

37_HAC RF WLAN5.3GHz_802.11a 6Mbps_Ch60

Communication System: UID 10069 - CAD, IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps);
Frequency: 5300 MHz; Duty Cycle: 1:11.3789

Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³

Ambient Temperature : 23.2 °C;

DASY5 Configuration:

- Probe: EF3DV3 - SN4050; ConvF(1, 1, 1); Calibrated: 2021.1.25
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1356; Calibrated: 2021.6.1
- 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)

Ch60/Hearing Aid Compatibility Test (101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 49.77 V/m; Power Drift = -0.08 dB

Applied MIF = -3.15 dB

RF audio interference level = 29.17 dBV/m

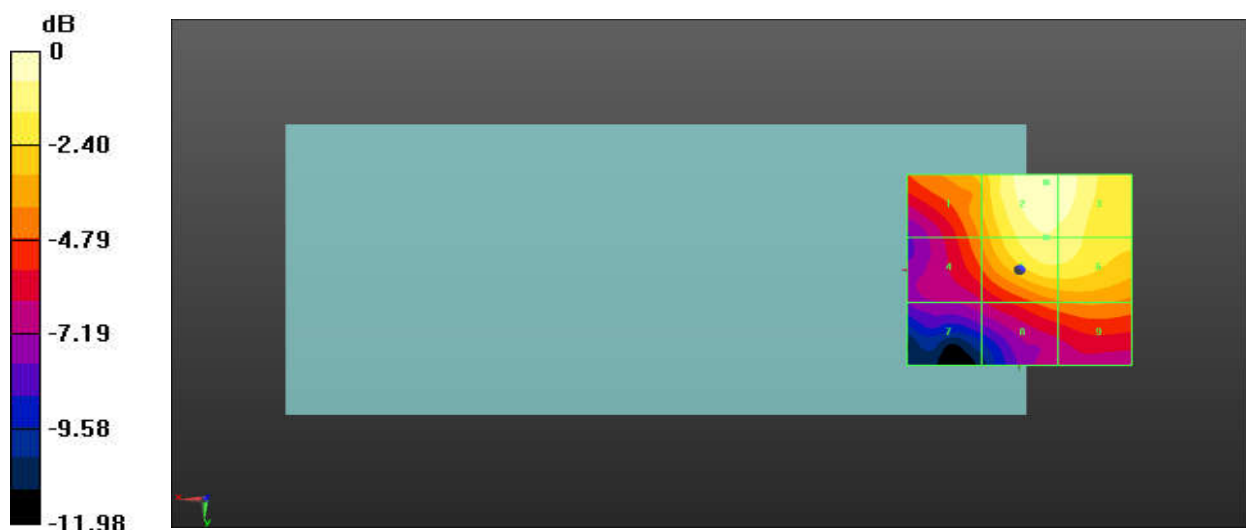
MIF scaled E-field

Grid 1 M4 26.41 dBV/m	Grid 2 M4 29.17 dBV/m	Grid 3 M4 29.04 dBV/m
Grid 4 M4 25.35 dBV/m	Grid 5 M4 28.3 dBV/m	Grid 6 M4 28.17 dBV/m
Grid 7 M4 22.67 dBV/m	Grid 8 M4 25 dBV/m	Grid 9 M4 25.34 dBV/m

Total = 29.17 dBV/m

E Category: M4

Location: -6, -23, 8.7 mm



0 dB = 28.73 V/m = 29.17 dBV/m

38_HAC RF WLAN5.3GHz_802.11a 6Mbps_Ch64

Communication System: UID 10069 - CAD, IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps);
Frequency: 5320 MHz; Duty Cycle: 1:11.3789

Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³

Ambient Temperature : 23.2 °C;

DASY5 Configuration:

- Probe: EF3DV3 - SN4050; ConvF(1, 1, 1); Calibrated: 2021.1.25
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1356; Calibrated: 2021.6.1
- 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)

Ch64/Hearing Aid Compatibility Test (101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 48.64 V/m; Power Drift = -0.07 dB

Applied MIF = -3.15 dB

RF audio interference level = 29.09 dBV/m

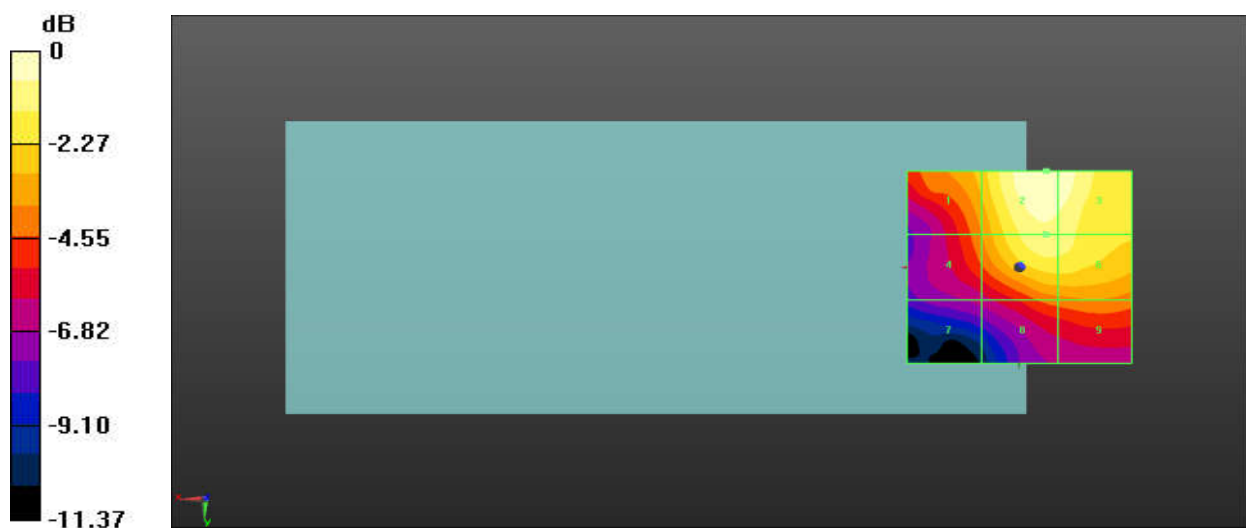
MIF scaled E-field

Grid 1 M4 26.46 dBV/m	Grid 2 M4 29.09 dBV/m	Grid 3 M4 28.94 dBV/m
Grid 4 M4 25.28 dBV/m	Grid 5 M4 28.12 dBV/m	Grid 6 M4 27.99 dBV/m
Grid 7 M4 22.7 dBV/m	Grid 8 M4 24.99 dBV/m	Grid 9 M4 25.28 dBV/m

Total = 29.09 dBV/m

E Category: M4

Location: -6, -25, 8.7 mm



0 dB = 28.48 V/m = 29.09 dBV/m

39_HAC RF WLAN5.5GHz_802.11a 6Mbps_Ch100

Communication System: UID 10069 - CAD, IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps);
Frequency: 5500 MHz; Duty Cycle: 1:11.3789

Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³

Ambient Temperature : 23.2 °C;

DASY5 Configuration:

- Probe: EF3DV3 - SN4050; ConvF(1, 1, 1); Calibrated: 2021.1.25
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1356; Calibrated: 2021.6.1
- 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)

Ch100/Hearing Aid Compatibility Test (101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 54.05 V/m; Power Drift = -0.07 dB

