



Date: 25.08.2022

Test Laboratory: SPEAG Lab2

DUT: HAC-Dipole 835 MHz; Type: CD835V3; Serial: CD835V3 - SN: 1023

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)

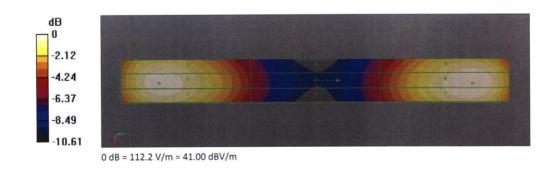
DASY52 Configuration:

- Probe: EF3DV3 SN4013; ConvF(1, 1, 1) @ 835 MHz; Calibrated: 28.12.2021
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 22.12.2021
- 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 = 132.6 V/m; Power Drift = 0.02 dB Applied MIF = 0.00 dB RF audio interference level = 41.00 dBV/m Emission category: M3

	Grid 2 M3 40.72 dBV/m	Grid 3 M3 40.44 dBV/m
	Grid 5 M4 35.88 dBV/m	Grid 6 M4 35.61 dBV/m
Grid 7 M3 40.95 dBV/m		Grid 9 M3 40.62 dBV/m



Certificate No: CD835V3-1023_Aug22





Dipole 1880 MHz

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



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

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

Accreditation No.: SCS 0108

ALIBRATION CE	ERTIFICATE		
bject	CD1880V3 - SN:	1018	
alibration procedure(s)	QA CAL-20.v7		
	Calibration Proce	dure for Validation Sources in air	
alibration date:	August 25, 2022		
		and standards, which realize the physical unit	te of measurements (SI)
his calibration certificate document	ts the traceability to natio	onal standards, which realize the physical unit obability are given on the following pages and	d are part of the certificate.
he measurements and the uncerta	unues with confidence pr	obability are given on the following pages and	a are part of the ostinioate.
n . m	d in the closed laborator	y facility: environment temperature (22 \pm 3)°C	and humidity $< 70\%$
all calibrations have been conducte	a in the closed laborator	y racincy. environment temperature (22 ± 0) C	and harmony to brok
Calibration Equipment used (M&TE	critical for calibration)		
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-22 (No. 217-03525/03524)	Apr-23
Power sensor NRP-Z91	SN: 103244	04-Apr-22 (No. 217-03524)	Apr-23
Power sensor NRP-Z91	SN: 103245	04-Apr-22 (No. 217-03525)	Apr-23
Reference 20 dB Attenuator	SN: BH9394 (20k)	04-Apr-22 (No. 217-03527)	Apr-23
Type-N mismatch combination	SN: 310982 / 06327	04-Apr-22 (No. 217-03528)	Apr-23
Probe EF3DV3	SN: 4013	28-Dec-21 (No. EF3-4013_Dec21)	Dec-22
DAE4	SN: 781	22-Dec-21 (No. DAE4-781_Dec21)	Dec-22
Cocondony Standarda	ID #	Check Date (in house)	Scheduled Check
Secondary Standards 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-22
Terrent Analyzer Agiloni 20000A			
	Name	Function	Signature
	Leif Klysner	Laboratory Technician	PINATA
Calibrated by:			Sa alter
Calibrated by:			117
	Sven Kühn	Technical Manager	117
Calibrated by: Approved by:	Sven Kühn	Technical Manager	su
	Sven Kühn	Technical Manager	5 C

Certificate No: CD1880V3-1018_Aug22

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Accreditation No.: SCS 0108

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

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 nonparallelity 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%.

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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 ± 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	86.9 V/m = 38.78 dBV/m	
Maximum measured above low end	100 mW input power	86.5 V/m = 38.74 dBV/m	
Averaged maximum above arm	100 mW input power	86.7 V/m ± 12.8 % (k=2)	

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters

Frequency	Return Loss	Impedance
1730 MHz	27.8 dB	54.2 Ω + 0.7 jΩ
1880 MHz	22.1 dB	54.7 Ω + 6.7 jΩ
1900 MHz	23.0 dB	55.8 Ω + 4.8 jΩ
1950 MHz	32.4 dB	52.4 Ω + 0.1 jΩ
2000 MHz	19.5 dB	47.5 Ω + 10.0 jΩ

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.

