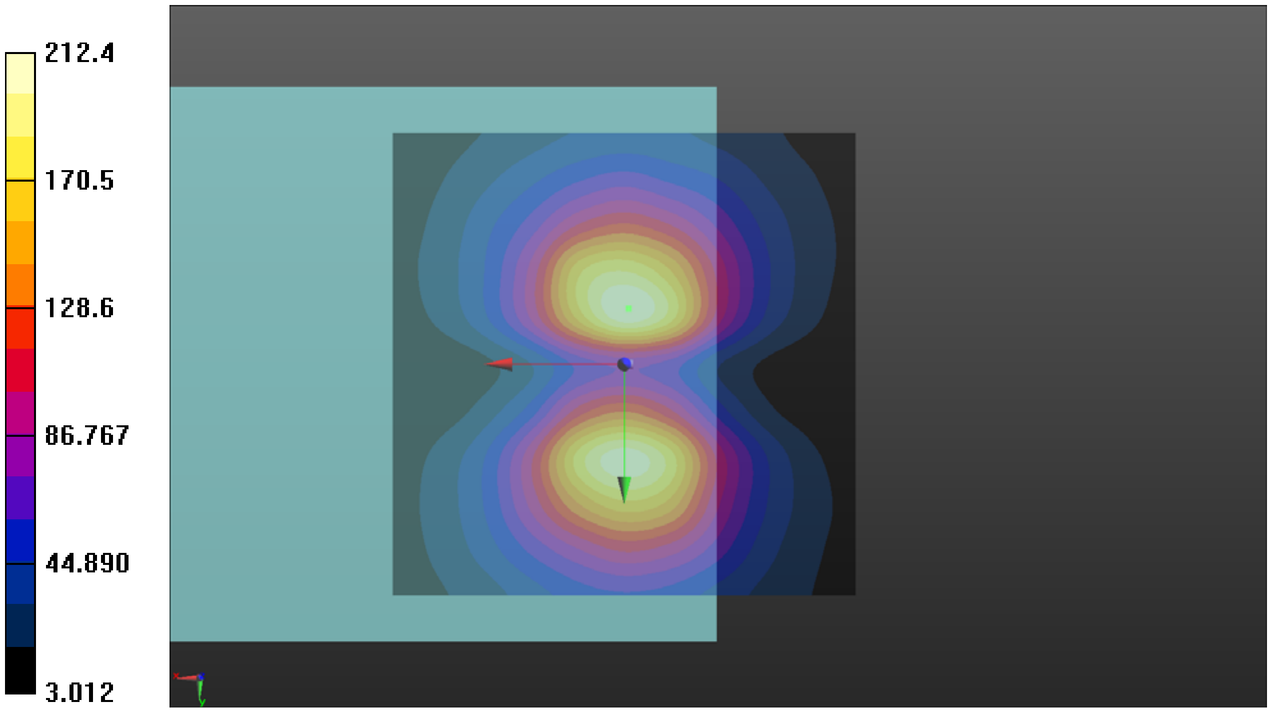
# P11 T-Coil_WLAN5.6G_802.11a_6Mbps_Ch116_AMR WB 6.6kbps_Sample1_Radial (Y)

**DUT: 191212C04**

Communication System: IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps); Frequency: 5580 MHz;Duty Cycle: 1:7.38
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3060; ; Calibrated: 2020/01/20
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 46.54 dB
ABM1 comp = -6.10 dBA/m
Location: -0.5, -6, 3.7 mm