Applied MIF = -3.15 dB

RF audio interference level = 29.88 dBV/m

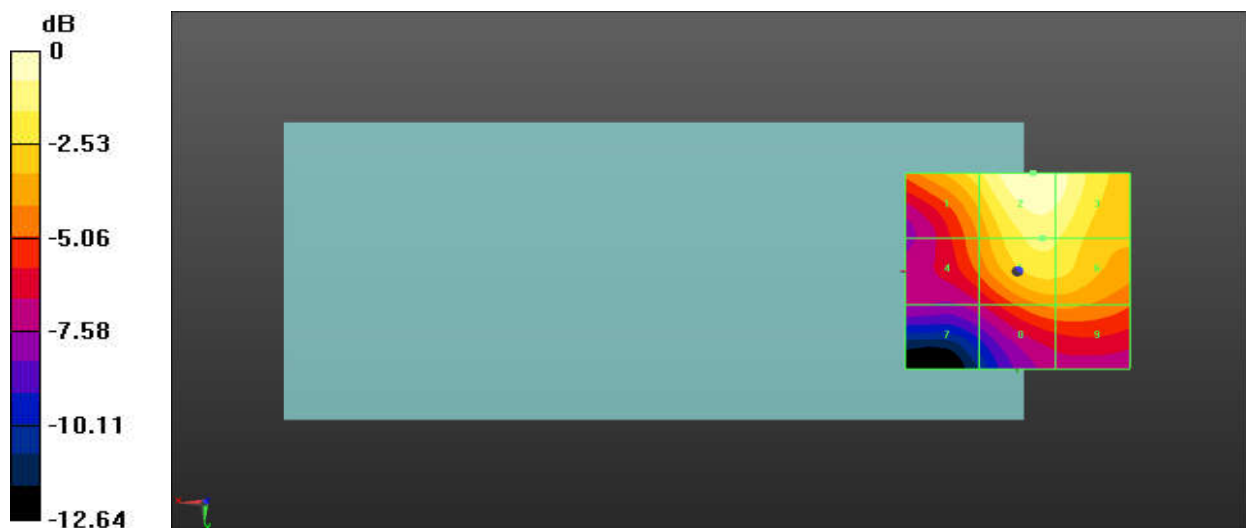
MIF scaled E-field

Grid 1 M4 28.02 dBV/m	Grid 2 M4 29.88 dBV/m	Grid 3 M4 29.5 dBV/m
Grid 4 M4 25.81 dBV/m	Grid 5 M4 28.44 dBV/m	Grid 6 M4 28.29 dBV/m
Grid 7 M4 23.05 dBV/m	Grid 8 M4 25.93 dBV/m	Grid 9 M4 25.96 dBV/m

Total = 29.88 dBV/m

E Category: M4

Location: -3.5, -25, 8.7 mm



0 dB = 31.20 V/m = 29.88 dBV/m

40_HAC RF WLAN5.5GHz_802.11a 6Mbps_Ch116

Communication System: UID 10069 - CAD, IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps);
Frequency: 5580 MHz; Duty Cycle: 1:11.3789

Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³

Ambient Temperature : 23.2 °C;

DASY5 Configuration:

- Probe: EF3DV3 - SN4050; ConvF(1, 1, 1); Calibrated: 2021.1.25
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1356; Calibrated: 2021.6.1
- 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)

Ch116/Hearing Aid Compatibility Test (101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 51.25 V/m; Power Drift = -0.01 dB

Applied MIF = -3.15 dB

RF audio interference level = 29.41 dBV/m

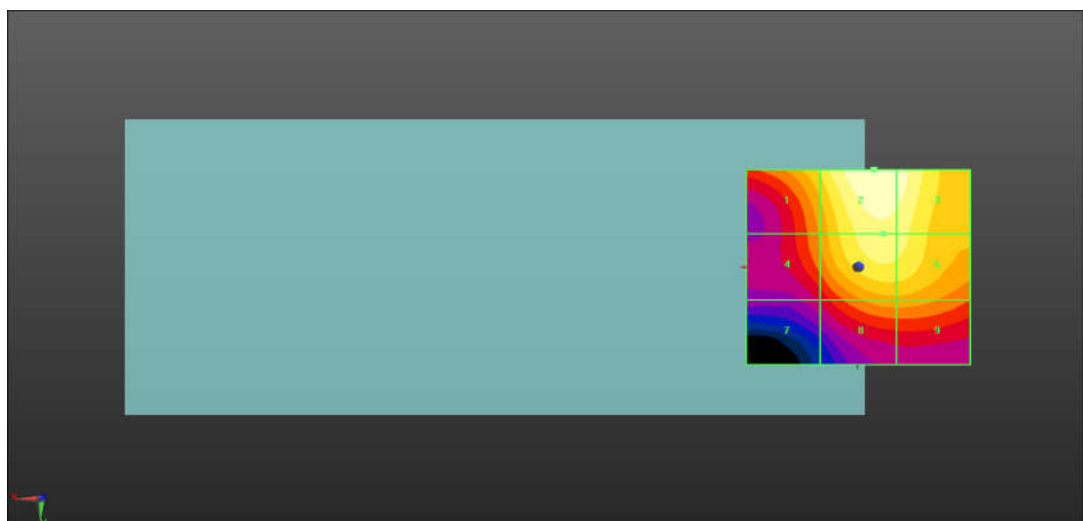
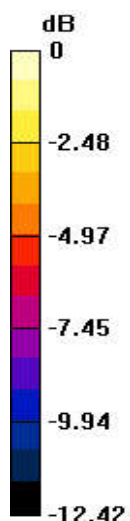
MIF scaled E-field

Grid 1 M4 27.16 dBV/m	Grid 2 M4 29.41 dBV/m	Grid 3 M4 29.06 dBV/m
Grid 4 M4 25.43 dBV/m	Grid 5 M4 28.31 dBV/m	Grid 6 M4 28.14 dBV/m
Grid 7 M4 22.96 dBV/m	Grid 8 M4 25.81 dBV/m	Grid 9 M4 25.81 dBV/m

Total = 29.41 dBV/m

E Category: M4

Location: -3.5, -25, 8.7 mm



0 dB = 29.55 V/m = 29.41 dBV/m

41_HAC RF WLAN5.5GHz_802.11a 6Mbps_Ch144

Communication System: UID 10069 - CAD, IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps);
Frequency: 5720 MHz; Duty Cycle: 1:11.3789

Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³

Ambient Temperature : 23.2 °C;

DASY5 Configuration:

- Probe: EF3DV3 - SN4050; ConvF(1, 1, 1); Calibrated: 2021.1.25
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1356; Calibrated: 2021.6.1
- 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)

Ch144/Hearing Aid Compatibility Test (101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 54.41 V/m; Power Drift = -0.07 dB

Applied MIF = -3.15 dB

RF audio interference level = 29.41 dBV/m

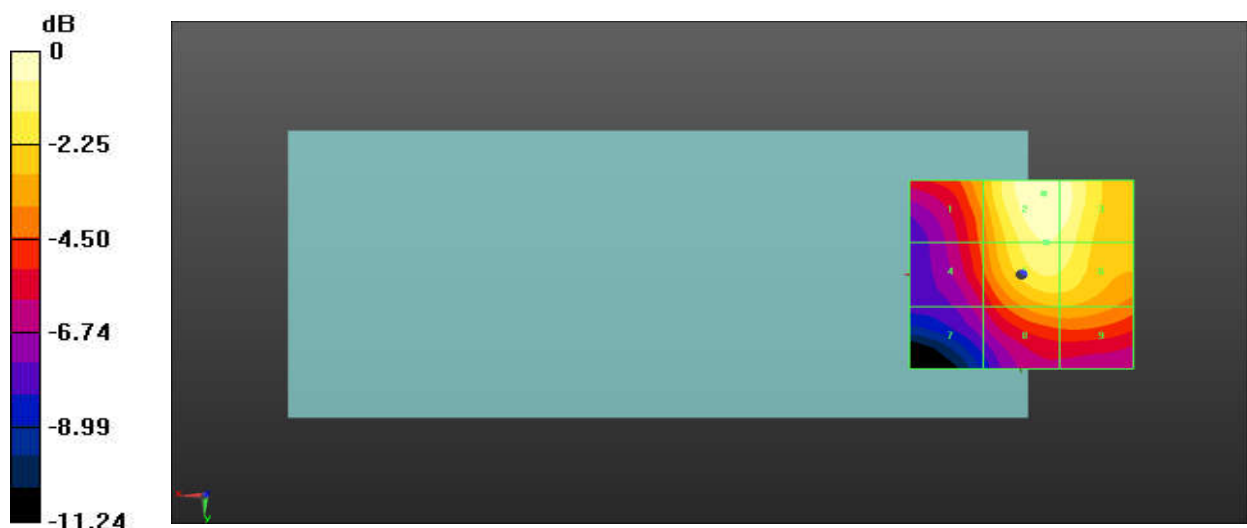
MIF scaled E-field

Grid 1 M4 26.53 dBV/m	Grid 2 M4 29.41 dBV/m	Grid 3 M4 29.16 dBV/m
Grid 4 M4 25.31 dBV/m	Grid 5 M4 28.66 dBV/m	Grid 6 M4 28.46 dBV/m
Grid 7 M4 23.43 dBV/m	Grid 8 M4 26.39 dBV/m	Grid 9 M4 26.39 dBV/m