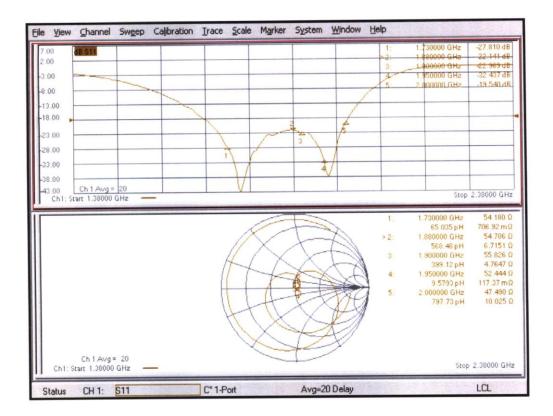
After long term use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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Impedance Measurement Plot



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Date: 25.08.2022

Test Laboratory: SPEAG Lab2

DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: CD1880V3 - SN: 1018

Communication System: UID 0 - CW ; Frequency: 1880 MHz Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m³ Phantom section: RF Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

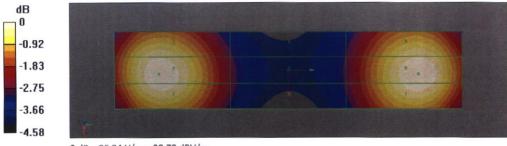
- Probe: EF3DV3 SN4013; ConvF(1, 1, 1) @ 1880 MHz; Calibrated: 28.12.2021 .
- Sensor-Surface: (Fix Surface) .
- Electronics: DAE4 Sn781; Calibrated: 22.12.2021
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070 .
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501) .

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 = 157.1 V/m; Power Drift = 0.01 dB Applied MIF = 0.00 dB RF audio interference level = 38.78 dBV/m Emission category: M2

MIF scaled E-field				
	Grid 1 M2	Grid 2 M2		

Grid 1 M2 38.66 dBV/m		Grid 3 M2 38.45 dBV/m
Grid 4 M2 36.05 dBV/m	Grid 5 M2 36.06 dBV/m	
	Grid 8 M2 38.78 dBV/m	Grid 9 M2 38.49 dBV/m



0 dB = 86.94 V/m = 38.78 dBV/m

Certificate No: CD1880V3-1018_Aug22





Dipole 2450 MHz

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CALIBRATION CE	ERTIFICATE		
Object	CD2450V3 - SN:	1021	
Calibration procedure(s)	QA CAL-20.v7 Calibration Proce	dure for Validation Sources in a	air
Calibration date:	August 25, 2022		
	d in the closed laborator	obability are given on the following pages a y facility: environment temperature (22 ± 3)	
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-22 (No. 217-03525/03524)	Apr-23
Power sensor NRP-Z91	SN: 103244	04-Apr-22 (No. 217-03524)	Apr-23
Power sensor NRP-Z91	SN: 103245	04-Apr-22 (No. 217-03525)	Apr-23
Reference 20 dB Attenuator	SN: BH9394 (20k)	04-Apr-22 (No. 217-03527)	Apr-23
Type-N mismatch combination	SN: 310982 / 06327	04-Apr-22 (No. 217-03528)	Apr-23
Probe EF3DV3	SN: 4013	28-Dec-21 (No. EF3-4013_Dec21)	Dec-22
DAE4	SN: 781	22-Dec-21 (No. DAE4-781_Dec21)	Dec-22
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-22
	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	Lef Algen
Approved by:	Sven Kühn	Technical Manager	Set Ilan
This calibration contificate shall not	be reproduced except in	full without written approval of the laborate	Issued: August 25, 2022
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Certificate No: CD2450V3-1021_Aug22

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Accreditation No.: SCS 0108

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

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%.

