

Fig B.20 T-coil LTE Band13

T-Coil Band41 5M Transverse

Date: 2018-6-23

Electronics: DAE4 Sn777

Medium: Air

Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 1 \text{ kg/m}^3$

Ambient Temperature: 22.5°C

Communication System: UID 0, LTE Band41 (0); Frequency: 2593 MHz; Duty Cycle: 1:1.5787

Probe: AM1DV2 - 1064;

T-Coil/General Scans/y (transversal) 4.2mm 50 x 50 5M/ABM Interpolated Signal(x,y,z)

(121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav

Output Gain: 100

Measure Window Start: 300ms

Measure Window Length: 1000ms

BWC applied: 0.16 dB

Device Reference Point: 0, 0, -6.3 mm

Cursor:

ABM1 = 8.65 dBA/m

BWC Factor = 0.16 dB

Location: 10.4, 4.6, 3.7 mm

T-Coil/General Scans/y (transversal) 4.2mm 50 x 50 5M/ABM Interpolated SNR(x,y,z)

(121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav

Output Gain: 100

Measure Window Start: 300ms

Measure Window Length: 1000ms

BWC applied: 0.16 dB

Device Reference Point: 0, 0, -6.3 mm

Cursor:

ABM1/ABM2 = 35.18 dB

ABM1 comp = 5.64 dBA/m

BWC Factor = 0.16 dB

Location: 3.8, 4.6, 3.7 mm

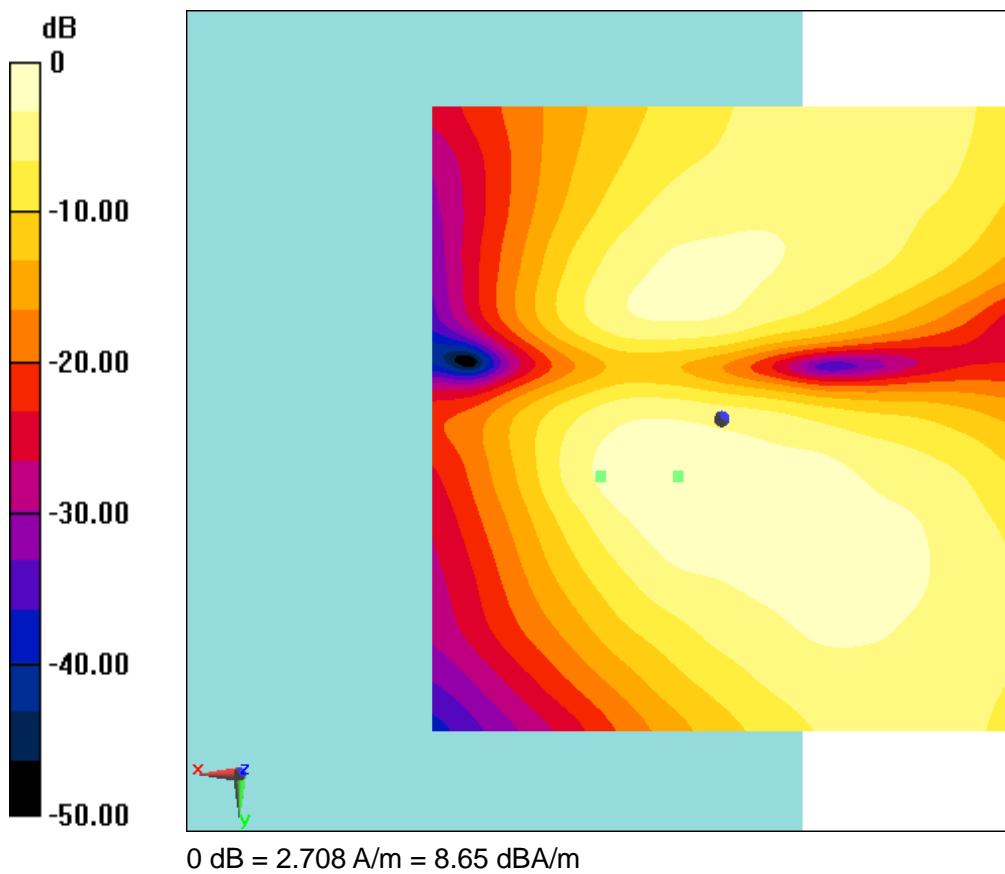


Fig B.21 T-coil LTE Band41

T-Coil Band41 20M Perpendicular

Date: 2018-6-23

Electronics: DAE4 Sn777

Medium: Air

Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 1 \text{ kg/m}^3$

Ambient Temperature: 22.5°C

Communication System: UID 0, LTE Band41 (0); Frequency: 2593 MHz; Duty Cycle: 1:1.5787

Probe: AM1DV2 - 1064;

T-Coil/General Scans/z (axial) 4.2mm 50 x 50 20M/ABM Interpolated Signal(x,y,z)**(121x121x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav

Output Gain: 100

Measure Window Start: 300ms

Measure Window Length: 1000ms

BWC applied: 0.16 dB

Device Reference Point: 0, 0, -6.3 mm

Cursor:

ABM1 = 15.56 dBA/m

BWC Factor = 0.16 dB

Location: 11.7, -3.3, 3.7 mm

T-Coil/General Scans/z (axial) 4.2mm 50 x 50 20M/ABM Interpolated SNR(x,y,z)**(121x121x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav

Output Gain: 100

Measure Window Start: 300ms

Measure Window Length: 1000ms

BWC applied: 0.16 dB

Device Reference Point: 0, 0, -6.3 mm

Cursor:

ABM1/ABM2 = 44.31 dB

ABM1 comp = 4.10 dBA/m

BWC Factor = 0.16 dB

Location: 0.4, -2.1, 3.7 mm

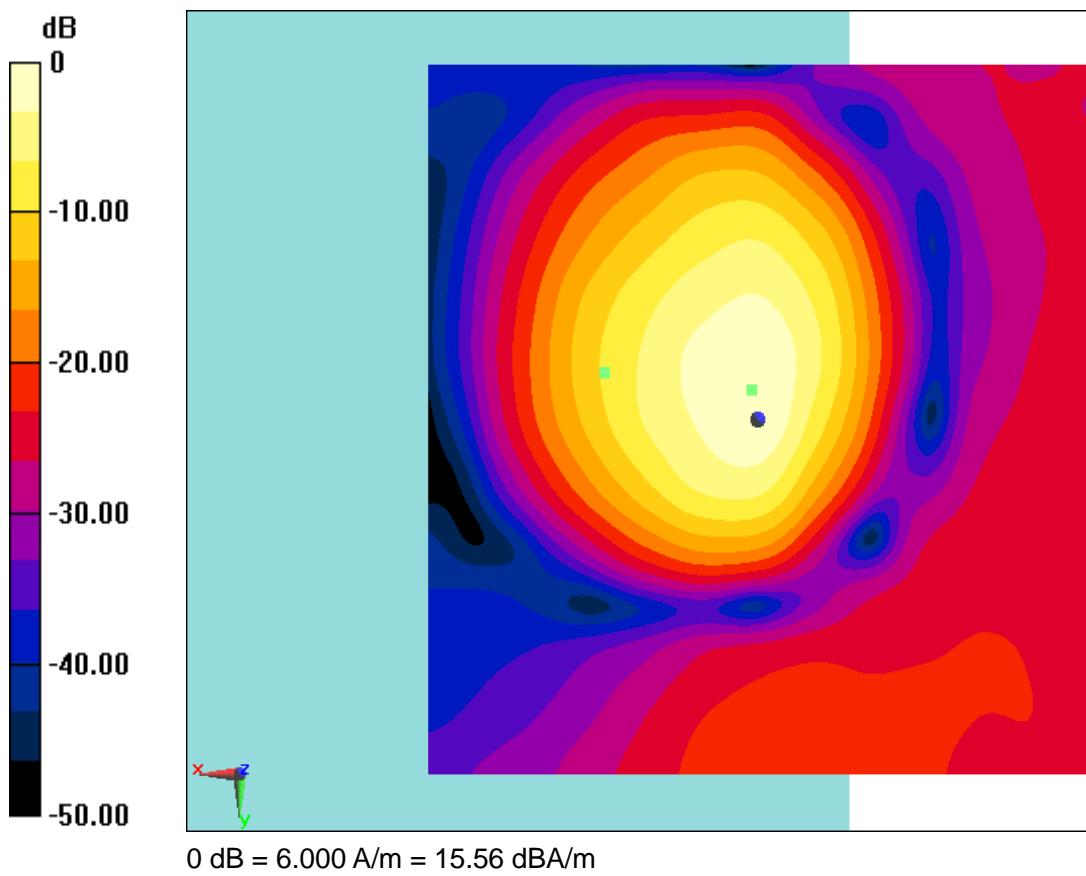


Fig B.22 T-coil LTE Band41

T-Coil Band66 10M Transverse

Date: 2018-6-23

Electronics: DAE4 Sn777

Medium: Air

Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 1 \text{ kg/m}^3$

Ambient Temperature: 22.5°C

Communication System: UID 0, LTE Band66 (0); Frequency: 1745 MHz; Duty Cycle: 1:1

Probe: AM1DV2 - 1064;

T-Coil/General Scans/y (transversal) 4.2mm 50 x 50 10M/ABM Interpolated Signal(x,y,z)

