

# Hearing Aid Compatibility (HAC) RF Emissions Test Report

APPLICANT : ZTE CORPORATION  
EQUIPMENT : LTE/WCDMA Multi-Mode Digital Mobile Phone  
BRAND NAME : ZTE  
MODEL NAME : Z2321A  
FCC ID : SRQ-Z2321A  
STANDARD : FCC 47 CFR §20.19  
: ANSI C63.19-2011

We, Sporton International (Kunshan) Inc., would like to declare that the tested sample has been evaluated in accordance with the procedures and had been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International (Kunshan) Inc., the test report shall not be reproduced except in full.



Approved by: Mark Qu / Manager



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### **Revision History**

<b>REPORT NO.</b>	<b>VERSION</b>	<b>DESCRIPTION</b>	<b>ISSUED DATE</b>
HA7N2807A	Rev. 01	Initial issue of report	Jan. 17, 2018



**1. Attestation of Test Results**

Applicant Name	ZTE CORPORATION
Equipment Name	LTE/WCDMA Multi-Mode Digital Mobile Phone
Brand Name	ZTE
Model Name	Z2321A
FCC ID	SRQ-Z2321A
HW Version	Z2321AHW1.0
SW Version	Z2321AV1.0.0B01
EUT Stage	Identical Prototype
HAC Rating	M4
Test Result	Pass

This device is compliance with HAC limits specified in guidelines FCC 47 CFR §20.19 and ANSI Standard ANSI C63.19.

**2. Administration Data**

Applicant	
Company Name	ZTE CORPORATION
Address	ZTE Plaza, Keji Road South, Hi-Tech, Industrial Park, Nanshan District, Shenzhen, Guangdong, 518057, P.R.China
Manufacturer	
Company Name	ZTE CORPORATION
Address	ZTE Plaza, Keji Road South, Hi-Tech, Industrial Park, Nanshan District, Shenzhen, Guangdong, 518057, P.R.China



### 3. Equipment Under Test Information

#### 3.1 General Information

Product Feature & Specification	
<b>Wireless Technology and Frequency Range</b>	WCDMA Band II: 1852.4 MHz ~ 1907.6 MHz WCDMA Band V: 826.4 MHz ~ 846.6 MHz LTE Band 2: 1850.7 MHz ~ 1909.3 MHz LTE Band 4: 1710.7 MHz ~ 1754.3 MHz LTE Band 5: 824.7 MHz ~ 848.3 MHz LTE Band 12: 699.7 MHz ~ 715.3 MHz Bluetooth: 2402 MHz ~ 2480 MHz
<b>Mode</b>	RMC/AMR 12.2Kbps HSDPA HSUPA HSPA+ (16QAM uplink is not supported) LTE: QPSK, 16QAM Bluetooth v2.0+EDR, Bluetooth v4.2 LE
<b>Remark:</b> 1. This device doesn't support VoIP function. 2. This device supports VoLTE operation.	



**3.2 Air Interface and Operating Mode**

Air Interface	Band MHz	Type	ANSI C63.19 Tested	Simultaneous Transmitter	Name of Voice Service	Power Reduction
WCDMA	850	VO	No <sup>(1)</sup>	BT	NA	No
	1900			BT		No
	HSPA	DT	No	BT		No
LTE	Band 2	VD	No <sup>(1)(2)</sup>	BT	VoLTE*	No
	Band 4			BT		No
	Band 5			BT		No
	Band 12			BT		No
BT	2450	DT	No	WCDMA,LTE	NA	No

VO= legacy Cellular Voice Service from Table 7.1 in 7.4.2.1 of ANSI C63.19-2011

DT= Digital Transport only (no voice)

VD= IP Voice Service over Digital Transport

BT= Bluetooth

**Remark:**

1. WCDMA and LTE is exempted from testing by low power exemption that its average antenna input power plus its MIF is ≤17 dBm, and is rated as M4.
2. \* Ref Lev in accordance with 7.4.2.1 of ANSI C63.19-2011 and the July 2012 VoLTE interpretation.
3. This device has no VOIP function for HSPA.

**3.3 Applied Standards**

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



### **4. HAC RF Emission**

FCC wireless hearing aid compatibility rules ensure that consumers with hearing loss are able to access wireless communications services through a wide selection of handsets without experiencing disabling radio frequency (RF) interference or other technical obstacles.