Certificate No: CD2450V3-1021_Aug22

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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	2450 MHz ± 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	86.0 V/m = 38.69 dBV/m
Maximum measured above low end	100 mW input power	85.8 V/m = 38.67 dBV/m
Averaged maximum above arm	100 mW input power	85.9 V/m ± 12.8 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters

Frequency	Return Loss	Impedance
2250 MHz	18.3 dB	63.2 Ω + 4.0 jΩ
2350 MHz	30.3 dB	52.1 Ω - 2.3 jΩ
2450 MHz	29.4 dB	53.1 Ω - 1.6 jΩ
2550 MHz	33.5 dB	51.0 Ω - 1.9 jΩ
2650 MHz	18.6 dB	60.7 Ω - 7.5 jΩ

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.

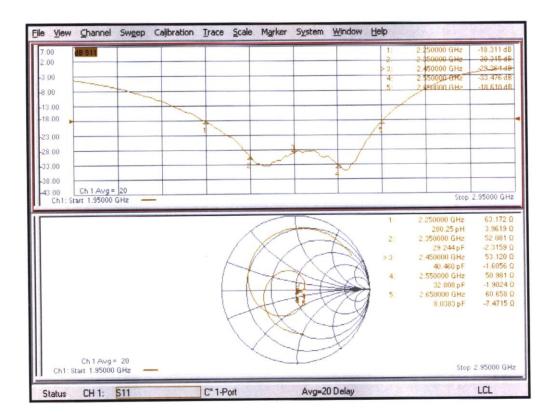
Certificate No: CD2450V3-1021_Aug22

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Impedance Measurement Plot



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Date: 25.08.2022

Test Laboratory: SPEAG Lab2

DUT: HAC Dipole 2450 MHz; Type: CD2450V3; Serial: CD2450V3 - SN: 1021

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: 28.12.2021 .
- Sensor-Surface: (Fix Surface) .
- Electronics: DAE4 Sn781; Calibrated: 22.12.2021
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070 ٠
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501) .

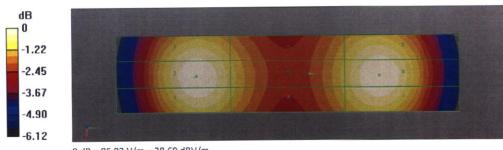
Dipole E-Field measurement @ 2450MHz/E-Scan - 2450MHz d=15mm/Hearing Aid Compatibility Test (41x181x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm Reference Value = 79.61 V/m; Power Drift = 0.02 dB Applied MIF = 0.00 dBRF audio interference level = 38.69 dBV/m Emission category: M2

MIF scaled E-field					
		Grid 2 M2 38.67 dBV/m			
		Grid 5 M2	_		
	Grid 4 IVIZ	GILU S IVIZ	Gina o Ivia		

37.7 dBV/m	37.72 dBV/m	37.53 dBV/m	
Grid 7 M2	Grid 8 M2	Grid 9 M2	
38.58 dBV/m	38.69 dBV/m	38.45 dBV/m	