Total = 29.41 dBV/m

E Category: M4

Location: -5, -21.5, 8.7 mm



0 dB = 29.53 V/m = 29.41 dBV/m

42_HAC RF WLAN5.8GHz_802.11a 6Mbps_Ch149

Communication System: UID 10069 - CAD, IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps);
Frequency: 5745 MHz; Duty Cycle: 1:11.3789

Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³

Ambient Temperature : 23.2 °C;

DASY5 Configuration:

- Probe: EF3DV3 - SN4050; ConvF(1, 1, 1); Calibrated: 2021.1.25
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1356; Calibrated: 2021.6.1
- 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)

Ch149/Hearing Aid Compatibility Test (101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 54.34 V/m; Power Drift = -0.03 dB

Applied MIF = -3.15 dB

RF audio interference level = 29.47 dBV/m

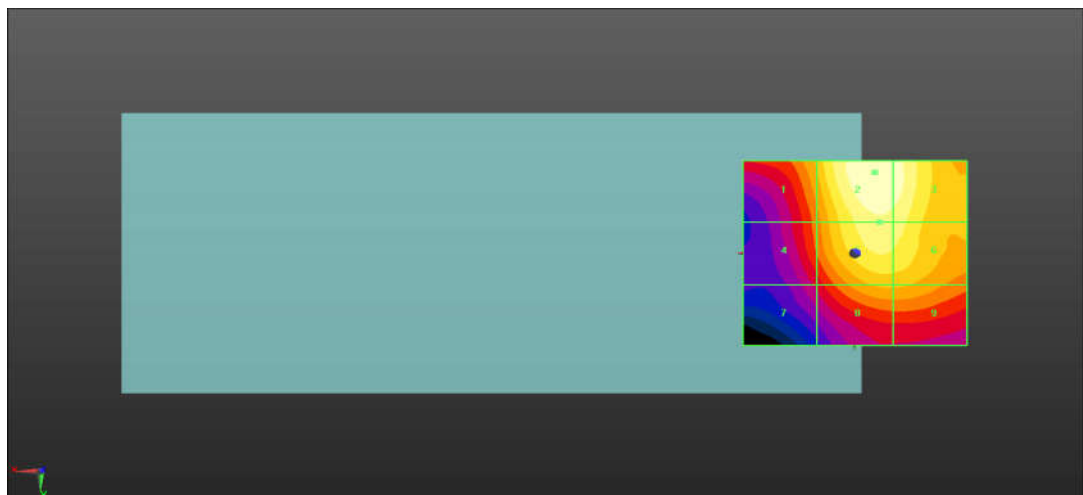
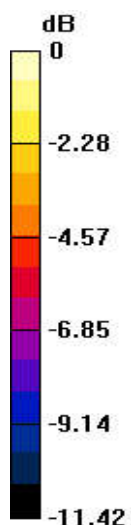
MIF scaled E-field

Grid 1 M4 26.64 dBV/m	Grid 2 M4 29.47 dBV/m	Grid 3 M4 29.15 dBV/m
Grid 4 M4 25.35 dBV/m	Grid 5 M4 28.56 dBV/m	Grid 6 M4 28.38 dBV/m
Grid 7 M4 23.66 dBV/m	Grid 8 M4 26.63 dBV/m	Grid 9 M4 26.62 dBV/m

Total = 29.47 dBV/m

E Category: M4

Location: -4.5, -22, 8.7 mm



0 dB = 29.74 V/m = 29.47 dBV/m

43_HAC RF WLAN5.8GHz_802.11a 6Mbps_Ch157

Communication System: UID 10069 - CAD, IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps);
Frequency: 5785 MHz; Duty Cycle: 1:11.3789

Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³

Ambient Temperature : 23.2 °C;

DASY5 Configuration:

- Probe: EF3DV3 - SN4050; ConvF(1, 1, 1); Calibrated: 2021.1.25
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1356; Calibrated: 2021.6.1
- 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)

Ch157/Hearing Aid Compatibility Test (101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 54.15 V/m; Power Drift = -0.07 dB

Applied MIF = -3.15 dB

RF audio interference level = 29.49 dBV/m

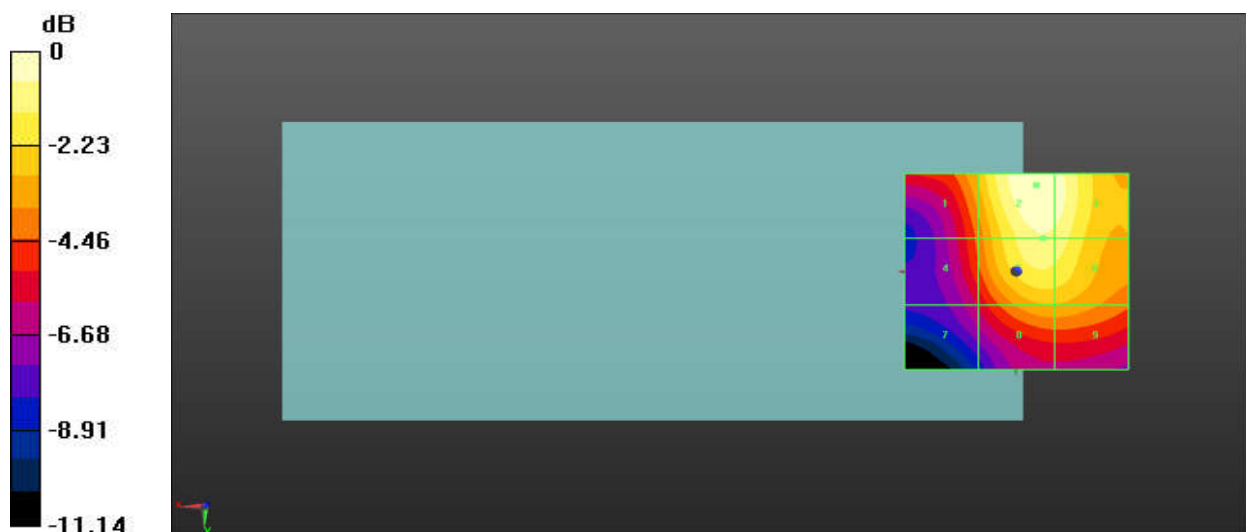
MIF scaled E-field

Grid 1 M4 26.67 dBV/m	Grid 2 M4 29.49 dBV/m	Grid 3 M4 29.2 dBV/m
Grid 4 M4 25.33 dBV/m	Grid 5 M4 28.67 dBV/m	Grid 6 M4 28.52 dBV/m
Grid 7 M4 23.68 dBV/m	Grid 8 M4 26.51 dBV/m	Grid 9 M4 26.49 dBV/m

Total = 29.49 dBV/m

E Category: M4

Location: -4.5, -22, 8.7 mm



0 dB = 29.83 V/m = 29.49 dBV/m

44_HAC RF WLAN5.8GHz_802.11a 6Mbps_Ch165

Communication System: UID 10069 - CAD, IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps);
Frequency: 5825 MHz; Duty Cycle: 1:11.3789

Medium: Air Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³

Ambient Temperature : 23.2 °C;

DASY5 Configuration:

- Probe: EF3DV3 - SN4050; ConvF(1, 1, 1); Calibrated: 2021.1.25
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1356; Calibrated: 2021.6.1
- 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)

Ch165/Hearing Aid Compatibility Test (101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 53.68 V/m; Power Drift = -0.12 dB