To define and measure the hearing aid compatibility of handsets, in CFR47 part 20.19 ANSI C63.19 is referenced. A handset is considered hearing aid-compatible for acoustic coupling if it meets a rating of at least M3 under ANSI C63.19, and A handset is considered hearing aid compatible for inductive coupling if it meets a rating of at least T3.

According to ANSI C63.19 2011 version, for acoustic coupling, the RF electric field emissions of wireless communication devices should be measured and rated according to the emission level as below.

Emission Categories	E-field emissions	
	<960Mhz	>960Mhz
<b>M1</b>	<b>50 to 55 dB (V/m)</b>	<b>40 to 45 dB (V/m)</b>
<b>M2</b>	<b>45 to 50 dB (V/m)</b>	<b>35 to 40 dB (V/m)</b>
<b>M3</b>	<b>40 to 45 dB (V/m)</b>	<b>30 to 35 dB (V/m)</b>
<b>M4</b>	<b>&lt;40 dB (V/m)</b>	<b>&lt;30 dB (V/m)</b>

**Table 4.1 Telephone near-field categories in linear units**

### 5. Measurement System Specification

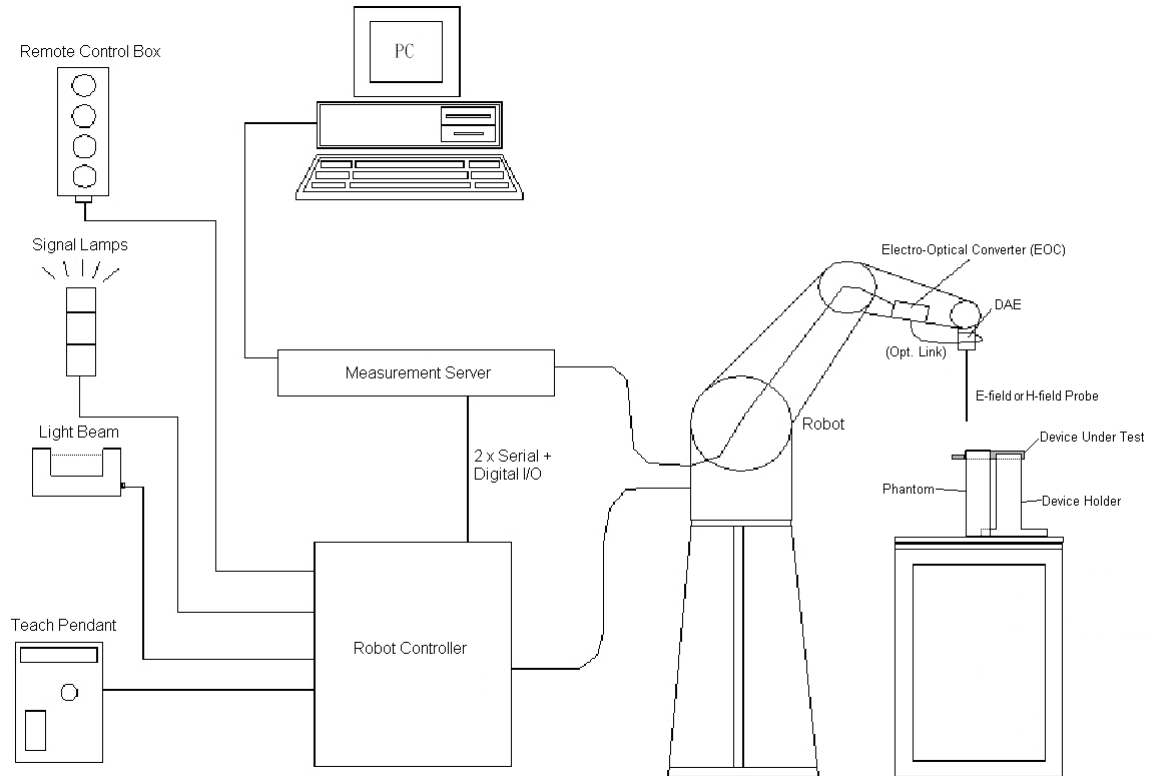
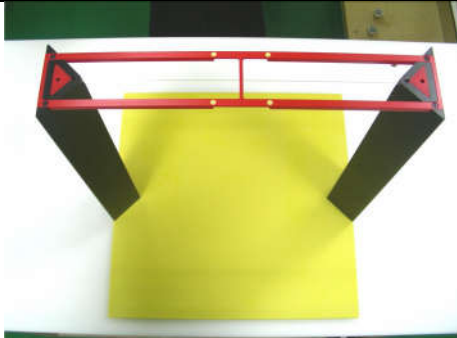