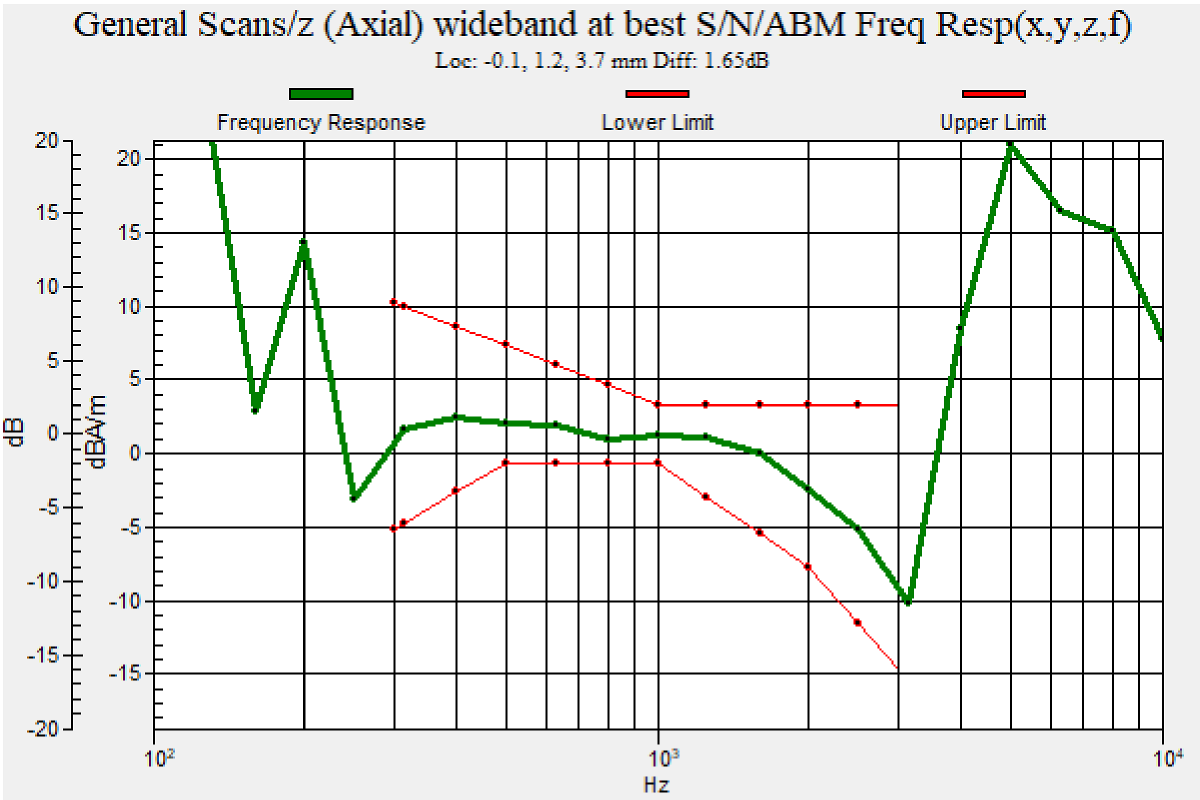
# P11 T-Coil_WLAN5.6G_802.11a_6Mbps_Ch116_AMR WB 6.6kbps_Sample1_Freq Resp

**DUT: 191212C04**

Communication System: IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps); Frequency: 5580 MHz;Duty Cycle: 1:7.38
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3060; ; Calibrated: 2020/01/20
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Measurement grid: dx=10mm, dy=10mm