Applied MIF = -3.15 dB

RF audio interference level = 29.97 dBV/m

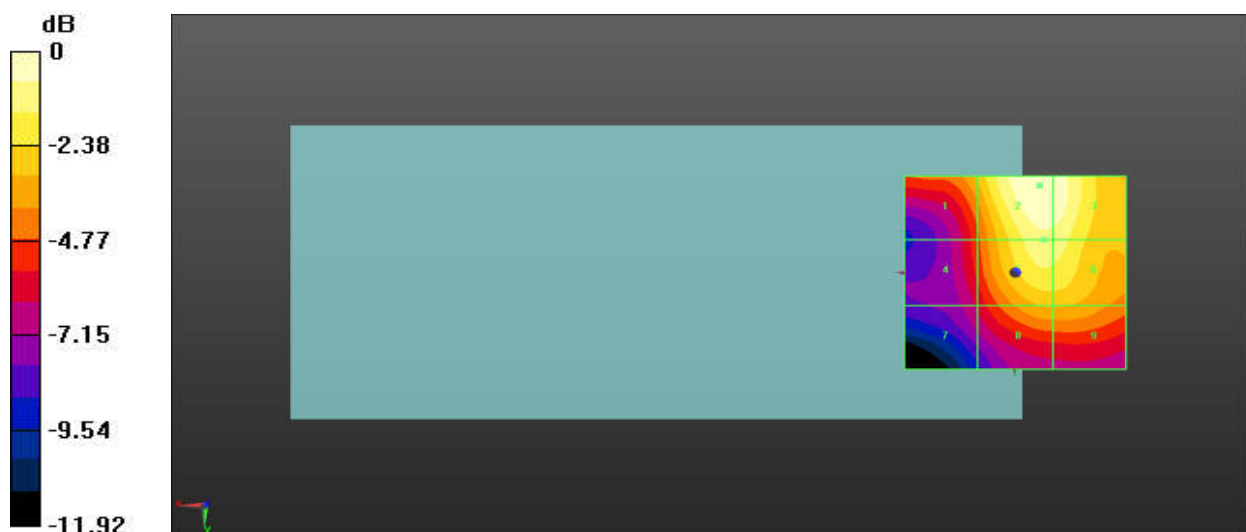
MIF scaled E-field

Grid 1 M4 26.98 dBV/m	Grid 2 M4 29.97 dBV/m	Grid 3 M4 29.77 dBV/m
Grid 4 M4 25.01 dBV/m	Grid 5 M4 28.95 dBV/m	Grid 6 M4 28.87 dBV/m
Grid 7 M4 23.81 dBV/m	Grid 8 M4 26.9 dBV/m	Grid 9 M4 26.9 dBV/m

Total = 29.97 dBV/m

E Category: M4

Location: -5.5, -22.5, 8.7 mm



0 dB = 31.50 V/m = 29.97 dBV/m



Appendix C. DASY Calibration Certificate

The DASY calibration certificates are shown as follows.



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 **Sporton**

Certificate No: **CD835V3-1045_Sep21**

CALIBRATION CERTIFICATE

Object **CD835V3 - SN: 1045**

Calibration procedure(s) **QA CAL-20.v7
 Calibration Procedure for Validation Sources in air**

Calibration date: **September 27, 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 $(22 \pm 3)^\circ\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	09-Apr-21 (No. 217-03291/03292)	Apr-22
Power sensor NRP-Z91	SN: 103244	09-Apr-21 (No. 217-03291)	Apr-22
Power sensor NRP-Z91	SN: 103245	09-Apr-21 (No. 217-03292)	Apr-22
Reference 20 dB Attenuator	SN: BH9394 (20k)	09-Apr-21 (No. 217-03343)	Apr-22
Type-N mismatch combination	SN: 310982 / 06327	09-Apr-21 (No. 217-03344)	Apr-22
Probe EF3DV3	SN: 4013	28-Dec-20 (No. EF3-4013_Dec20)	Dec-21
DAE4	SN: 781	23-Dec-20 (No. DAE4-781_Dec20)	Dec-21

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter Agilent 4419B	SN: GB42420191	09-Oct-09 (in house check Oct-20)	In house check: Oct-23
Power sensor HP E4412A	SN: US38485102	05-Jan-10 (in house check Oct-20)	In house check: Oct-23
Power sensor HP 8482A	SN: US37295597	09-Oct-09 (in house check Oct-20)	In house check: Oct-23
RF generator R&S SMT-06	SN: 837633/005	10-Jan-19 (in house check Oct-20)	In house check: Oct-23
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-21

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: September 27, 2021

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



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**

References

- [1] ANSI-C63.19-2019 (ANSI-C63.19-2011)
American National Standard, Methods of Measurement of Compatibility between Wireless Communications
Devices and Hearing Aids.

Methods Applied and Interpretation of Parameters:

- **Coordinate System:** y-axis is in the direction of the dipole arms. z-axis is from the basis of the antenna (mounted on the table) towards its feed point between the two dipole arms. x-axis is normal to the other axes. In coincidence with the standards [1], the measurement planes (probe sensor center) are selected to be at a distance of 15 mm above the top metal edge of the dipole arms.
- **Measurement Conditions:** Further details are available from the hardcopies at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated. The forward power to the dipole connector is set with a calibrated power meter connected and monitored with an auxiliary power meter connected to a directional coupler. While the dipole under test is connected, the forward power is adjusted to the same level.
- **Antenna Positioning:** The dipole is mounted on a HAC Test Arch phantom using the matching dipole positioner with the arms horizontal and the feeding cable coming from the floor. The measurements are performed in a shielded room with absorbers around the setup to reduce the reflections. It is verified before the mounting of the dipole under the Test Arch phantom, that its arms are perfectly in a line. It is installed on the HAC dipole positioner with its arms parallel below the dielectric reference wire and able to move elastically in vertical direction without changing its relative position to the top center of the Test Arch phantom. The vertical distance to the probe is adjusted after dipole mounting with a DASY5 Surface Check job. Before the measurement, the distance between phantom surface and probe tip is verified. The proper measurement distance is selected by choosing the matching section of the HAC Test Arch phantom with the proper device reference point (upper surface of the dipole) and the matching grid reference point (tip of the probe) considering the probe sensor offset. The vertical distance to the probe is essential for the accuracy.
- **Feed Point Impedance and Return Loss:** These parameters are measured using a Vector Network Analyzer. The impedance is specified at the SMA connector of the dipole. The influence of reflections was eliminating by applying the averaging function while moving the dipole in the air, at least 70cm away from any obstacles.
- **E-field distribution:** E field is measured in the x-y-plane with an isotropic E-field probe with 100 mW forward power to the antenna feed point. In accordance with [1], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 15 mm (in z) above the metal top of the dipole arms. Two 3D maxima are available near the end of the dipole arms. Assuming the dipole arms are perfectly in one line, the average of these two maxima (in subgrid 2 and subgrid 8) is determined to compensate for any non-parallelity to the measurement plane as well as the sensor displacement. The E-field value stated as calibration value represents the maximum of the interpolated 3D-E-field, in the plane above the dipole surface.

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%.

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.10.4
Phantom	HAC Test Arch	
Distance Dipole Top - Probe Center	15 mm	
Scan resolution	dx, dy = 5 mm	
Frequency	835 MHz $\pm$ 1 MHz	
Input power drift	< 0.05 dB	

Maximum Field values at 835 MHz

E-field 15 mm above dipole surface	condition	Interpolated maximum
Maximum measured above high end	100 mW input power	108.2 V/m = 40.68 dBV/m
Maximum measured above low end	100 mW input power	105.4 V/m = 40.46 dBV/m
Averaged maximum above arm	100 mW input power	106.8 V/m $\pm$ 12.8 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters

Frequency	Return Loss	Impedance
800 MHz	15.7 dB	39.6 Ω - 10.5 j Ω
835 MHz	31.8 dB	49.3 Ω + 2.5 j Ω
880 MHz	19.0 dB	56.2 Ω - 10.2 j Ω
900 MHz	18.4 dB	49.6 Ω - 12.0 j Ω
945 MHz	20.4 dB	48.2 Ω + 9.2 j Ω