(121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav

Output Gain: 100

Measure Window Start: 300ms

Measure Window Length: 1000ms

BWC applied: 0.16 dB

Device Reference Point: 0, 0, -6.3 mm

Cursor:

ABM1 = 6.35 dBA/m

BWC Factor = 0.16 dB

Location: 11.7, 4.6, 3.7 mm

T-Coil/General Scans/y (transversal) 4.2mm 50 x 50 10M/ABM Interpolated SNR(x,y,z)

(121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav

Output Gain: 100

Measure Window Start: 300ms

Measure Window Length: 1000ms

BWC applied: 0.16 dB

Device Reference Point: 0, 0, -6.3 mm

Cursor:

ABM1/ABM2 = 41.75 dB

ABM1 comp = 1.30 dBA/m

BWC Factor = 0.16 dB

Location: 3.3, -12.5, 3.7 mm

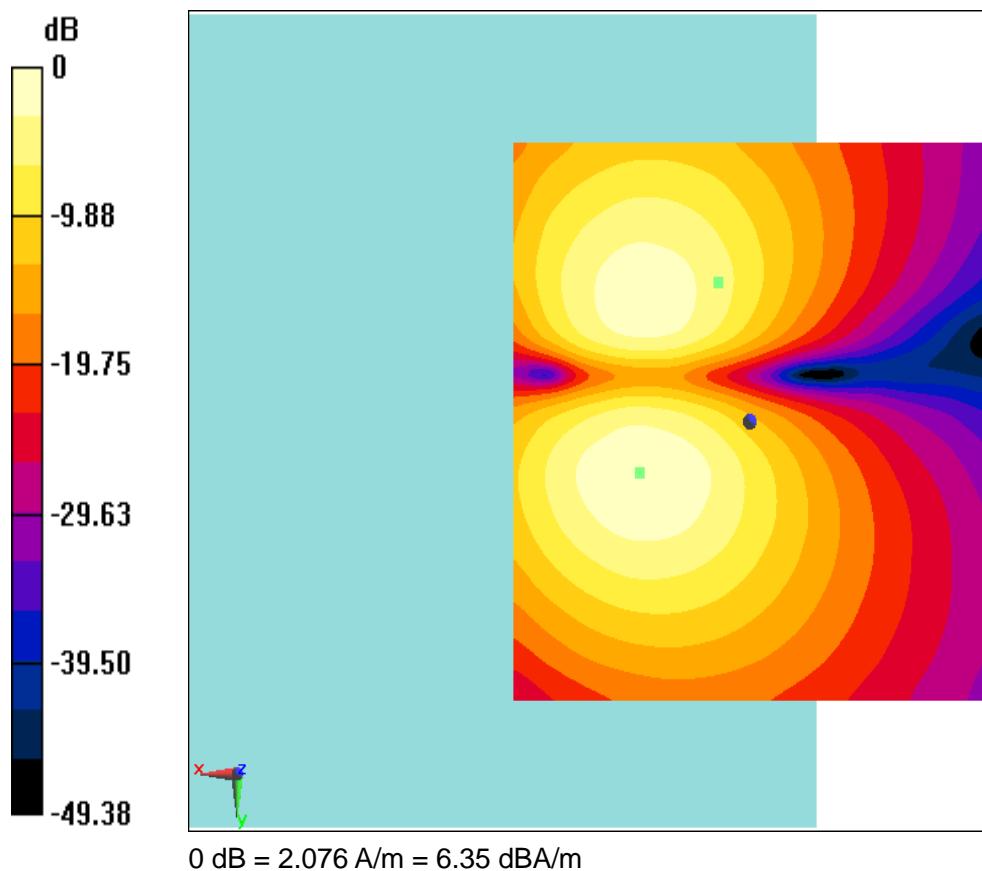


Fig B.23 T-coil LTE Band66

T-Coil Band66 10M Perpendicular

Date: 2018-6-23

Electronics: DAE4 Sn777

Medium: Air

Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 1 \text{ kg/m}^3$

Ambient Temperature: 22.5°C

Communication System: UID 0, LTE Band66 (0); Frequency: 1745 MHz; Duty Cycle: 1:1

Probe: AM1DV2 - 1064;

T-Coil/General Scans/z (axial) 4.2mm 50 x 50 10M/ABM Interpolated Signal(x,y,z)

(121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav

Output Gain: 100

Measure Window Start: 300ms

Measure Window Length: 1000ms

BWC applied: 0.16 dB

Device Reference Point: 0, 0, -6.3 mm

Cursor:

ABM1 = 13.60 dBA/m

BWC Factor = 0.16 dB

Location: 11.7, -3.3, 3.7 mm

T-Coil/General Scans/z (axial) 4.2mm 50 x 50 10M/ABM Interpolated SNR(x,y,z)

(121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav

Output Gain: 100

Measure Window Start: 300ms

Measure Window Length: 1000ms

BWC applied: 0.16 dB

Device Reference Point: 0, 0, -6.3 mm

Cursor:

ABM1/ABM2 = 49.30 dB

ABM1 comp = 7.48 dBA/m

BWC Factor = 0.16 dB

Location: 3.8, -0.8, 3.7 mm

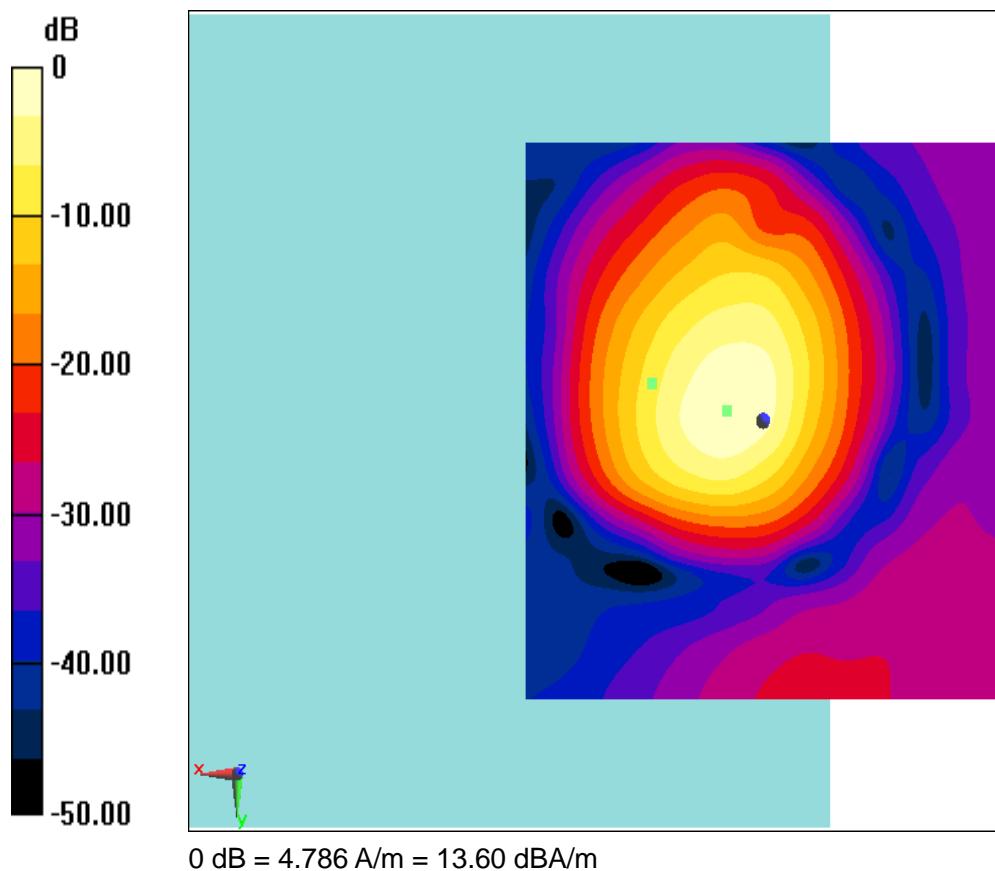


Fig B.24 T-coil LTE Band66

T-Coil LTE WiFi-2.4G Transverse

Date: 2018-6-30

Electronics: DAE4 Sn777

Medium: Air

Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 1 \text{ kg/m}^3$

Ambient Temperature: 22.5°C

Communication System: WiFi-2.4G; Frequency: 2437 MHz; Duty Cycle: 1:1

Probe: AM1DV2 - 1064;

4.2mm 50 x 50 WB 23.85kbps 11b 5.5Mbps/ABM Interpolated Signal(x,y,z) (121x121x1):

Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav

Output Gain: 100

Measure Window Start: 300ms

Measure Window Length: 1000ms

BWC applied: 0.16 dB

Device Reference Point: 0, 0, -6.3 mm

Cursor:

ABM1 = 8.01 dBA/m

BWC Factor = 0.16 dB

Location: 12.1, 4.6, 3.7 mm

T-Coil/General Scans 11b ch6/y (transversal) 4.2mm 50 x 50 WB 23.85kbps 11b**5.5Mbps/ABM Interpolated SNR(x,y,z) (121x121x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav

Output Gain: 100

Measure Window Start: 300ms

Measure Window Length: 1000ms

BWC applied: 0.16 dB

Device Reference Point: 0, 0, -6.3 mm

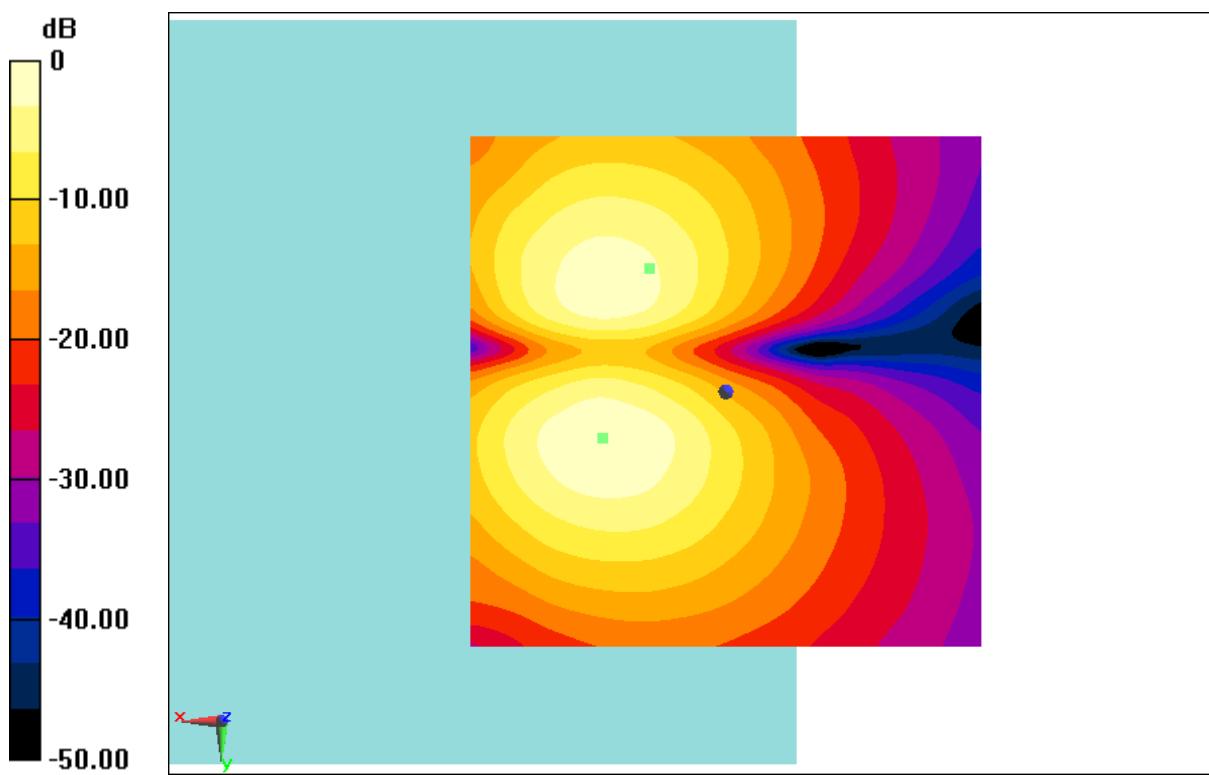
Cursor:

ABM1/ABM2 = 49.91 dB

ABM1 comp = 5.23 dBA/m

BWC Factor = 0.16 dB

Location: 7.5, -12.1, 3.7 mm



0 dB = 2.516 A/m = 8.01 dBA/m

Fig B.25 T-Coil WiFi-2.4G

T-Coil WiFi-2.4G Perpendicular

Date: 2018-6-30

Electronics: DAE4 Sn777

Medium: Air

Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 1 \text{ kg/m}^3$

Ambient Temperature: 22.5°C

Communication System: WiFi-2.4G; Frequency: 2437 MHz; Duty Cycle: 1:1

Probe: AM1DV2 - 1064;

T-Coil/General Scans 11b ch6/z (axial) 4.2mm 50 x 50 WB 23.85kbps 11b

5.5Mbps/ABM Interpolated Signal(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav

Output Gain: 100

Measure Window Start: 300ms

Measure Window Length: 1000ms

BWC applied: 0.16 dB

Device Reference Point: 0, 0, -6.3 mm

Cursor:

ABM1 = 14.48 dBA/m

BWC Factor = 0.16 dB

Location: 11.3, -3.3, 3.7 mm

T-Coil/General Scans 11b ch6/z (axial) 4.2mm 50 x 50 WB 23.85kbps 11b

5.5Mbps/ABM Interpolated SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav

Output Gain: 100

Measure Window Start: 300ms

Measure Window Length: 1000ms

BWC applied: 0.16 dB

Device Reference Point: 0, 0, -6.3 mm

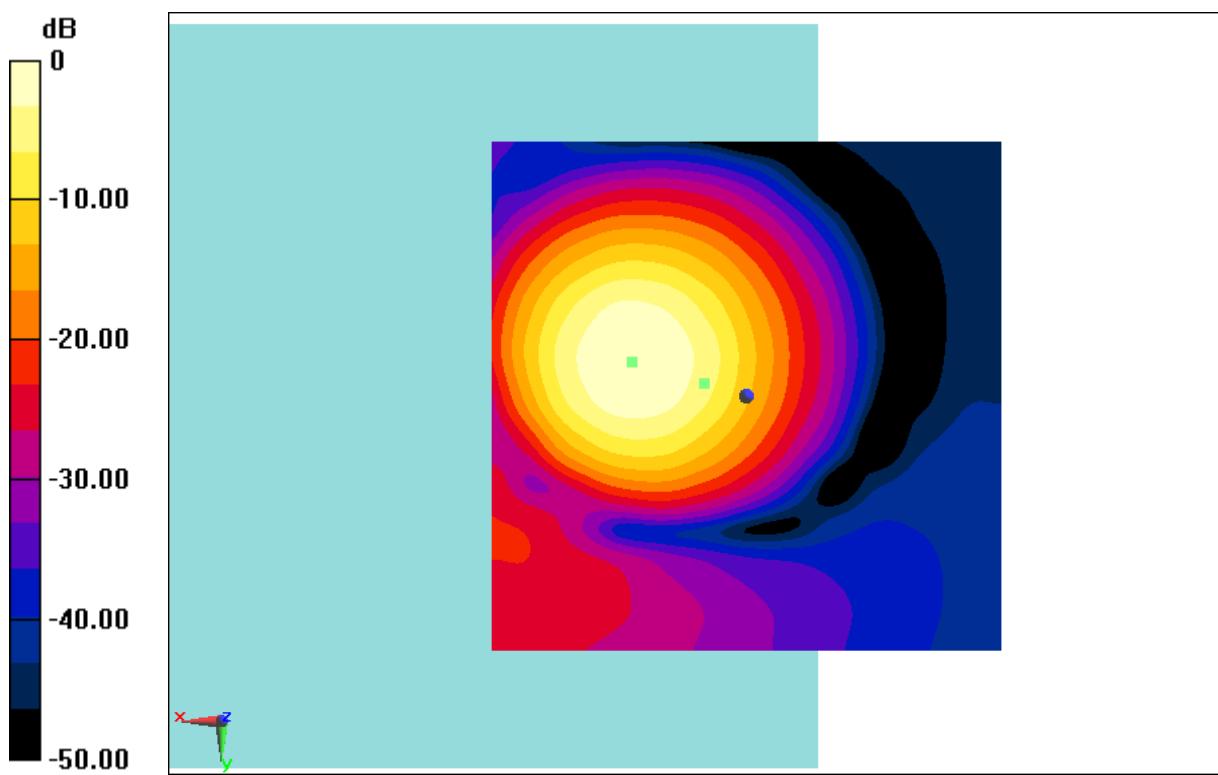
Cursor:

ABM1/ABM2 = 47.24 dB

ABM1 comp = 9.42 dBA/m

BWC Factor = 0.16 dB

Location: 4.2, -1.3, 3.7 mm



0 dB = 5.299 A/m = 14.48 dBA/m

Fig B.26 T-Coil WiFi-2.4G

T-Coil WiFi-5G Transverse

Date: 2018-6-30

Electronics: DAE4 Sn777

Medium: Air

Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 1 \text{ kg/m}^3$

Ambient Temperature: 22.5°C

Communication System: WiFi-5G; Frequency: 5220 MHz; Duty Cycle: 1:1

Probe: AM1DV2 - 1064;

T-Coil/General Scans/y (transversal) 4.2mm 50 x 50 11n 20M 3/ABM Interpolated

Signal(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav

Output Gain: 100

Measure Window Start: 300ms

Measure Window Length: 1000ms

BWC applied: 0.16 dB

Device Reference Point: 0, 0, -6.3 mm

Cursor:

ABM1 = 7.82 dBA/m

BWC Factor = 0.16 dB

Location: 11.7, 4.2, 3.7 mm

T-Coil/General Scans/y (transversal) 4.2mm 50 x 50 11n 20M 3/ABM Interpolated

SNR(x,y,z) (121x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav

Output Gain: 100

Measure Window Start: 300ms

Measure Window Length: 1000ms

BWC applied: 0.16 dB

Device Reference Point: 0, 0, -6.3 mm

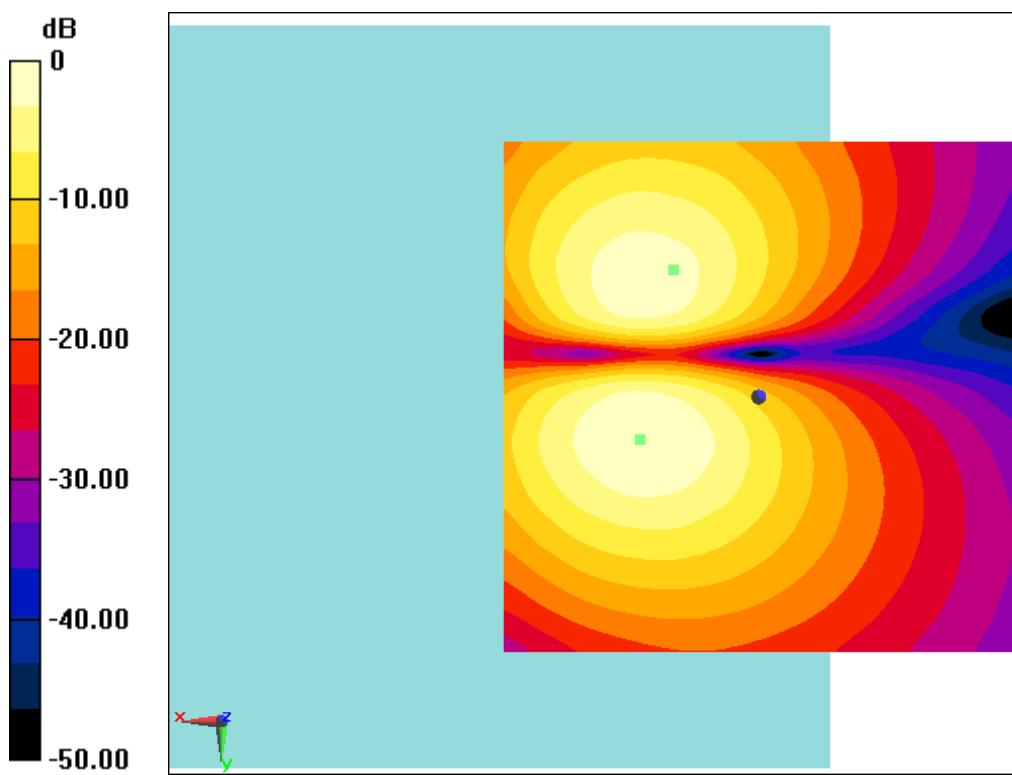
Cursor:

ABM1/ABM2 = 52.82 dB

ABM1 comp = 6.03 dBA/m

BWC Factor = 0.16 dB

Location: 8.3, -12.5, 3.7 mm



0 dB = 2.461 A/m = 7.82 dBA/m

Fig B.27 T-Coil WiFi-5G

T-Coil WiFi-5G Perpendicular

Date: 2018-6-30

Electronics: DAE4 Sn777

Medium: Air

Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 1 \text{ kg/m}^3$

Ambient Temperature: 22.5°C

Communication System: WiFi-5G; Frequency: 5220 MHz; Duty Cycle: 1:1

Probe: AM1DV2 - 1064;

T-Coil/General Scans/z (axial) 4.2mm 50 x 50 11n 20M/ABM Interpolated Signal(x,y,z)**(121x121x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav

Output Gain: 100

Measure Window Start: 300ms

Measure Window Length: 1000ms

BWC applied: 0.16 dB

Device Reference Point: 0, 0, -6.3 mm

Cursor:

ABM1 = 14.67 dBA/m

BWC Factor = 0.16 dB

Location: 11.7, -3.3, 3.7 mm

T-Coil/General Scans/z (axial) 4.2mm 50 x 50 11n 20M/ABM Interpolated SNR(x,y,z)**(121x121x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Signal Type: Audio File (.wav) 48k_voice_1kHz_1s.wav

Output Gain: 100

Measure Window Start: 300ms

Measure Window Length: 1000ms

BWC applied: 0.16 dB

Device Reference Point: 0, 0, -6.3 mm

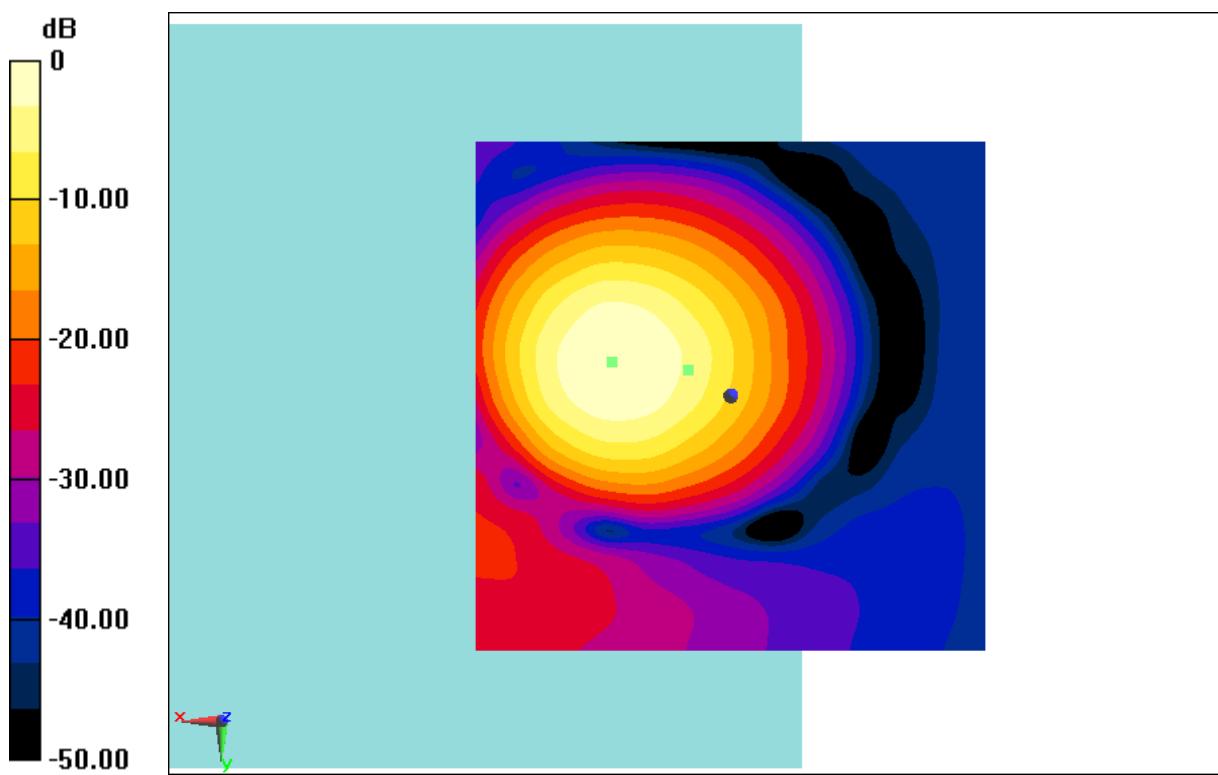
Cursor:

ABM1/ABM2 = 53.91 dB

ABM1 comp = 10.67 dBA/m

BWC Factor = 0.16 dB

Location: 4.2, -2.5, 3.7 mm



0 dB = 5.413 A/m = 14.67 dBA/m

Fig B.28 T-Coil WiFi-5G

ANNEX C FREQUENCY REPONSE CURVES

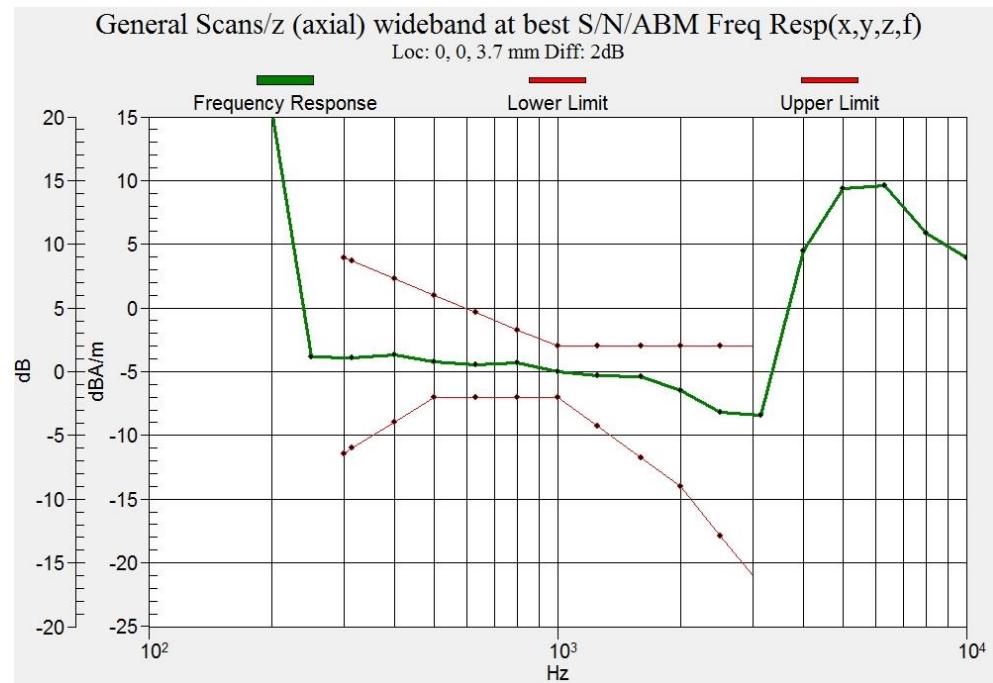


Figure C.1 Frequency Response of GSM 850

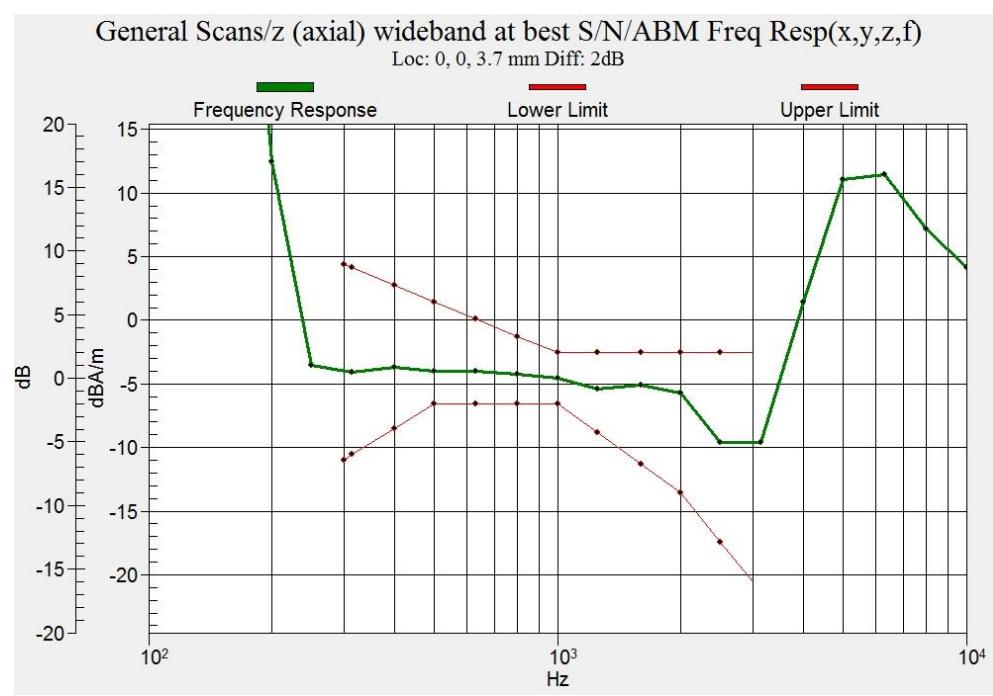


Figure C.2 Frequency Response of GSM 1900

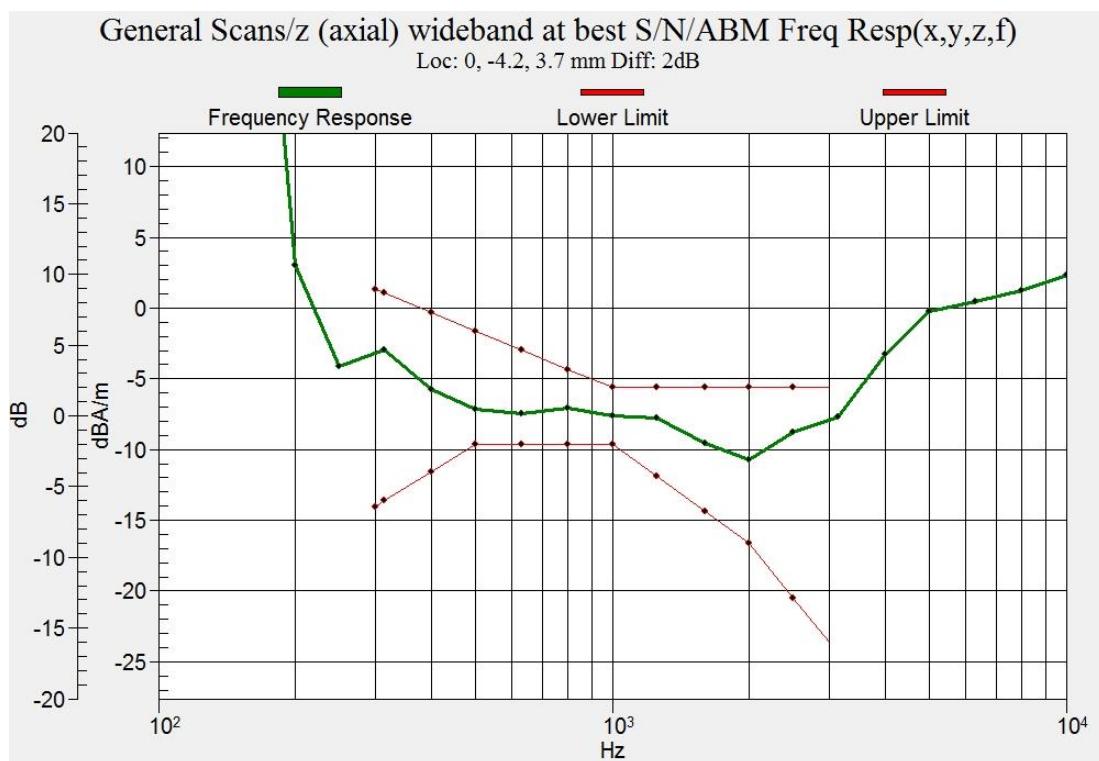


Figure C.3 Frequency Response of WCDMA 850

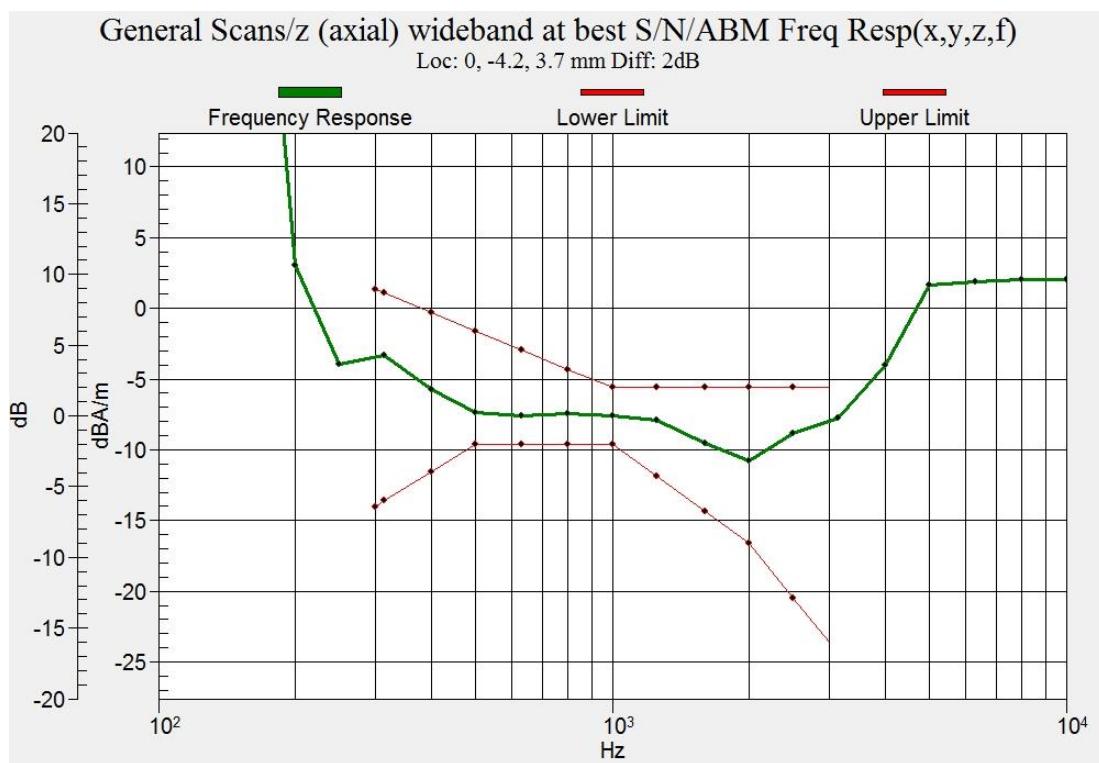


Figure C.4 Frequency Response of WCDMA 1900

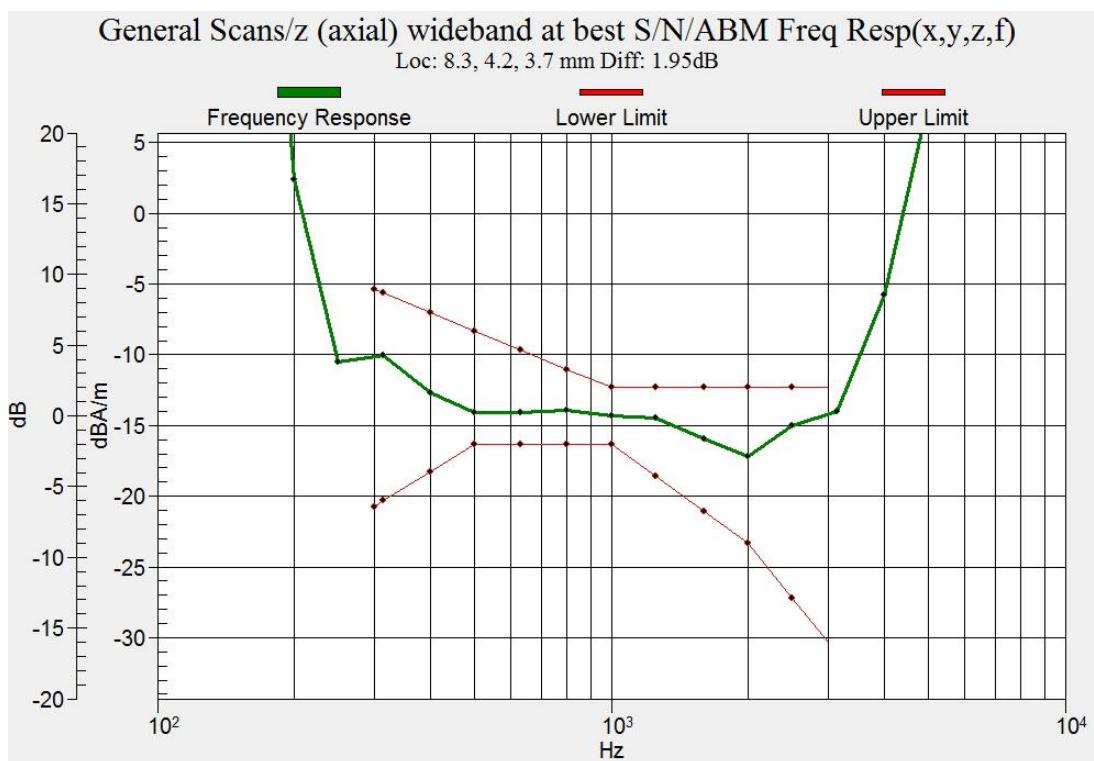