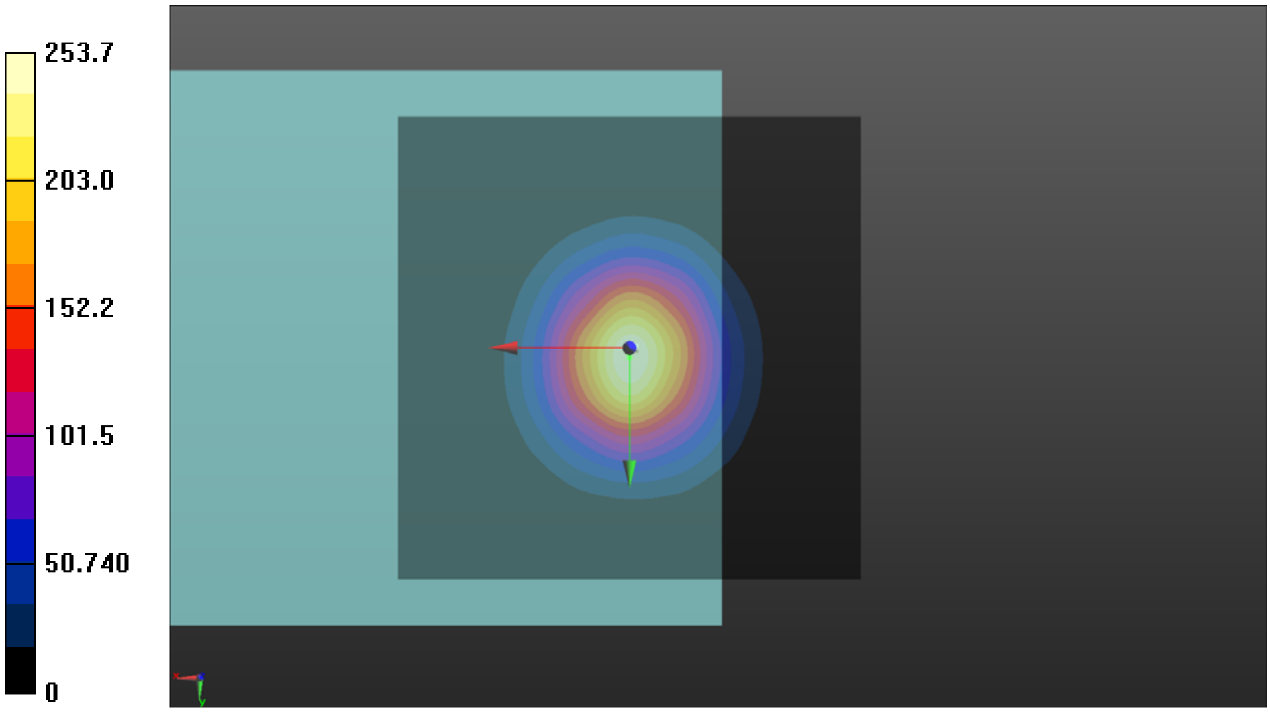
## P12 T-Coil_WLAN5.8G_802.11a_6Mbps_Ch157_AMR WB 6.6kbps_Sample1_Axial (Z)

**DUT: 191212C04**

Communication System: IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps); Frequency: 5785 MHz;Duty Cycle: 1:7.38
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3060; ; Calibrated: 2020/01/20
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 48.09 dB
ABM1 comp = 2.21 dBA/m
Location: 0, 1, 3.7 mm



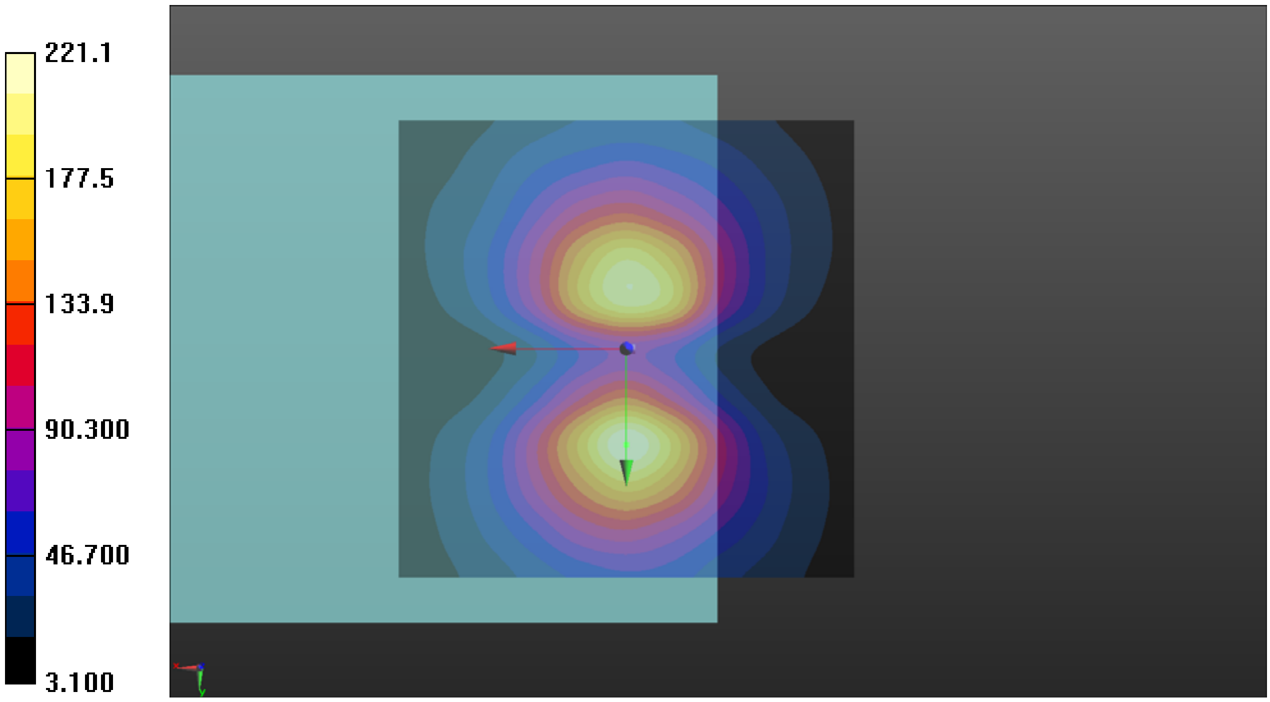
# P12 T-Coil_WLAN5.8G_802.11a_6Mbps_Ch157_AMR WB 6.6kbps_Sample1_Radial (Y)