3.2 Antenna Design and Handling

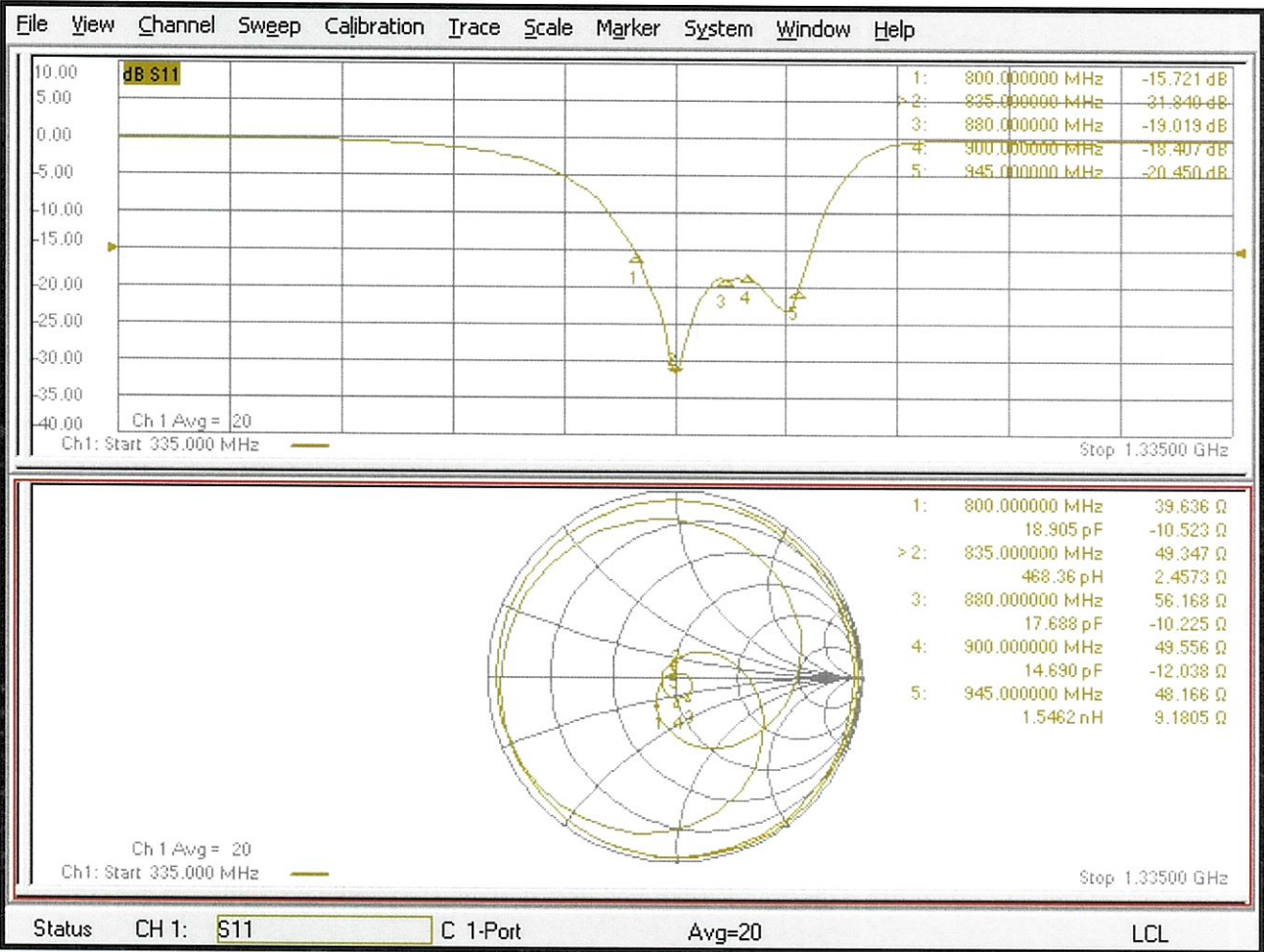
The calibration dipole has a symmetric geometry with a built-in two stub matching network, which leads to the enhanced bandwidth.

The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.

Do not apply force to dipole arms, as they are liable to bend. The soldered connections near the feedpoint may be damaged. After excessive mechanical stress or overheating, check the impedance characteristics to ensure that the internal matching network is not affected.

After long term use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

Impedance Measurement Plot



DASY5 E-field Result

Date: 27.09.2021

Test Laboratory: SPEAG Lab2

DUT: HAC-Dipole 835 MHz; Type: CD835V3; Serial: CD835V3 - SN: 1045

Communication System: UID 0 - CW ; Frequency: 835 MHz

Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³

Phantom section: RF Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EF3DV3 - SN4013; ConvF(1, 1, 1) @ 835 MHz; Calibrated: 28.12.2020
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 23.12.2020
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole E-Field measurement @ 835MHz/E-Scan - 835MHz d=15mm/Hearing Aid Compatibility Test (41x361x1):

Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 127.6 V/m; Power Drift = 0.01 dB

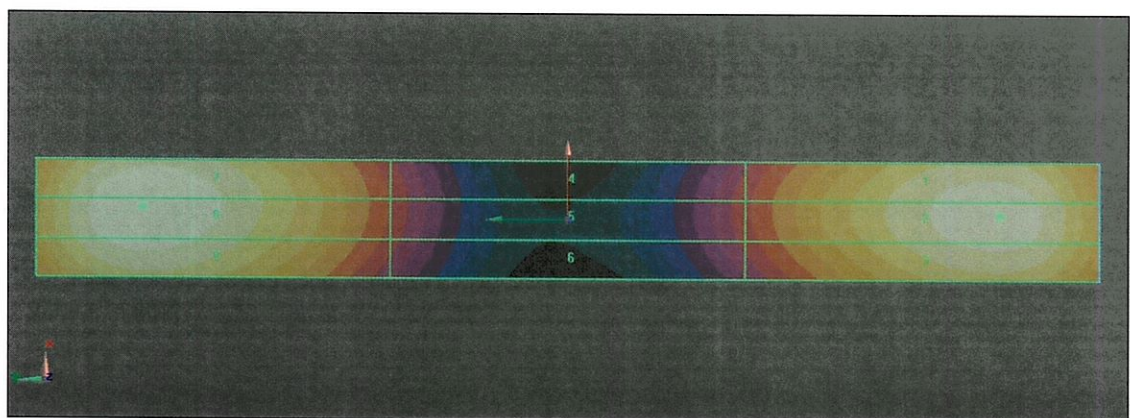
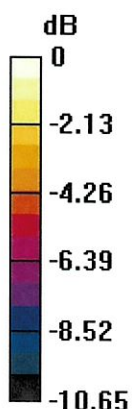
Applied MIF = 0.00 dB

RF audio interference level = 40.69 dBV/m

Emission category: M3

MIF scaled E-field

Grid 1 M3 40.39 dBV/m	Grid 2 M3 40.46 dBV/m	Grid 3 M3 40.17 dBV/m
Grid 4 M4 35.69 dBV/m	Grid 5 M4 35.69 dBV/m	Grid 6 M4 35.38 dBV/m
Grid 7 M3 40.64 dBV/m	Grid 8 M3 40.68 dBV/m	Grid 9 M3 40.31 dBV/m



0 dB = 108.2 V/m = 40.68 dBV/m



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Accreditation No.: **SCS 0108**

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Client **Sporton**

Certificate No: **CD1880V3-1038_Sep21**

CALIBRATION CERTIFICATE

Object **CD1880V3 - SN: 1038**

Calibration procedure(s) **QA CAL-20.v7**
Calibration Procedure for Validation Sources in air

Calibration date: **September 27, 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
Power meter NRP	SN: 104778	09-Apr-21 (No. 217-03291/03292)	Apr-22
Power sensor NRP-Z91	SN: 103244	09-Apr-21 (No. 217-03291)	Apr-22
Power sensor NRP-Z91	SN: 103245	09-Apr-21 (No. 217-03292)	Apr-22
Reference 20 dB Attenuator	SN: BH9394 (20k)	09-Apr-21 (No. 217-03343)	Apr-22
Type-N mismatch combination	SN: 310982 / 06327	09-Apr-21 (No. 217-03344)	Apr-22
Probe EF3DV3	SN: 4013	28-Dec-20 (No. EF3-4013_Dec20)	Dec-21
DAE4	SN: 781	23-Dec-20 (No. DAE4-781_Dec20)	Dec-21

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter Agilent 4419B	SN: GB42420191	09-Oct-09 (in house check Oct-20)	In house check: Oct-23
Power sensor HP E4412A	SN: US38485102	05-Jan-10 (in house check Oct-20)	In house check: Oct-23
Power sensor HP 8482A	SN: US37295597	09-Oct-09 (in house check Oct-20)	In house check: Oct-23
RF generator R&S SMT-06	SN: 837633/005	10-Jan-19 (in house check Oct-20)	In house check: Oct-23
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-21

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	

Approved by:	Katja Pokovic	Technical Manager
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Issued: September 27, 2021

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

References

- [1] ANSI-C63.19-2019 (ANSI-C63.19-2011)
American National Standard, Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.

