Annex 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.

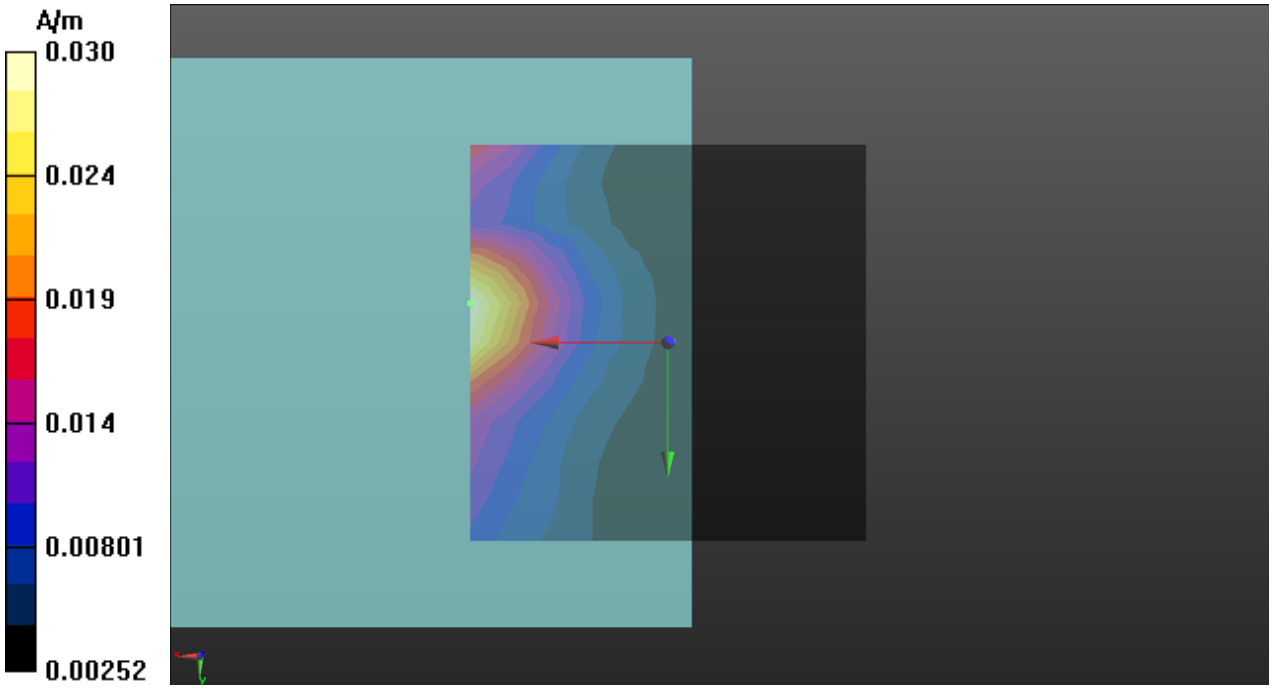
P36 OTT_5G NR n77_DFT-S QPSK100M_Ch656000_Duo Opus 75kbps_Radial (Y)_ABM2

DUT: BFJZ-WTW-P21100637

Communication System: UID 10973 - AAB, 5G NR (DFT-s-OFDM, 1 RB, 100 MHz, QPSK, 30 kHz); Frequency: 3840 MHz;Duty Cycle: 1:8.05
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: 2021/01/20
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn579; Calibrated: 2021/06/02
- 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
ABM2 = -30.46 dBA/m
Location: 25, -5, 3.7 mm