dBV/m



0 dB = 86.03 V/m = 38.69 dBV/m

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Dipole 2600 MHz

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CALIBRATION CI	ERTIFICATE		
Object	CD2600V3 - SN:	1017	
Calibration procedure(s)	QA CAL-20.v7 Calibration Proce	dure for Validation Sources in a	ir
Calibration date:	August 25, 2022		
All calibrations have been conducte	d in the closed laborator	robability are given on the following pages a y facility: environment temperature $(22 \pm 3)^{\circ}$	
	d in the closed laborator		
All calibrations have been conducte Calibration Equipment used (M&TE Primary Standards	d in the closed laborator critical for calibration)	y facility: environment temperature (22 ± 3) Cal Date (Certificate No.) 04-Apr-22 (No. 217-03525/03524) 04-Apr-22 (No. 217-03524)	°C and humidity < 70%. Scheduled Calibration Apr-23 Apr-23
All calibrations have been conducte Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91	d in the closed laborator critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245	v facility: environment temperature (22 ± 3) ⁴ Cal Date (Certificate No.) 04-Apr-22 (No. 217-03525/03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525)	°C and humidity < 70%. Scheduled Calibration Apr-23 Apr-23 Apr-23
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All calibrations have been conducte Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination	d in the closed laborator critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327	y facility: environment temperature (22 ± 3) ⁴ Cal Date (Certificate No.) 04-Apr-22 (No. 217-03525/03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527) 04-Apr-22 (No. 217-03528)	°C and humidity < 70%. Scheduled Calibration Apr-23 Apr-23 Apr-23 Apr-23 Apr-23 Apr-23
All calibrations have been conducte Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator	d in the closed laborator critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: BH9394 (20k)	y facility: environment temperature (22 ± 3) ⁴ Cal Date (Certificate No.) 04-Apr-22 (No. 217-03525/03524) 04-Apr-22 (No. 217-03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527)	°C and humidity < 70%. Scheduled Calibration Apr-23 Apr-23 Apr-23 Apr-23 Apr-23
All calibrations have been conducte Calibration Equipment used (M&TE Primary Standards Power meter NRP Power sensor NRP-Z91 Power sensor NRP-Z91 Reference 20 dB Attenuator Type-N mismatch combination Probe EF3DV3	d in the closed laborator critical for calibration) ID # SN: 104778 SN: 103244 SN: 103245 SN: 103245 SN: BH9394 (20k) SN: 310982 / 06327 SN: 4013	y facility: environment temperature (22 ± 3) ⁵ <u>Cal Date (Certificate No.)</u> 04-Apr-22 (No. 217-03525/03524) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03525) 04-Apr-22 (No. 217-03527) 04-Apr-22 (No. 217-03528) 28-Dec-21 (No. EF3-4013_Dec21)	°C and humidity < 70%. Scheduled Calibration Apr-23 Apr-23 Apr-23 Apr-23 Apr-23 Apr-23 Dec-22
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Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





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

Accreditation No.: SCS 0108

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

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 nonparallelity 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%.

Certificate No: CD2600V3-1017_Aug22

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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	2600 MHz ± 1 MHz	
Input power drift	< 0.05 dB	

Maximum Field values at 2600 MHz

E-field 15 mm above dipole surface	condition	Interpolated maximum
Maximum measured above high end	100 mW input power	86.0 V/m = 38.69 dBV/m
Maximum measured above low end	100 mW input power	85.7 V/m = 38.66 dBV/m
Averaged maximum above arm	100 mW input power	85.9 V/m ± 12.8 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters

Frequency	Return Loss	Impedance
2450 MHz	24.5 dB	44.6 Ω + 1.5 jΩ
2550 MHz	21.6 dB	57.9 Ω + 4.4 jΩ
2600 MHz	20.7 dB	59.4 Ω - 3.8 jΩ
2650 MHz	19.4 dB	54.9 Ω - 10.2 jΩ
2750 MHz	15.7 dB	41.4 Ω - 12.3 jΩ

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.

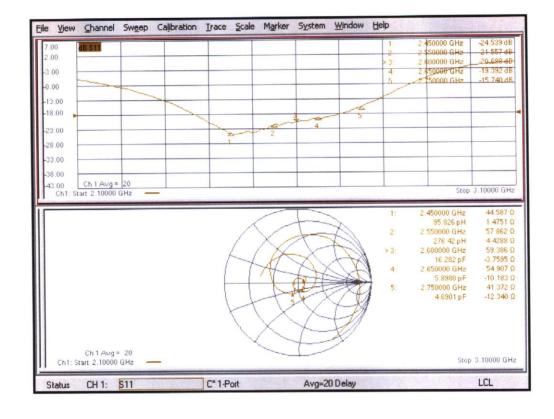
Certificate No: CD2600V3-1017_Aug22

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Impedance Measurement Plot



Certificate No: CD2600V3-1017_Aug22

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Date: 25.08.2022

Test Laboratory: SPEAG Lab2

DUT: HAC Dipole 2600 MHz; Type: CD2600V3; Serial: CD2600V3 - SN: 1017

Communication System: UID 0 - CW ; Frequency: 2600 MHz Medium parameters used: $\sigma=0$ S/m, $\epsilon_r=1$; $\rho=0$ kg/m^3 Phantom section: RF Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