Methods Applied and Interpretation of Parameters:

- **Coordinate System:** y-axis is in the direction of the dipole arms. z-axis is from the basis of the antenna (mounted on the table) towards its feed point between the two dipole arms. x-axis is normal to the other axes. In coincidence with the standards [1], the measurement planes (probe sensor center) are selected to be at a distance of 15 mm above the top metal edge of the dipole arms.
- **Measurement Conditions:** Further details are available from the hardcopies at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated. The forward power to the dipole connector is set with a calibrated power meter connected and monitored with an auxiliary power meter connected to a directional coupler. While the dipole under test is connected, the forward power is adjusted to the same level.
- **Antenna Positioning:** The dipole is mounted on a HAC Test Arch phantom using the matching dipole positioner with the arms horizontal and the feeding cable coming from the floor. The measurements are performed in a shielded room with absorbers around the setup to reduce the reflections. It is verified before the mounting of the dipole under the Test Arch phantom, that its arms are perfectly in a line. It is installed on the HAC dipole positioner with its arms parallel below the dielectric reference wire and able to move elastically in vertical direction without changing its relative position to the top center of the Test Arch phantom. The vertical distance to the probe is adjusted after dipole mounting with a DASY5 Surface Check job. Before the measurement, the distance between phantom surface and probe tip is verified. The proper measurement distance is selected by choosing the matching section of the HAC Test Arch phantom with the proper device reference point (upper surface of the dipole) and the matching grid reference point (tip of the probe) considering the probe sensor offset. The vertical distance to the probe is essential for the accuracy.
- **Feed Point Impedance and Return Loss:** These parameters are measured using a Vector Network Analyzer. The impedance is specified at the SMA connector of the dipole. The influence of reflections was eliminated by applying the averaging function while moving the dipole in the air, at least 70cm away from any obstacles.
- **E-field distribution:** E field is measured in the x-y-plane with an isotropic E-field probe with 100 mW forward power to the antenna feed point. In accordance with [1], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 15 mm (in z) above the metal top of the dipole arms. Two 3D maxima are available near the end of the dipole arms. Assuming the dipole arms are perfectly in one line, the average of these two maxima (in subgrid 2 and subgrid 8) is determined to compensate for any non-parallelity to the measurement plane as well as the sensor displacement. The E-field value stated as calibration value represents the maximum of the interpolated 3D-E-field, in the plane above the dipole surface.

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%.

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.10.4
Phantom	HAC Test Arch	
Distance Dipole Top - Probe Center	15 mm	
Scan resolution	dx, dy = 5 mm	
Frequency	1880 MHz $\pm$ 1 MHz	
Input power drift	< 0.05 dB	

Maximum Field values at 1880 MHz

E-field 15 mm above dipole surface	condition	Interpolated maximum
Maximum measured above high end	100 mW input power	86.3 V/m = 38.72 dBV/m
Maximum measured above low end	100 mW input power	84.7 V/m = 38.56 dBV/m
Averaged maximum above arm	100 mW input power	85.5 V/m $\pm$ 12.8 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters

Frequency	Return Loss	Impedance
1730 MHz	22.1 dB	55.9 Ω + 5.9 j Ω
1880 MHz	22.1 dB	58.1 Ω + 2.7 j Ω
1900 MHz	22.1 dB	58.5 Ω - 0.6 j Ω
1950 MHz	26.6 dB	50.3 Ω - 4.7 j Ω
2000 MHz	20.5 dB	43.5 Ω + 6.0 j Ω

3.2 Antenna Design and Handling

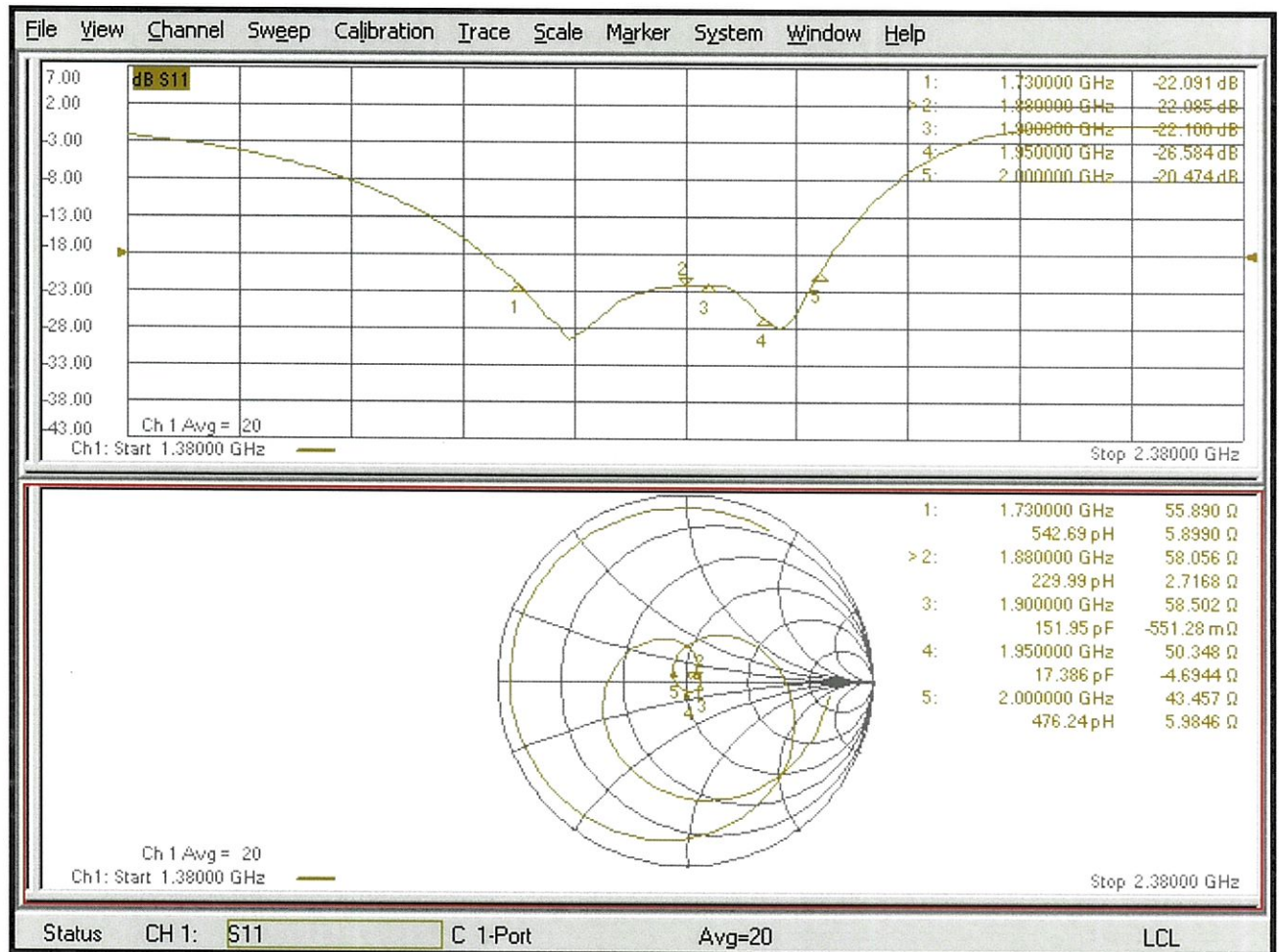
The calibration dipole has a symmetric geometry with a built-in two stub matching network, which leads to the enhanced bandwidth.

The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.

Do not apply force to dipole arms, as they are liable to bend. The soldered connections near the feedpoint may be damaged. After excessive mechanical stress or overheating, check the impedance characteristics to ensure that the internal matching network is not affected.