Figure C.5 Frequency Response of WCDMA 1700

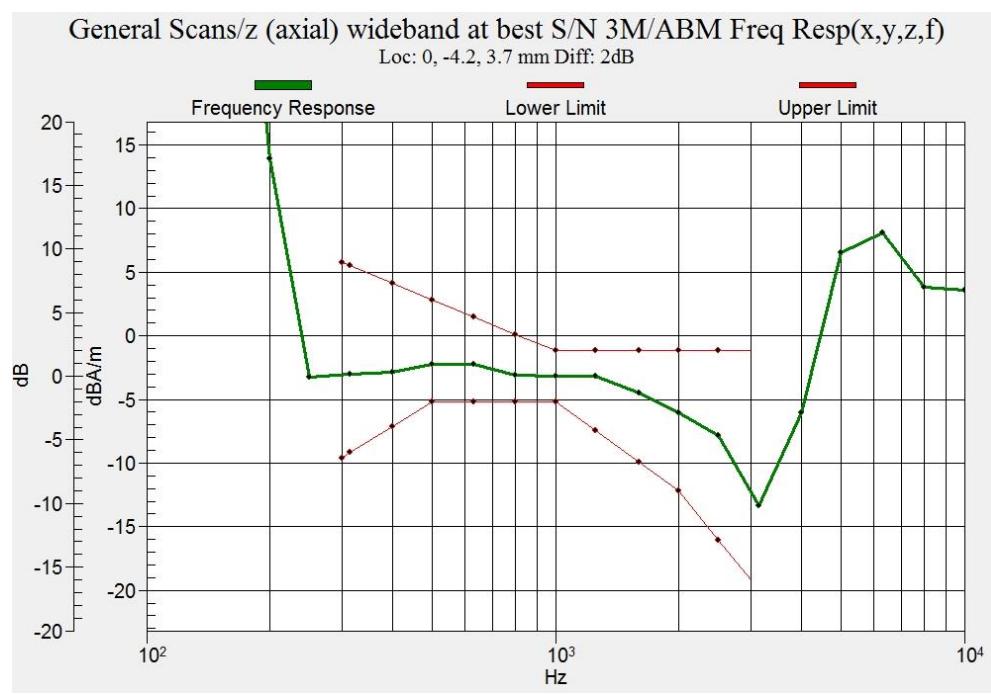


Figure C.6 Frequency Response of LTE B2

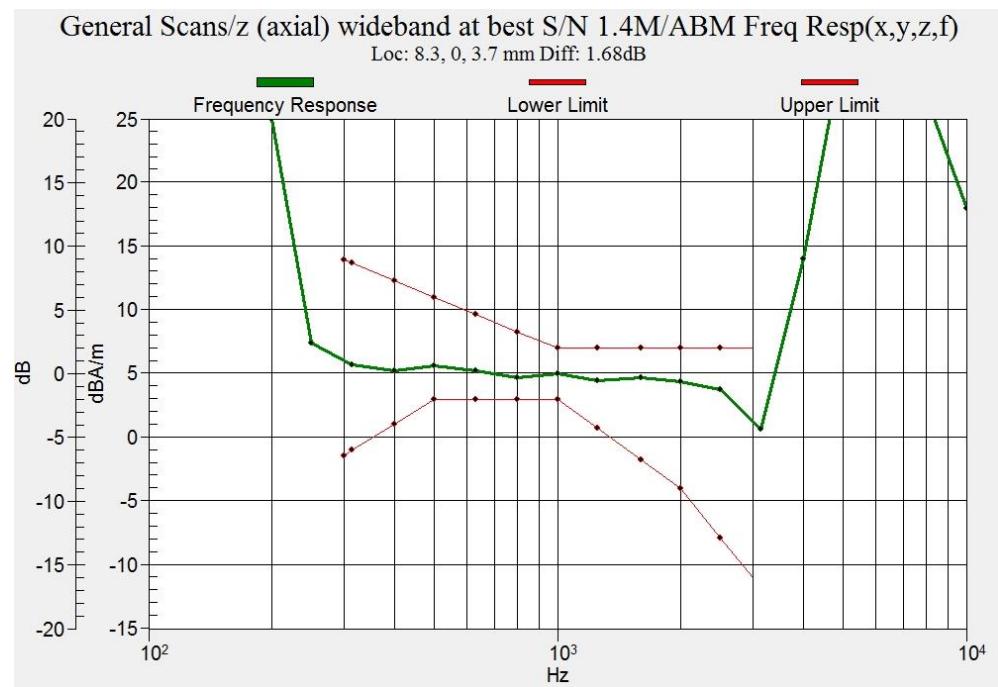


Figure C.7 Frequency Response of LTE B5

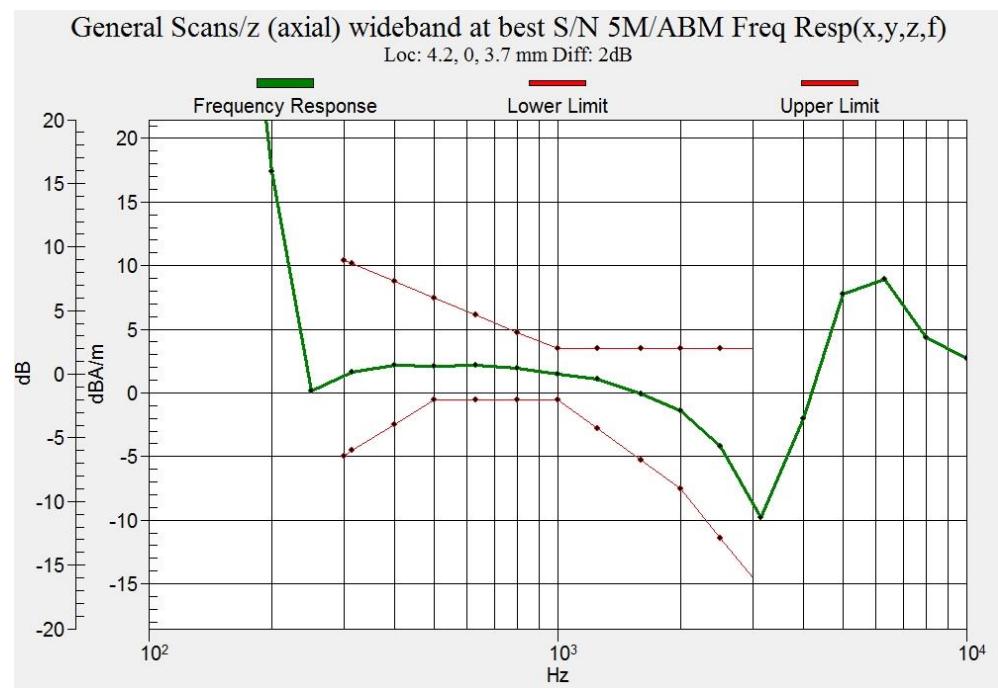


Figure C.8 Frequency Response of LTE B7

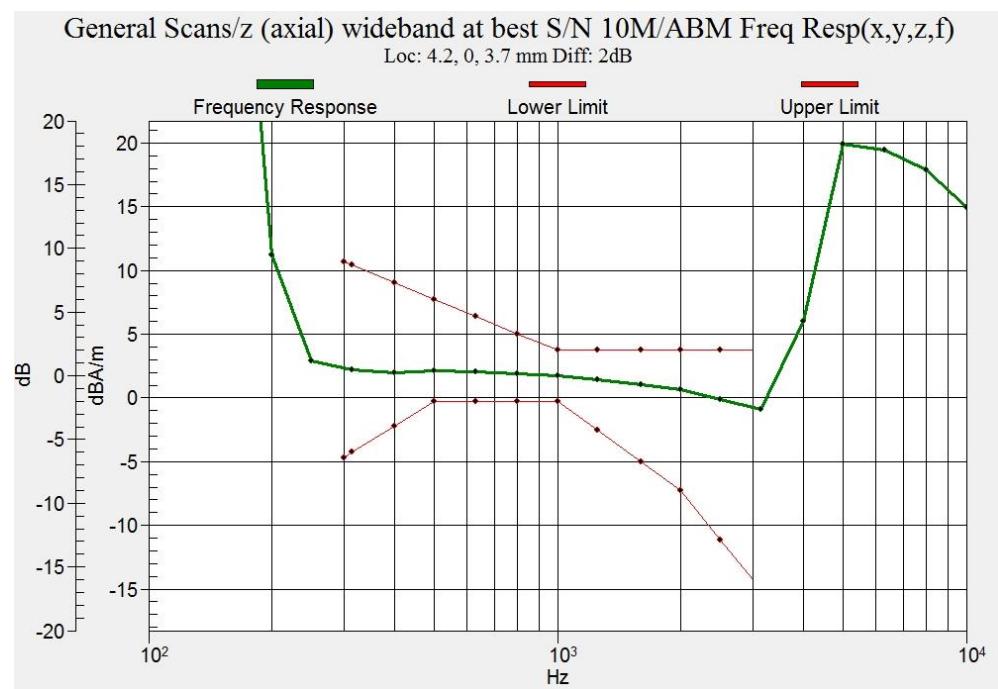


Figure C.9 Frequency Response of LTE B12

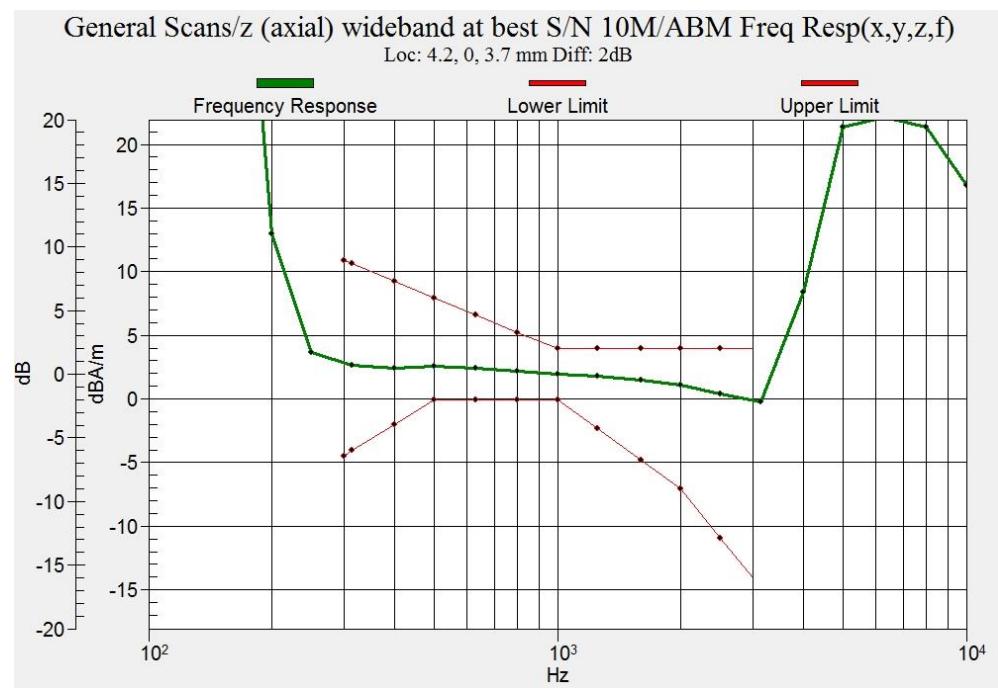


Figure C.10 Frequency Response of LTE B13

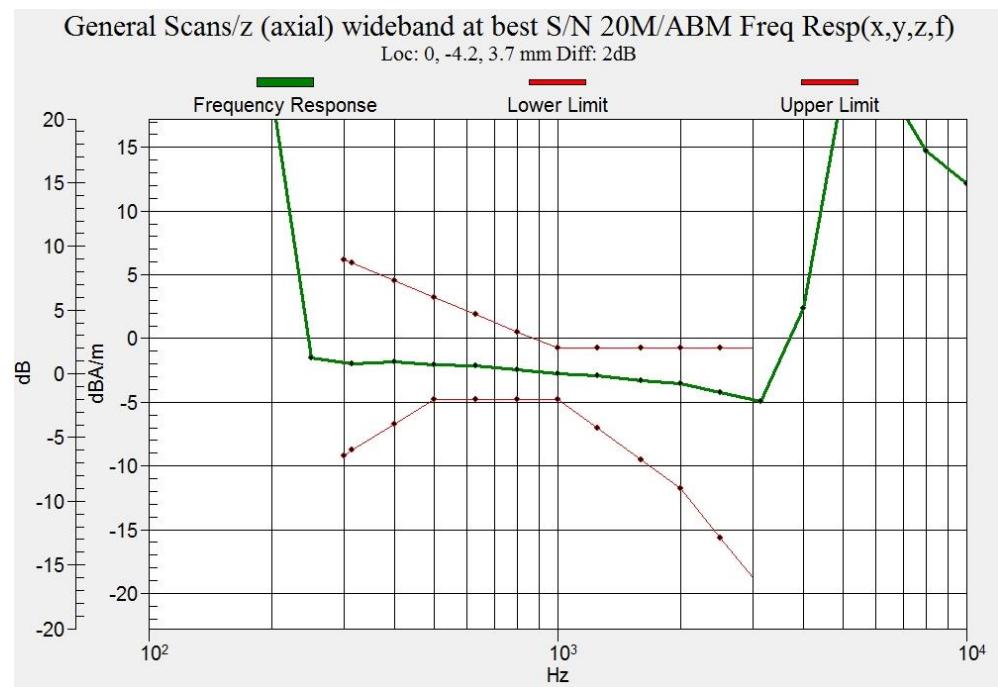


Figure C.11 Frequency Response of LTE B41