Fig 5.1 SPEAG DASY5 System Configurations

#### 5.1 Test Arch Phantom

<p><b>Construction :</b></p>	<p>Enables easy and well defined positioning of the phone and validation dipoles as well as simple teaching of the robot.</p>	 <p>Fig 5.2 Photo of Arch Phantom</p>
<p><b>Dimensions :</b></p>	<p>370 x 370 x 370 mm</p>	



**5.2 E-Field Probe System**

**E-Field Probe Specification  
<ER3DV6>**

<b>Construction</b>	One dipole parallel, two dipoles normal to probe axis Built-in shielding against static charges
<b>Calibration</b>	In air from 100 MHz to 3.0 GHz (absolute accuracy $\pm 6.0\%$ , $k=2$ )
<b>Frequency</b>	100 MHz to 6 GHz; Linearity: $\pm 2.0$ dB (100 MHz to 3 GHz)
<b>Directivity</b>	$\pm 0.2$ dB in air (rotation around probe axis) $\pm 0.4$ dB in air (rotation normal to probe axis)
<b>Dynamic Range</b>	2 V/m to 1000 V/m (M3 or better device readings fall well below diode compression point)
<b>Linearity</b>	$\pm 0.2$ dB
<b>Dimensions</b>	Overall length: 330 mm (Tip: 16 mm) Tip diameter: 8 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.5 mm



**Fig 5.3 Photo of E-field Probe**

**Probe Tip Description:**

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

**5.3 System Hardware**

**DAE**

The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit.

**Robot**

The SPEAG DASY system uses the high precision robots (DASY5: TX90XL) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY5: CS8c) from Stäubli is used.

### 5.4 Data Storage and Evaluation

The DASY software stores the assessed data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all the necessary software parameters for the data evaluation (probe calibration data, and device frequency and modulation data) in measurement files.

<b>Probe parameters :</b>	- Sensitivity	Norm <sub>i</sub> , a <sub>i0</sub> , a <sub>i1</sub> , a <sub>i2</sub>
	- Conversion factor	ConvF <sub>i</sub>
	- Diode compression point	dcp <sub>i</sub>
<b>Device parameters :</b>	- Frequency	f
	- Crest factor	cf
	- Conductivity	σ
<b>Media parameters :</b>	- Density	ρ

The formula for each channel can be given as :

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

- with V<sub>i</sub> = compensated signal of channel i, (i = x, y, z)  
 U<sub>i</sub> = input signal of channel i, (i = x, y, z)  
 cf = crest factor of exciting field (DASY parameter)  
 dcp<sub>i</sub> = diode compression point (DASY parameter)

From the compensated input signals, the primary field data for each channel can be evaluated :

$$\text{E-field Probes : } E_i = \sqrt{\frac{V_i}{\text{Norm}_i \cdot \text{ConvF}}}$$

- with V<sub>i</sub> = compensated signal of channel i, (i = x, y, z)  
 Norm<sub>i</sub> = sensor sensitivity of channel i, (i = x, y, z), μV/(V/m)<sup>2</sup> for E-field Probes  
 ConvF = sensitivity enhancement in solution  
 f = carrier frequency [GHz]  
 E<sub>i</sub> = electric field strength of channel i in V/m

The RSS value of the field components gives the total field strength (Hermitian magnitude) :

$$E_{\text{tot}} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.

## **6. Measurement System Validation**

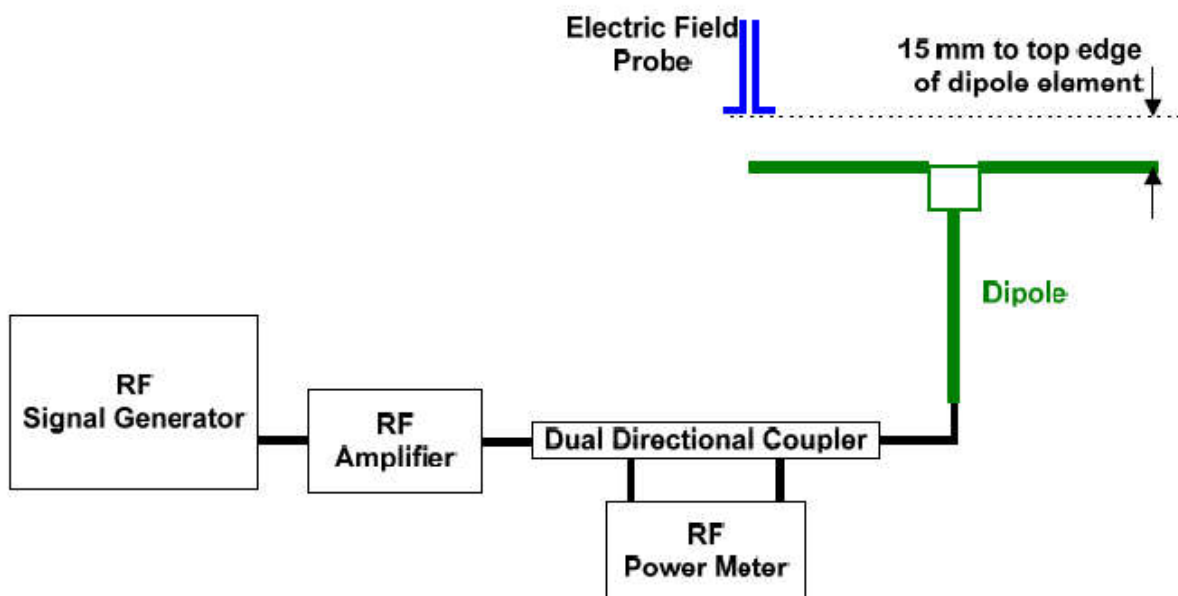
Each DASY system is equipped with one or more system validation kits. These units, together with the predefined measurement procedures within the DASY software, enable the user to conduct the system performance check and system validation. System validation kit includes a dipole, tripod holder to fix it underneath the test Arch and a corresponding distance holder.

### **6.1 Purpose of System Performance Check**

The system performance check verifies that the system operates within its specifications. System and operator errors can be detected and corrected. It is recommended that the system performance check be performed prior to any usage of the system in order to guarantee reproducible results. The system performance check uses normal HAC measurements in a simplified setup with a well characterized source. This setup was selected to give a high sensitivity to all parameters that might fail or vary over time. The system check does not intend to replace the calibration of the components, but indicates situations where the system uncertainty is exceeded due to drift or failure.

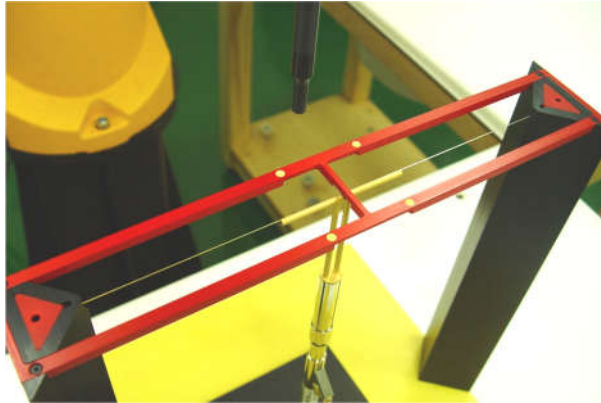
### **6.2 System Setup**

1. In the simplified setup for system evaluation, the EUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave which comes from a signal generator.
2. The center point of the probe element(s) is 15mm from the closest surface of the dipole elements.
3. The calibrated dipole must be placed beneath the arch phantom. The equipment setup is shown below:



**Fig. 6.1 System Validation Setup**

The output power on dipole port must be calibrated to 20dBm (100mW) before dipole is connected.