After long term use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

Impedance Measurement Plot



DASY5 E-field Result

Date: 27.09.2021

Test Laboratory: SPEAG Lab2

DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: CD1880V3 - SN: 1038

Communication System: UID 0 - CW ; Frequency: 1880 MHz

Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³

Phantom section: RF Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EF3DV3 - SN4013; ConvF(1, 1, 1) @ 1880 MHz; Calibrated: 28.12.2020
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 23.12.2020
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole E-Field measurement @ 1880MHz/E-Scan - 1880MHz d=15mm/Hearing Aid Compatibility Test (41x181x1):

Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 151.4 V/m; Power Drift = -0.00 dB

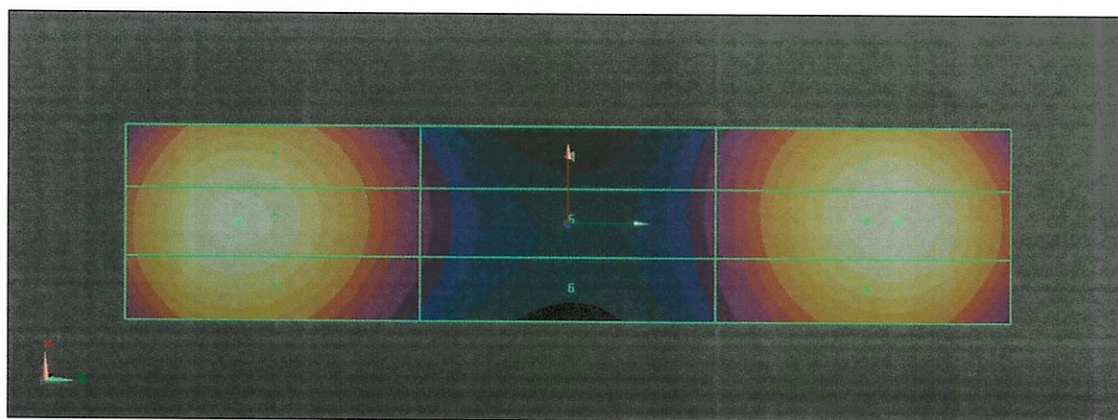
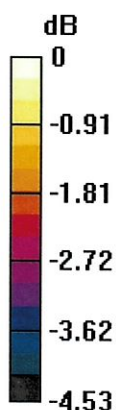
Applied MIF = 0.00 dB

RF audio interference level = 38.72 dBV/m

Emission category: M2

MIF scaled E-field

Grid 1 M2 38.39 dBV/m	Grid 2 M2 38.56 dBV/m	Grid 3 M2 38.37 dBV/m
Grid 4 M2 35.91 dBV/m	Grid 5 M2 35.93 dBV/m	Grid 6 M2 35.8 dBV/m
Grid 7 M2 38.61 dBV/m	Grid 8 M2 38.72 dBV/m	Grid 9 M2 38.45 dBV/m



0 dB = 86.34 V/m = 38.72 dBV/m



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Accreditation No.: **SCS 0108**

Client **Sporton**

Certificate No: **CD2450V3-1186_Jan19**

CALIBRATION CERTIFICATE

Object **CD2450V3 - SN: 1186**

Calibration procedure(s) **QA CAL-20.v7**
Calibration Procedure for Validation Sources in air

Calibration date: **January 30, 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 $(22 \pm 3)^\circ\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-18 (No. 217-02672/02673)	Apr-19
Power sensor NRP-Z91	SN: 103244	04-Apr-18 (No. 217-02672)	Apr-19
Power sensor NRP-Z91	SN: 103245	04-Apr-18 (No. 217-02673)	Apr-19
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-18 (No. 217-02682)	Apr-19
Type-N mismatch combination	SN: 5047.2 / 06327	04-Apr-18 (No. 217-02683)	Apr-19
Probe EF3DV3	SN: 4013	03-Jan-19 (No. EF3-4013_Jan19)	Jan-20
DAE4	SN: 781	09-Jan-19 (No. DAE4-781_Jan19)	Jan-20

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter Agilent 4419B	SN: GB42420191	09-Oct-09 (in house check Oct-17)	In house check: Oct-20
Power sensor HP E4412A	SN: US38485102	05-Jan-10 (in house check Oct-17)	In house check: Oct-20
Power sensor HP 8482A	SN: US37295597	09-Oct-09 (in house check Oct-17)	In house check: Oct-20
RF generator R&S SMT-06	SN: 832283/011	27-Aug-12 (in house check Oct-17)	In house check: Oct-20
Network Analyzer HP B358A	SN: US41080477	31-Mar-14 (in house check Oct-18)	In house check: Oct-19

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

Issued: January 31, 2019

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Accreditation No.: **SCS 0108**

References

- [1] ANSI-C63.19-2011
American National Standard, Methods of Measurement of Compatibility between Wireless Communications
Devices and Hearing Aids.

Methods Applied and Interpretation of Parameters:

- **Coordinate System:** y-axis is in the direction of the dipole arms. z-axis is from the basis of the antenna (mounted on the table) towards its feed point between the two dipole arms. x-axis is normal to the other axes. In coincidence with the standards [1], the measurement planes (probe sensor center) are selected to be at a distance of 15 mm above the top metal edge of the dipole arms.
- **Measurement Conditions:** Further details are available from the hardcopies at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated. The forward power to the dipole connector is set with a calibrated power meter connected and monitored with an auxiliary power meter connected to a directional coupler. While the dipole under test is connected, the forward power is adjusted to the same level.
- **Antenna Positioning:** The dipole is mounted on a HAC Test Arch phantom using the matching dipole positioner with the arms horizontal and the feeding cable coming from the floor. The measurements are performed in a shielded room with absorbers around the setup to reduce the reflections. It is verified before the mounting of the dipole under the Test Arch phantom, that its arms are perfectly in a line. It is installed on the HAC dipole positioner with its arms parallel below the dielectric reference wire and able to move elastically in vertical direction without changing its relative position to the top center of the Test Arch phantom. The vertical distance to the probe is adjusted after dipole mounting with a DASY5 Surface Check job. Before the measurement, the distance between phantom surface and probe tip is verified. The proper measurement distance is selected by choosing the matching section of the HAC Test Arch phantom with the proper device reference point (upper surface of the dipole) and the matching grid reference point (tip of the probe) considering the probe sensor offset. The vertical distance to the probe is essential for the accuracy.
- **Feed Point Impedance and Return Loss:** These parameters are measured using a HP 8753E Vector Network Analyzer. The impedance is specified at the SMA connector of the dipole. The influence of reflections was eliminating by applying the averaging function while moving the dipole in the air, at least 70cm away from any obstacles.
- **E-field distribution:** E field is measured in the x-y-plane with an isotropic ER3D-field probe with 100 mW forward power to the antenna feed point. In accordance with [1], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 15 mm (in z) above the metal top of the dipole arms. Two 3D maxima are available near the end of the dipole arms. Assuming the dipole arms are perfectly in one line, the average of these two maxima (in subgrid 2 and subgrid 8) is determined to compensate for any non-parallelity to the measurement plane as well as the sensor displacement. The E-field value stated as calibration value represents the maximum of the interpolated 3D-E-field, in the plane above the dipole surface.

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%.