**DUT: 191212C04**

Communication System: IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps); Frequency: 5785 MHz;Duty Cycle: 1:7.38
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3060; ; Calibrated: 2020/01/20
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Interpolated grid: dx=1.000 mm, dy=1.000 mm
ABM1/ABM2 = 46.89 dB
ABM1 comp = -5.78 dBA/m
Location: 0, 10.5, 3.7 mm



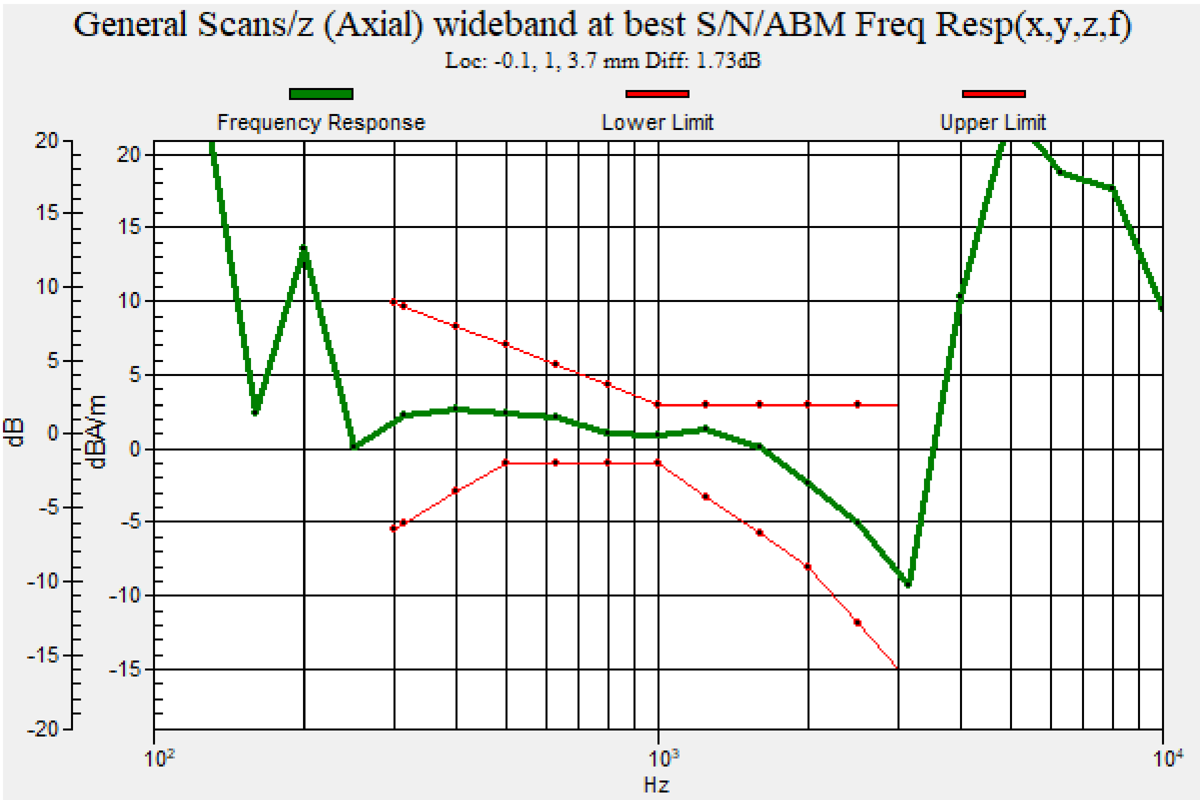
# P12 T-Coil_WLAN5.8G_802.11a_6Mbps_Ch157_AMR WB 6.6kbps_Sample1_Freq Resp