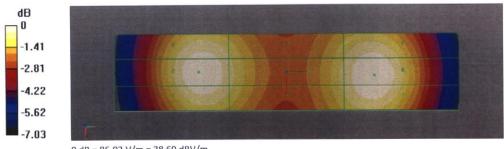
- Probe: EF3DV3 SN4013; ConvF(1, 1, 1) @ 2600 MHz; Calibrated: 28.12.2021
- . Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 22.12.2021 .
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070 ٠
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole E-Field measurement @ 2600MHz/E-Scan - 2600MHz 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 = 69.34 V/m; Power Drift = -0.03 dB Applied MIF = 0.00 dBRF audio interference level = 38.69 dBV/m Emission category: M2

MIF scaled E-field

Grid 1 M2	Grid 2 M2	Grid 3 M2
38.49 dBV/m	38.66 dBV/m	38.46 dBV/m
	Grid 5 M2 37.97 dBV/m	
		Grid 9 M2
38.62 dBV/m	38.69 dBV/m	38.42 dBV/m



0 dB = 86.03 V/m = 38.69 dBV/m

Certificate No: CD2600V3-1017_Aug22





Dipole 3500 MHz

Client

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



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Accreditation No.: SCS 0108

Certificate No: CD3500V3-1008_Aug22

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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

CTTL (Auden) CALIBRATION CERTIFICATE CD3500V3 - SN: 1008 Object QA CAL-20.v7 Calibration procedure(s) Calibration Procedure for Validation Sources in air August 25, 2022 Calibration date: 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) Scheduled Calibration Cal Date (Certificate No.) ID # Primary Standards Apr-23 04-Apr-22 (No. 217-03525/03524) SN: 104778 Power meter NRP SN: 103244 04-Apr-22 (No. 217-03524) Apr-23 Power sensor NRP-Z91 04-Apr-22 (No. 217-03525) Apr-23 SN: 103245 Power sensor NRP-Z91 Apr-23 04-Apr-22 (No. 217-03527) Reference 20 dB Attenuator SN: BH9394 (20k) SN: 310982 / 06327 04-Apr-22 (No. 217-03528) Apr-23 Type-N mismatch combination 28-Dec-21 (No. EF3-4013_Dec21) Dec-22 SN: 4013 Probe EF3DV3 22-Dec-21 (No. DAE4-781_Dec21) Dec-22 SN: 781 DAE4 Scheduled Check Check Date (in house) Secondary Standards ID # In house check: Oct-23 SN: GB42420191 09-Oct-09 (in house check Oct-20) Power meter Agilent 4419B In house check: Oct-23 05-Jan-10 (in house check Oct-20) Power sensor HP E4412A SN: US38485102 In house check: Oct-23 SN: US37295597 09-Oct-09 (in house check Oct-20) Power sensor HP 8482A In house check: Oct-23 10-Jan-19 (in house check Oct-20) RF generator R&S SMT-06 SN: 837633/005 In house check: Oct-22 SN: US41080477 31-Mar-14 (in house check Oct-20) Network Analyzer Agilent E8358A Signature Function Name Laboratory Technician Leif Klysner Calibrated by: Technical Manager Sven Kühn Approved by: Issued: August 25, 2022 This calibration certificate shall not be reproduced except in full without written approval of the laboratory. Certificate No: CD3500V3-1008_Aug22 Page 1 of 5





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





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

Accreditation No.: SCS 0108

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

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%.

Certificate No: CD3500V3-1008_Aug22

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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	3500 MHz ± 1 MHz	
Input power drift	< 0.05 dB	

Maximum Field values at 3500 MHz

E-field 15 mm above dipole surface	condition	Interpolated maximum
Maximum measured above high end	100 mW input power	85.0 V/m = 38.59 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	84.3 V/m ± 12.8 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters