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.10.2
Phantom	HAC Test Arch	
Distance Dipole Top - Probe Center	15 mm	
Scan resolution	dx, dy = 5 mm	
Frequency	2450 MHz $\pm$ 1 MHz	
Input power drift	< 0.05 dB	

Maximum Field values at 2450 MHz

E-field 15 mm above dipole surface	condition	Interpolated maximum
Maximum measured above high end	100 mW input power	84.5 V/m = 38.54 dBV/m
Maximum measured above low end	100 mW input power	83.7 V/m = 38.45 dBV/m
Averaged maximum above arm	100 mW input power	84.1 V/m $\pm$ 12.8 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters

Frequency	Return Loss	Impedance
2250 MHz	17.2 dB	64.4 Ω + 6.3 j Ω
2350 MHz	26.9 dB	53.7 Ω - 2.8 j Ω
2450 MHz	32.4 dB	52.1 Ω - 1.3 j Ω
2550 MHz	46.8 dB	50.3 Ω + 0.4 j Ω
2650 MHz	17.8 dB	64.1 Ω - 4.0 j Ω

3.2 Antenna Design and Handling

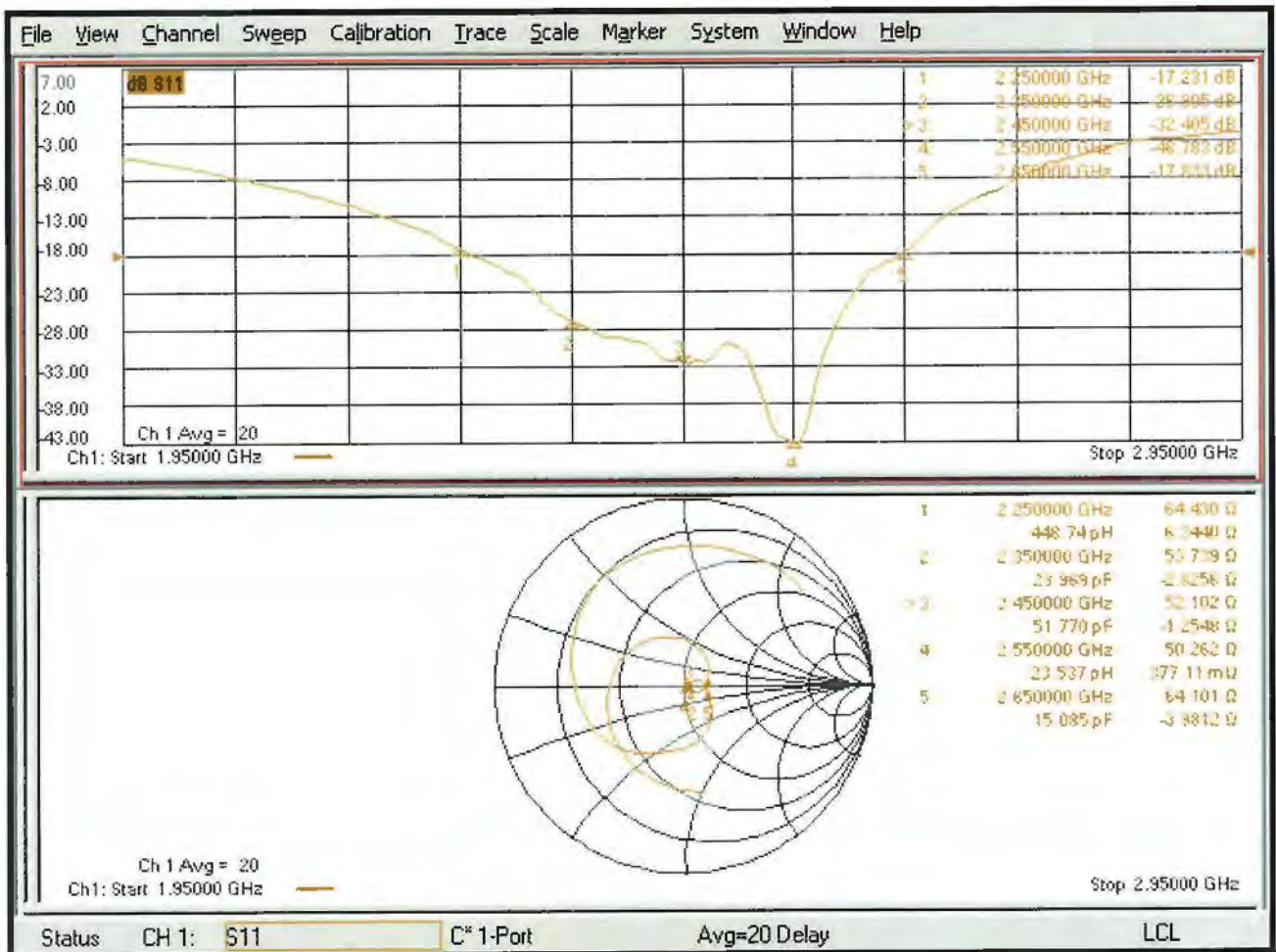
The calibration dipole has a symmetric geometry with a built-in two stub matching network, which leads to the enhanced bandwidth.

The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.

Do not apply force to dipole arms, as they are liable to bend. The soldered connections near the feedpoint may be damaged. After excessive mechanical stress or overheating, check the impedance characteristics to ensure that the internal matching network is not affected.

After long term use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

Impedance Measurement Plot



DASY5 E-field Result

Date: 30.01.2019

Test Laboratory: SPEAG Lab2

DUT: HAC Dipole 2450 MHz; Type: CD2450V3; Serial: CD2450V3 - SN: 1186

Communication System: UID 0 - CW ; Frequency: 2450 MHz

Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³

Phantom section: RF Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EF3DV3 - SN4013; ConvF(1, 1, 1) @ 2450 MHz; Calibrated: 03.01.2019
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 09.01.2019
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

Dipole E-Field measurement @ 2450MHz/E-Scan - 2450MHz d=15mm/Hearing Aid Compatibility Test (41x181x1):

Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 72.75 V/m; Power Drift = -0.00 dB

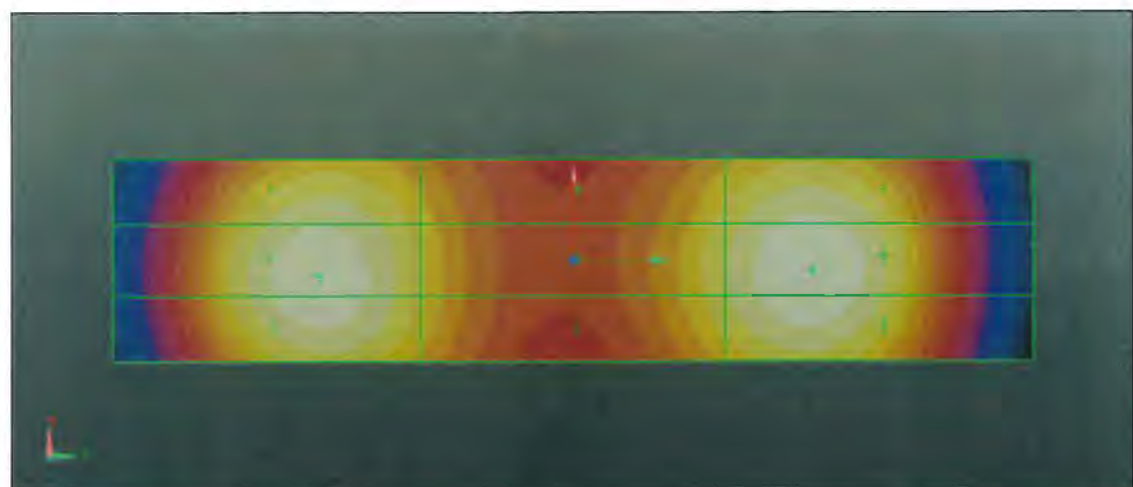
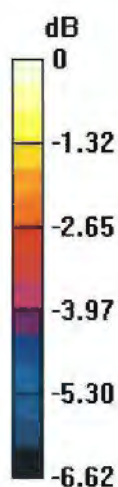
Applied MIF = 0.00 dB

RF audio interference level = 38.54 dBV/m

Emission category: M2

MIF scaled E-field

Grid 1 M2 38.09 dBV/m	Grid 2 M2 38.45 dBV/m	Grid 3 M2 38.43 dBV/m
Grid 4 M2 37.44 dBV/m	Grid 5 M2 37.67 dBV/m	Grid 6 M2 37.62 dBV/m
Grid 7 M2 38.24 dBV/m	Grid 8 M2 38.54 dBV/m	Grid 9 M2 38.45 dBV/m



0 dB = 84.53 V/m = 38.54 dBV/m

C2450V3, serial no. 1186 Extended Dipole Calibrations

Referring to KDB 450824, if dipoles are verified in return loss ($< -20\text{dB}$, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

<Justification of the extended calibration>

CD2450V3 – serial no. 1186						
	2450MHZ					
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
01.30.2019 (Cal. Report)	-32.405		52.102		-1.2548	
01.29.2020 (extended)	-31.338	3.293	51.312	0.79	3.4986	4.7534
01.28.2021 (extended)	-29.309	9.554	55.238	-3.136	-3.9601	2.7053

The return loss is $< -20\text{dB}$, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.