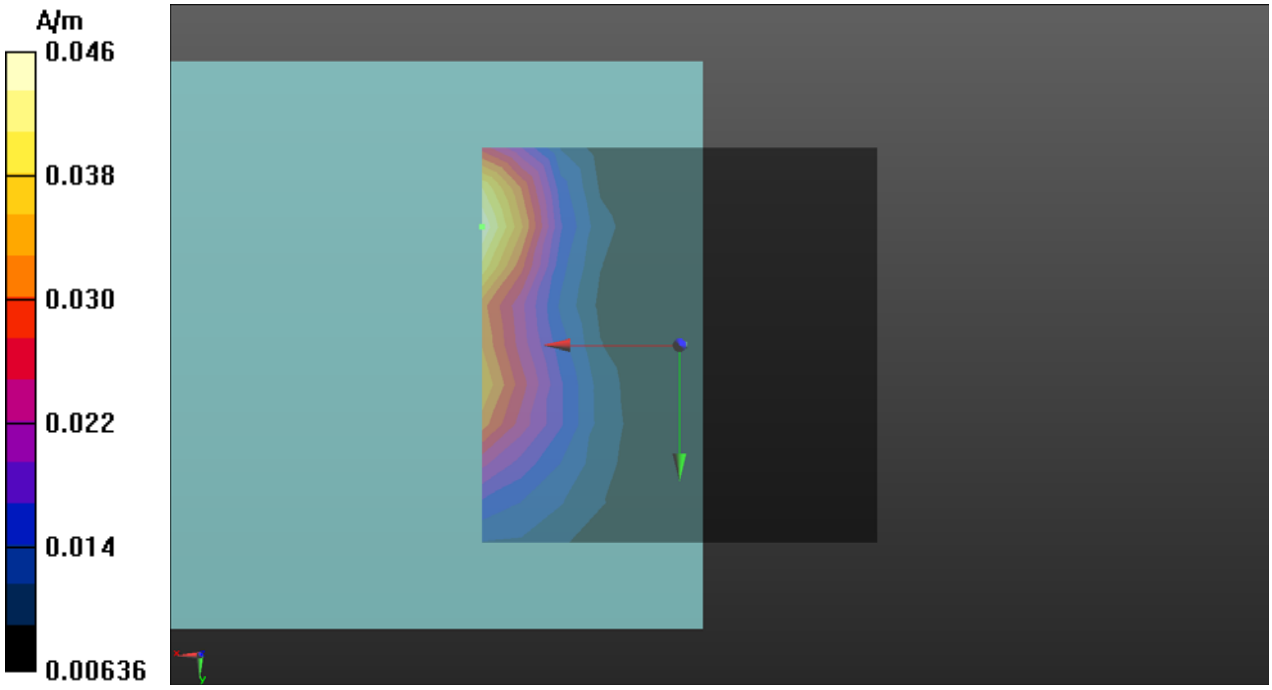
P36 OTT_5G NR n77_DFT-S QPSK100M_Ch656000_Duo Opus 75kbps_Axial (Z)_ABM2

DUT: BFJZ-WTW-P21100637

Communication System: UID 10973 - AAB, 5G NR (DFT-s-OFDM, 1 RB, 100 MHz, QPSK, 30 kHz); Frequency: 3840 MHz;Duty Cycle: 1:8.05
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: 2021/01/20
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn579; Calibrated: 2021/06/02
- 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
ABM2 = -26.68 dBA/m
Location: 25, -15, 3.7 mm



Annex 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
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 **B.V. ADT (Auden)**

Certificate No: AM1DV3-3060_Jan21

CALIBRATION CERTIFICATE

Object: AM1DV3 - SN: 3060

Calibration procedure(s): QA CAL-24.v4
Calibration procedure for AM1D magnetic field probes and TMFS in the audio range

Calibration date: January 20, 2021

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	07-Sep-20 (No. 28647)	Sep-21
Reference Probe AM1DV2	SN: 1008	15-Dec-20 (No. AM1DV2-1008_Dec20)	Dec-21
DAE4	SN: 781	23-Dec-20 (No. DAE4-781_Dec20)	Dec-21

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
AMCC	SN: 1050	01-Oct-13 (in house check Oct-20)	Oct-23
AMMI Audio Measuring Instrument	SN: 1062	26-Sep-12 (in house check Oct-20)	Oct-23

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

Issued: January 25, 2021

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)	**52.3 °**	+/- 3.6 ° (k=2)
Sensor angle	(in DASY system)	**0.30 °**	+/- 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%.

Annex C. HAC T-Coil Test Result

HAC Testing Results are shown as below.

Interim Procedure for OTT VOIP over 5G NR

The following procedure listed in KDB 285076 D03 is used to evaluate OTT VolP over 5G NR.
1. This procedure is applicable for 5G FR1 calls that use the same protocol, codec(s), and reference level as OTT calls
2. Establish the ABM $1_{5G\ FR1}$ value by using the $ABM1_{OTT}$ magnetic intensity for an LTE call in the same band as the 5G FR1 band under test.
3. Also note the actual $ABM2_{LTE}$ OTT value.
4. Establish an $ABM2_{5G\ FR1}$ value, using a 5G manufacture test mode over 5G FR1 channels for the same band under test.
5. Calculate the rating by following steps:
a. Record both $ABM2_{LTE}$ and $ABM2_{5G\ FR1}$ for comparison.
b. ABM1 = $ABM1_{OTT}$
C. AMB2 = $ABM2_{5G\ FR1}$
d. SNNR = ($ABM1_{OTT}$ - $ABM2_{5G\ FR1}$) - 3 dB; A 3dB margin is built in to ensure conservative results with this interim procedure.

The above is only applicable for OTT VolP scenarios, this device does not support VoNR over IMS.

The manufacturer has confirmed the handset as designed is expected to exhibit similar audio intensity levels between an OTT VoIP call placed over LTE and 5G FR1 data connection.

Note:
1. Due to test equipment limitations, ABM1 measurements were not possible. Therefore, the interim procedure for OTT VolP over 5G NR was followed to obtain SNR values. Additionally, frequency response measurements were not possible due to test equipment limitations.

2. This handset as designed is expected to exhibit similar audio intensity levels between OTT VoIP calls over 4G LTE data connections and 5G Sub-6GHz data connections. And the results using ABM1 values obtained from OTT connections over LTE bands for OTT VOIP and ABM2 values for 5G Sub-6GHz connections over the same bands, while maintaining a S+N/N margin of 3db or greater from the rating threshold is a reasonable representation of the HAC rating over these 5G Sub-6GHz connections.

Plot No.	EUT Configuration	Air Interface	WaveForm	Bandwidth (MHz)	Modulation	RB Size	RB Offset	Channel	Codec Setting	UL-DL Configuration	Probe Orientation	ABM1 OTT (dB A/m)	ABM2 5G FR1 (dB A/m)	SNR NR (dB)
	1	5G NR n77	CP-OFDM	20	QPSK	1	1	656000	Duo Opus 75kbps		Axial (Z)	10.67	-25.22	35.89
	1	5G NR n77	CP-OFDM	20	QPSK	1	53	656000	Duo Opus 75kbps		Axial (Z)	10.67	-25.97	36.64
	1	5G NR n77	CP-OFDM	20	QPSK	1	104	656000	Duo Opus 75kbps		Axial (Z)	10.67	-26.3	36.97
	1	5G NR n77	CP-OFDM	20	QPSK	50	0	656000	Duo Opus 75kbps		Axial (Z)	10.67	-26.71	37.38
	1	5G NR n77	CP-OFDM	20	QPSK	50	28	656000	Duo Opus 75kbps		Axial (Z)	10.67	-26.69	37.36
	1	5G NR n77	CP-OFDM	20	QPSK	50	56	656000	Duo Opus 75kbps		Axial (Z)	10.67	-29.58	40.25
	1	5G NR n77	CP-OFDM	20	QPSK	100	0	656000	Duo Opus 75kbps		Axial (Z)	10.67	-29.9	40.57
	1	5G NR n77	CP-OFDM	20	16QAM	1	1	656000	Duo Opus 75kbps		Axial (Z)	10.67	-27.64	38.31
	1	5G NR n77	CP-OFDM	20	64QAM	1	1	656000	Duo Opus 75kbps		Axial (Z)	10.67	-28.61	39.28
	1	5G NR n77	CP-OFDM	20	256QAM	1	1	656000	Duo Opus 75kbps		Axial (Z)	10.67	-27.95	38.62
	1	5G NR n77	CP-OFDM	15	QPSK	1	1	656000	Duo Opus 75kbps		Axial (Z)	10.67	-25.77	36.44
	1	5G NR n77	CP-OFDM	10	QPSK	1	1	656000	Duo Opus 75kbps		Axial (Z)	10.67	-25.89	36.56
	1	5G NR n77	CP-OFDM	5	QPSK	1	1	656000	Duo Opus 75kbps		Axial (Z)	10.67	-26.2	36.87
	1	5G NR n77	DFTS-OFDM	20	QPSK	1	1	656000	Duo Opus 75kbps		Axial (Z)	10.67	-26.68	37.35
	1	5G NR n77	DFTS-OFDM	20	QPSK	1	53	656000	Duo Opus 75kbps		Axial (Z)	10.67	-26.95	37.62
	1	5G NR n77	DFTS-OFDM	20	QPSK	1	104	656000	Duo Opus 75kbps		Axial (Z)	10.67	-27.12	37.79
	1	5G NR n77	DFTS-OFDM	20	QPSK	50	0	656000	Duo Opus 75kbps		Axial (Z)	10.67	-27.14	37.81
	1	5G NR n77	DFTS-OFDM	20	QPSK	50	28	656000	Duo Opus 75kbps		Axial (Z)	10.67	-27.92	38.59
	1	5G NR n77	DFTS-OFDM	20	QPSK	50	56	656000	Duo Opus 75kbps		Axial (Z)	10.67	-27.99	38.66
	1	5G NR n77	DFTS-OFDM	20	QPSK	100	0	656000	Duo Opus 75kbps		Axial (Z)	10.67	-28.07	38.74
	1	5G NR n77	DFTS-OFDM	20	16QAM	1	1	656000	Duo Opus 75kbps		Axial (Z)	10.67	-27.97	38.64
	1	5G NR n77	DFTS-OFDM	20	64QAM	1	1	656000	Duo Opus 75kbps		Axial (Z)	10.67	-27.88	38.55
	1	5G NR n77	DFTS-OFDM	20	256QAM	1	1	656000	Duo Opus 75kbps		Axial (Z)	10.67	-27.4	38.07
	1	5G NR n77	DFTS-OFDM	15	QPSK	1	1	656000	Duo Opus 75kbps		Axial (Z)	10.67	-27.44	38.11
	1	5G NR n77	DFTS-OFDM	10	QPSK	1	1	656000	Duo Opus 75kbps		Axial (Z)	10.67	-26.72	37.39
	1	5G NR n77	DFTS-OFDM	5	QPSK	1	1	656000	Duo Opus 75kbps		Axial (Z)	10.67	-26.84	37.51

Plot No.	EUT Configuration	Band	Mode	Channel	Codec Setting	Probe Orientation	ABM1 OTT (dB A/m)	ABM2 5G FR1 (dB A/m)	ABM2 LTE OTT (dB A/m)	Ambient Noise (dB A/m)	Frequency Response Margin (dB)	Frequency Response	SNR (dB)	SNR-3 (dB)	FCC Limit (dB)	FCC Margin (dB)	T-Rating
1	1	5G NR n77	DFT-S_QPSK100M	656000	Duo Opus 75kbps	Axial (Z)	10.67	-26.68	-34.97	N/A	n/a	Pass	37.35	34.35	20	-14.35	T4
	1	5G NR n77	DFT-S_QPSK100M	656000	Duo Opus 75kbps	Radial (Y)	-3.92	-30.46	-40.39	N/A			26.54	23.54	20	-3.54	T3

Annex D. Calibration of Test Equipment List

Calibration of Test Equipment List are shown as below.

Equipments used for HAC T-Coil Testing					
Equipment	**Manufacturer**	**Model**	**SN**	**Cal. Date**	**Cal. Interval**
Audio Band Magnetic Probe	SPEAG	AM1DV3	3060	Jan. 20, 2021	1 Year
Data Acquisition Electronics	SPEAG	DAE3	579	Jun. 02, 2021	1 Year
Universal Radio Communication Tester	R&S	CMW500	164864	Apr. 23, 2021	1 Year
Universal Radio Communication Tester	R&S	CMW500	152443	Nov. 26, 2020	1 Year
Test Arch Phantom	SPEAG	Arch	N/A	N/A	N/A