**Fig 6.2 Dipole Setup**



## **7. RF Emissions Test Procedure**

Referenced from ANSI C63.19 -2011 section 5.5.1

- a) Confirm the proper operation of the field probe, probe measurement system, and other instrumentation and the positioning system.
- b) Position the WD in its intended test position.
- c) Set the WD to transmit a fixed and repeatable combination of signal power and modulation characteristic that is representative of the worst case (highest interference potential) encountered in normal use. Transiently occurring start-up, changeover, or termination conditions, or other operations likely to occur less than 1% of the time during normal operation, may be excluded from consideration.
- d) The center sub-grid shall be centered on the T-Coil mode perpendicular measurement point or the acoustic output, as appropriate. Locate the field probe at the initial test position in the 50 mm by 50 mm grid, which is contained in the measurement plane, refer to illustrated in Figure 8.2. If the field alignment method is used, align the probe for maximum field reception.
- e) Record the reading at the output of the measurement system.
- f) Scan the entire 50 mm by 50 mm region in equality spaced increments and record the reading at each measurement point, The distance between measurement points shall be sufficient to assure the identification of the maximum reading.
- g) Identify the five contiguous sub-grids around the center sub-grid whose maximum reading is the lowest of all available choices. This eliminates the three sub-grids with the maximum readings. Thus, the six areas to be used to determine the WD's highest emissions are identified.
- h) Identify the maximum reading within the non-excluded sub-grids identified in step g).
- i) *Indirect measurement method*  
The RF audio interference level in dB (V/m) is obtained by adding the MIF (in dB) to the maximum steady-state rms field-strength reading, in dB (V/m)
- j) Compare this RF audio interference level with the categories in ANSI C63.19-2011 clause 8 and record the resulting WD category rating.
- k) For the T-Coil mode M-rating assessment, determine whether the chosen perpendicular measurement point is contained in an included sub-grid of the first scan. If so, then a second scan is not necessary. The first scan and resultant category rating may be used for the T-Coil mode M rating.

Otherwise, repeat step a) through step i), with the grid shifted so that it is centered on the perpendicular measurement point. Record the WD category rating.



Referenced from ANSI C63.19 -2011 section 5.5.1

- a) Confirm the proper operation of the field probe, probe measurement system, and other instrumentation and the positioning system.
- b) Position the WD in its intended test position.
- c) Set the WD to transmit a fixed and repeatable combination of signal power and modulation characteristic that is representative of the worst case (highest interference potential) encountered in normal use. Transiently occurring start-up, changeover, or termination conditions, or other operations likely to occur less than 1% of the time during normal operation, may be excluded from consideration.
- d) The center sub-grid shall be centered on the T-Coil mode perpendicular measurement point or the acoustic output, as appropriate. Locate the field probe at the initial test position in the 50 mm by 50 mm grid, which is contained in the measurement plane, refer to illustrated in Figure 8.2. If the field alignment method is used, align the probe for maximum field reception.
- e) Record the reading at the output of the measurement system.
- f) Scan the entire 50 mm by 50 mm region in equality spaced increments and record the reading at each measurement point, The distance between measurement points shall be sufficient to assure the identification of the maximum reading.
- g) Identify the five contiguous sub-grids around the center sub-grid whose maximum reading is the lowest of all available choices. This eliminates the three sub-grids with the maximum readings. Thus, the six areas to be used to determine the WD's highest emissions are identified.
- h) Identify the maximum reading within the non-excluded sub-grids identified in step g).
- i) *Indirect measurement method*  
The RF audio interference level in dB (V/m) is obtained by adding the MIF (in dB) to the maximum steady-state rms field-strength reading, in dB (V/m)
- j) Compare this RF audio interference level with the categories in ANSI C63.19-2011 clause 8 and record the resulting WD category rating.
- k) For the T-Coil perpendicular measurement location is  $\geq 5.0$  mm from the center of the acoustic output, then two different 50 mm by 50 mm areas may need to be scanned, the first for the microphone mode assessment and the second for the T-Coil assessment.
- l) The second for the T-Coil assessment, with the grid shifted so that it is centered on the perpendicular measurement point. Record the WD category rating.