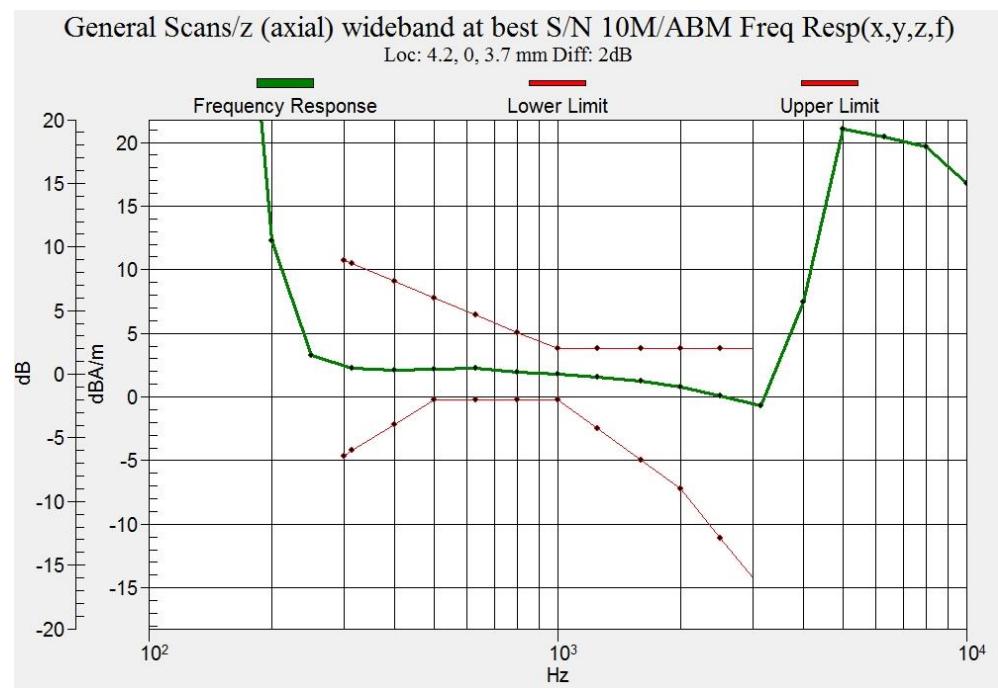


Figure C.12 Frequency Response of LTE B66



Figure C.13 Frequency Response of WiFi-2.4G

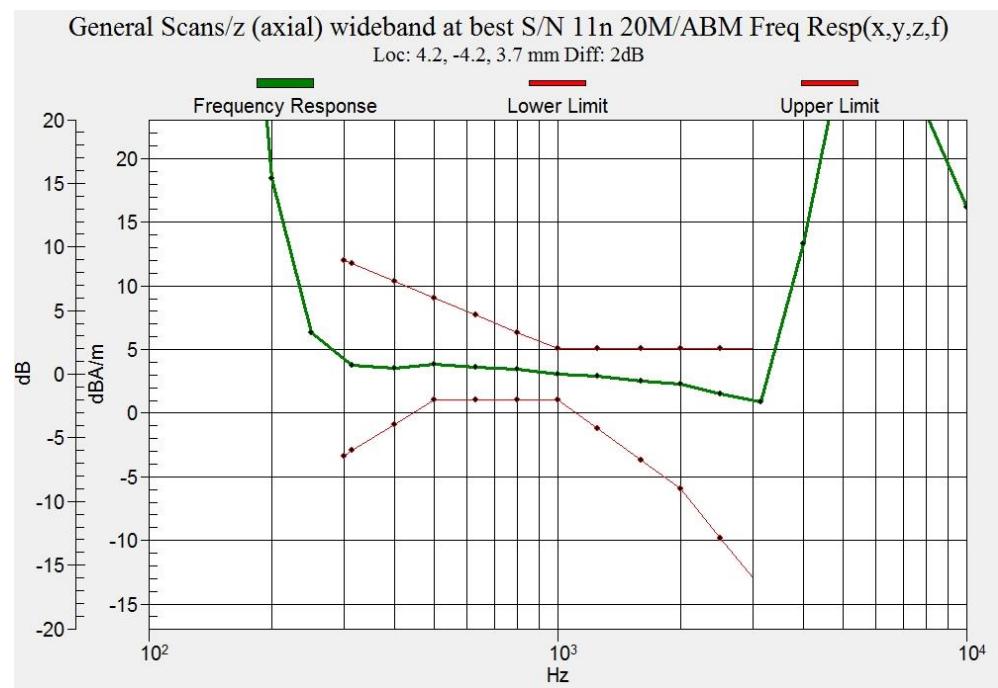


Figure C.14 Frequency Response of WiFi-5G

ANNEX D PROBE CALIBRATION CERTIFICATE

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



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

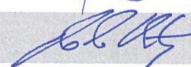
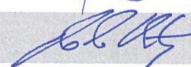
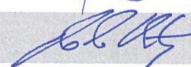
Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Client CTTL-BJ (Auden)

Certificate No: AM1DV2-1064_Jul17

CALIBRATION CERTIFICATE

Object	AM1DV2 - SN: 1064																																										
Calibration procedure(s)	QA CAL-24.v4 Calibration procedure for AM1D magnetic field probes and TMFS in the audio range																																										
Calibration date:	July 20, 2017																																										
<p>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.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.</p> <p>Calibration Equipment used (M&TE critical for calibration)</p> <table border="1"><thead><tr><th>Primary Standards</th><th>ID #</th><th>Cal Date (Certificate No.)</th><th>Scheduled Calibration</th></tr></thead><tbody><tr><td>Keithley Multimeter Type 2001</td><td>SN: 0810278</td><td>09-Sep-16 (No. 19065)</td><td>Sep-17</td></tr><tr><td>Reference Probe AM1DV2</td><td>SN: 1008</td><td>30-Dec-16 (No. AM1D-1008_Dec16)</td><td>Dec-17</td></tr><tr><td>DAE4</td><td>SN: 781</td><td>13-Jul-17 (No. DAE4-781_Jul17)</td><td>Jul-18</td></tr></tbody></table> <table border="1"><thead><tr><th>Secondary Standards</th><th>ID #</th><th>Check Date (in house)</th><th>Scheduled Check</th></tr></thead><tbody><tr><td>AMCC</td><td>SN: 1050</td><td>01-Oct-13 (in house check Sep-15)</td><td>Oct-17</td></tr><tr><td>AMMI Audio Measuring Instrument</td><td>SN: 1062</td><td>26-Sep-12 (in house check Sep-15)</td><td>Oct-17</td></tr></tbody></table> <table border="1"><thead><tr><th>Calibrated by:</th><th>Name</th><th>Function</th><th>Signature</th></tr></thead><tbody><tr><td></td><td>Claudio Leubler</td><td>Laboratory Technician</td><td></td></tr><tr><th>Approved by:</th><th>Katja Pokovic</th><th>Technical Manager</th><td></td></tr></tbody></table> <p>Issued: July 20, 2017</p> <p>This calibration certificate shall not be reproduced except in full without written approval of the laboratory.</p>				Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration	Keithley Multimeter Type 2001	SN: 0810278	09-Sep-16 (No. 19065)	Sep-17	Reference Probe AM1DV2	SN: 1008	30-Dec-16 (No. AM1D-1008_Dec16)	Dec-17	DAE4	SN: 781	13-Jul-17 (No. DAE4-781_Jul17)	Jul-18	Secondary Standards	ID #	Check Date (in house)	Scheduled Check	AMCC	SN: 1050	01-Oct-13 (in house check Sep-15)	Oct-17	AMMI Audio Measuring Instrument	SN: 1062	26-Sep-12 (in house check Sep-15)	Oct-17	Calibrated by:	Name	Function	Signature		Claudio Leubler	Laboratory Technician		Approved by:	Katja Pokovic	Technical Manager	
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Calibrated by:	Name	Function	Signature																																								
	Claudio Leubler	Laboratory Technician																																									
Approved by:	Katja Pokovic	Technical Manager																																									

[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	AM1DV2 Audio Magnetic 1D Field Probe
Type No	SP AM1 001 AF
Serial No	1064

Overall length	296 mm
Tip diameter	6.0 mm (at the tip)
Sensor offset	3.0 mm (centre of sensor from tip)
Internal Amplifier	40 dB

Manufacturer / Origin	Schmid & Partner Engineering AG, Zurich, Switzerland
Manufacturing date	November 06, 2007
Last calibration date	July 22, 2016

Calibration data

Connector rotation angle (in DASY system) **104.1 °** +/- 3.6 ° (k=2)

Sensor angle (in DASY system) **0.44 °** +/- 0.5 ° (k=2)

Sensitivity at 1 kHz (in DASY system) **0.0657 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 E DAE CALIBRATION CERTIFICATE

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



S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
C 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 CTTL (Auden)

Certificate No: DAE4-777_Sep17

CALIBRATION CERTIFICATE

Object DAE4 - SD 000 D04 BM - SN: 777

Calibration procedure(s) QA CAL-06.v29
Calibration procedure for the data acquisition electronics (DAE)

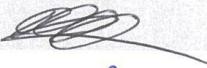
Calibration date: September 08, 2017

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 $(22 \pm 3)^\circ\text{C}$ 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	31-Aug-17 (No:21092)	Aug-18
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	05-Jan-17 (in house check)	In house check: Jan-18
Calibrator Box V2.1	SE UMS 006 AA 1002	05-Jan-17 (in house check)	In house check: Jan-18

Calibrated by:	Name Dominique Steffen	Function Laboratory Technician	Signature 
Approved by:	Sven Kühn	Deputy Manager	

Issued: September 8, 2017

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

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



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Accreditation No.: SCS 0108

Glossary

DAE	data acquisition electronics
Connector angle	information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle:* The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
 - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
 - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.
 - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.
 - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage
 - *Input Offset Measurement:* Output voltage and statistical results over a large number of zero voltage measurements.
 - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.
 - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
 - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
 - *Power consumption:* Typical value for information. Supply currents in various operating modes.

**DC Voltage Measurement**

A/D - Converter Resolution nominal

High Range: 1LSB = $6.1\mu V$, full range = -100...+300 mVLow Range: 1LSB = $61nV$, full range = -1.....+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	$405.400 \pm 0.02\% (k=2)$	$405.869 \pm 0.02\% (k=2)$	$405.579 \pm 0.02\% (k=2)$
Low Range	$3.96640 \pm 1.50\% (k=2)$	$3.96264 \pm 1.50\% (k=2)$	$4.00499 \pm 1.50\% (k=2)$

Connector Angle

Connector Angle to be used in DASY system	$97.0^\circ \pm 1^\circ$
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Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μ V)	Difference (μ V)	Error (%)
Channel X	+ Input	200022.73	-12.42	-0.01
Channel X	+ Input	20003.49	-1.25	-0.01
Channel X	- Input	-19998.82	6.77	-0.03
Channel Y	+ Input	200025.10	-10.04	-0.01
Channel Y	+ Input	20007.22	2.54	0.01
Channel Y	- Input	-20002.34	3.30	-0.02
Channel Z	+ Input	200028.10	-6.82	-0.00
Channel Z	+ Input	20002.36	-2.19	-0.01
Channel Z	- Input	-20003.64	2.12	-0.01

Low Range		Reading (μ V)	Difference (μ V)	Error (%)
Channel X	+ Input	2000.54	-0.37	-0.02
Channel X	+ Input	201.37	0.50	0.25
Channel X	- Input	-199.19	-0.20	0.10
Channel Y	+ Input	1999.95	-0.89	-0.04
Channel Y	+ Input	200.04	-0.75	-0.37
Channel Y	- Input	-199.96	-0.85	0.43
Channel Z	+ Input	2001.05	0.20	0.01
Channel Z	+ Input	199.88	-0.86	-0.43
Channel Z	- Input	-200.02	-0.88	0.44

2. Common mode sensitivity

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading (μ V)	Low Range Average Reading (μ V)
Channel X	200	5.45	3.79
	-200	3.93	0.83
Channel Y	200	7.70	7.39
	-200	-9.52	-8.90
Channel Z	200	7.51	6.49
	-200	-9.21	-8.71

3. Channel separation

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Input Voltage (mV)	Channel X (μ V)	Channel Y (μ V)	Channel Z (μ V)
Channel X	200	-	-1.61	-2.84
Channel Y	200	8.30	-	0.46
Channel Z	200	6.69	5.02	-

4. AD-Converter Values with inputs shorted

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	15919	14652
Channel Y	16343	14477
Channel Z	16033	14911

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Input $10M\Omega$

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	-0.50	-2.04	0.95	0.51
Channel Y	1.56	0.40	2.80	0.48
Channel Z	0.26	-0.78	1.16	0.42

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	-0.01	-8	-9

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

Appendix to test report no. I18Z60272-SEM03/04

The photos of HAC test