**DUT: 191212C04**

Communication System: IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps); Frequency: 5785 MHz;Duty Cycle: 1:7.38
Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m$^3$
Ambient Temperature：23.7 ℃

DASY5 Configuration:
- Probe: AM1DV3 - 3060; ; Calibrated: 2020/01/20
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE4 Sn1585; Calibrated: 2019/06/07
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**T-Coil scan (scan for ANSI C63.19 compliance)/General Scans:** Measurement grid: dx=10mm, dy=10mm



# Appendix B. Calibration Certificate for Probe

The SPEAG calibration certificates are shown as follows.

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

**S** **Schweizerischer Kalibrierdienst**
**C** **Service suisse d'étalonnage**
**S** **Servizio svizzero di taratura**
**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** B.V. ADT (Auden)

**Certificate No: AM1DV3-3060_Jan20**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | AM1DV3 - SN: 3060 |
| Calibration procedure(s) | QA CAL-24.v4<br>Calibration procedure for AM1D magnetic field probes and TMFS in the audio range |
| Calibration date: | January 20, 2020 |

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-Sep-19 (No. 25949) | Sep-20 |
| Reference Probe AM1DV3 | SN: 3000 | 13-Aug-19 (No. AM1DV3-3000_Aug19) | Aug-20 |
| DAE4 | SN: 781 | 27-Dec-19 (No. DAE4-781_Dec19) | Dec-20 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| AMCC | SN: 1050 | 01-Oct-13 (in house check Oct-17) | Oct-20 |
| AMMI Audio Measuring Instrument | SN: 1062 | 26-Sep-12 (in house check Oct-17) | Oct-20 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Claudio Leubler | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: January 21, 2020

## [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.

### AM1D probe identification and configuration data

| | |
|---|---|
| Item | **AM1DV3** Audio Magnetic 1D Field Probe |
| Type No | SP AM1 001 BA |
| Serial No | **3060** |

| | |
|---|---|
| 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, Zurich, Switzerland |

### Calibration data

| | | | |
|---|---|---|---|
| Connector rotation angle | (in DASY system) | **51.1 °** | +/- 3.6 ° (k=2) |
| Sensor angle | (in DASY system) | **0.63 °** | +/- 0.5 ° (k=2) |
| Sensitivity at 1 kHz | (in DASY system) | **0.00732 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%.

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

**S** **Schweizerischer Kalibrierdienst**
**C** **Service suisse d'étalonnage**
**S** **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: AM1DV3-3067_Dec19**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | AM1DV3 - SN: 3067 |
| Calibration procedure(s) | QA CAL-24.v4<br>Calibration procedure for AM1D magnetic field probes and TMFS in the audio range |
| Calibration date: | December 10, 2019 |

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-Sep-19 (No. 25949) | Sep-20 |
| Reference Probe AM1DV3 | SN: 3000 | 13-Aug-19 (No. AM1DV3-3000_Aug19) | Aug-20 |
| DAE4 | SN: 781 | 09-Jan-19 (No. DAE4-781_Jan19) | Jan-20 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| AMCC | SN: 1050 | 01-Oct-13 (in house check Oct-17) | Oct-20 |
| AMMI Audio Measuring Instrument | SN: 1062 | 26-Sep-12 (in house check Oct-17) | Oct-20 |

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

Issued: December 10, 2019

## [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.

## AM1D probe identification and configuration data

| | |
|---|---|
| Item | **AM1DV3** Audio Magnetic 1D Field Probe |
| Type No | SP AM1 001 BA |
| Serial No | **3067** |

| | |
|---|---|
| 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, Zurich, Switzerland |

## Calibration data

| | | | |
|---|---|---|---|
| Connector rotation angle | (in DASY system) | **268.1 °** | +/- 3.6 ° (k=2) |
| Sensor angle | (in DASY system) | **0.65 °** | +/- 0.5 ° (k=2) |
| Sensitivity at 1 kHz | (in DASY system) | **0.00738 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%.

# Appendix C. Photographs of EUT and Setup

The photographs of EUT and setup for HAC measurement are shown as follows.