### Test Instructions

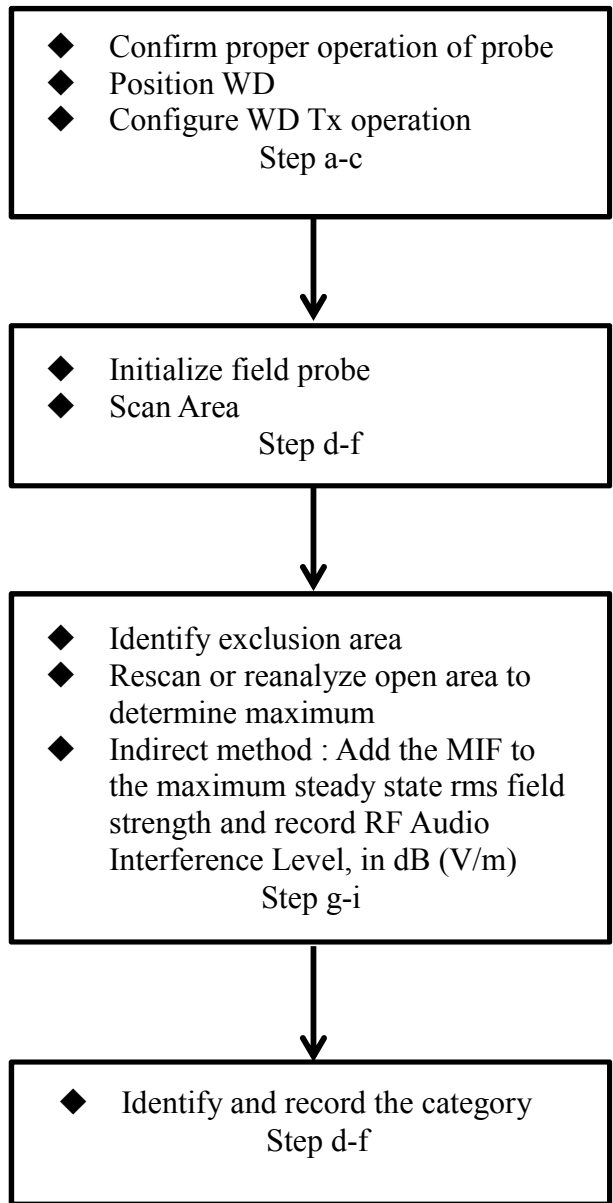


Fig 8.1 Flow Chart of HAC RF Emission



Fig 8.2 EUT reference and plane for HAC RF emission measurements

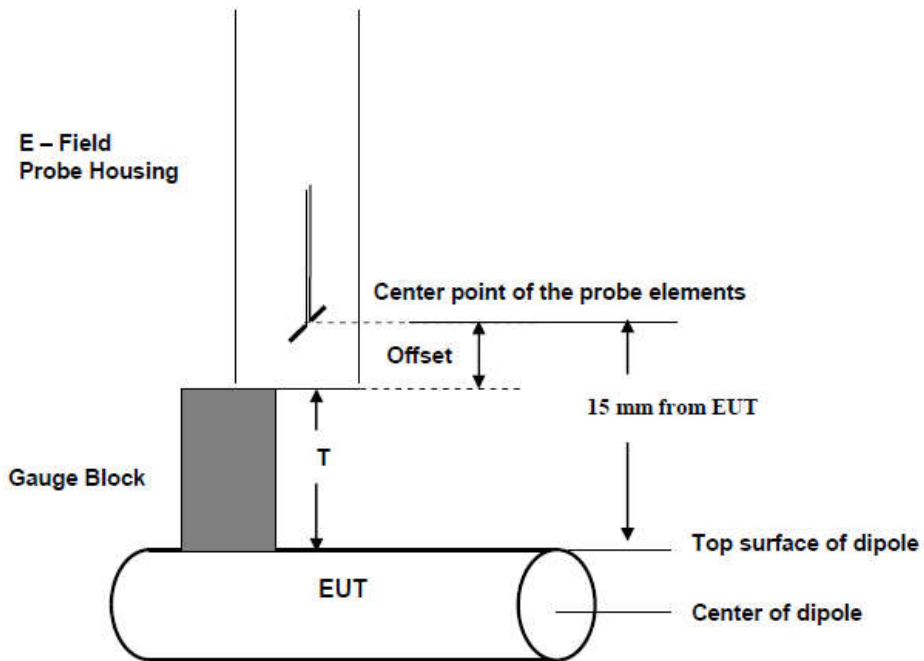


Fig. 8.3 Gauge block with E-field probe





## **8. Modulation Interference Factor**

The HAC Standard ANSI C63.19-2011 defines a new scaling using the Modulation Interference Factor (MIF).

For any specific fixed and repeatable modulated signal, a modulation interference factor (MIF, expressed in dB) may be developed that relates its interference potential to its steady-state rms signal level or average power level. This factor is a function only of the audio-frequency amplitude modulation characteristics of the signal and is the same for field-strength and conducted power measurements. It is important to emphasize that the MIF is valid only for a specific repeatable audio-frequency amplitude modulation characteristic. Any change in modulation characteristic requires determination and application of a new MIF

The Modulation Interference factor (MIF, in dB) is added to the measured average E-field (in dBV/m) and converts it to the RF Audio Interference level (in dBV/m). This level considers the audible amplitude modulation components in the RF E-field. CW fields without amplitude modulation are assumed to not interfere with the hearing aid electronics. Modulations without time slots and low fluctuations at low frequencies have low MIF values, TDMA modulations with narrow transmission and repetition rates of few 100 Hz have high MIF values and give similar classifications as ANSI C63.19-2011.

ER3D, EF3D and EU2D E-field probes have a bandwidth <10 kHz and can therefore not evaluate the RF envelope in the full audio band. DASY52 is therefore using the indirect measurement method according to ANSI C63.19-2011 which is the primary method. These near field probes read the averaged E-field measurement. Especially for the new high peak-to-average (PAR) signal types, the probes shall be linearized by PMR calibration in order to not overestimate the field reading. Probe Modulation Response (PMR) calibration linearizes the probe response over its dynamic range for specific modulations which are characterized by their UID and result in an uncertainty specified in the probe calibration certificate. The MIF is characteristic for a given waveform envelope and can be used as a constant conversion factor if the probe has been PMR calibrated.

The evaluation method for the MIF is defined in ANSI C63.19-2011 section D.7. An RMS demodulated RF signal is fed to a spectral filter (similar to an A weighting filter) and forwarded to a temporal filter acting as a quasi-peak detector. The averaged output of these filtering is scaled to a 1 kHz 80% AM signal as reference. MIF measurement requires additional instrumentation and is not well suited for evaluation by the end user with reasonable uncertainty. It may alternatively be determined through analysis and simulation, because it is constant and characteristic for a communication signal. DASY52 uses well-defined signals for PMR calibration. The MIF of these signals has been determined by simulation and it is automatically applied.



MIF values applied in this test report were provided by the HAC equipment provider, SPEAG, and the values are listed below

Table with 3 columns: UID, Communication System Name, MIF(dB). Rows include various LTE-FDD and UMTS-FDD configurations with their corresponding MIF values.

The MIF measurement uncertainty is estimated as follows, declared by HAC equipment provider SPEAG, for modulation frequencies from slotted waveforms with fundamental frequency and at least 2 harmonics within 10 kHz:

- i) 0.2 dB for MIF: -7 to +5 dB,
ii) 0.5 dB for MIF: -13 to +11 dB
iii) 1 dB for MIF: > -20 dB



9. Low-power Exemption

Mode		Average Power (dBm)
WCDMA	Band V	24.00
	Band II	24.00
LTE	Band 2	24.50
	Band 4	24.50
	Band 5	24.00
	Band 12	24.50

<Low Power Exemption>

Air Interface	Max Average Antenna Input Power (dBm)	Worst Case MIF (dB)	Power + MIF(dB)	C63.19 test required
WCDMA Band V	24.00	-27.23	-3.23	No
WCDMA Band II	24.00	-27.23	-3.23	No
LTE	24.50	-9.76	14.74	No

General Note:

1. According to ANSI C63.19 2011-version, for WWAN RF air interface technology of a device is exempt from testing when its average antenna input power plus its MIF is  $\leq 17$  dBm for any of its operating modes.
2. For LTE operation the worst case MIF plus the worst case average antenna input power for all modes are investigated to determine the testing requirements for this device.
3. Chose the maximum power of all bands to calculate low power exemption.
4. HAC RF rating is M4 for the air interface which meets the low power exemption.



## **10. References**

- [1] ANSI C63.19-2011, "American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids", 27 May 2011.
- [2] FCC KDB 285076 D01v05, "Equipment Authorization Guidance for Hearing Aid Compatibility", Sep 2017
- [3] FCC KDB 285076 D02v03, "Guidance for Performing T-Coil tests for Air Interfaces Supporting Voice over IP to support CMRS based telephone services", Sep 2017
- [4] SPEAG DASY System Handbook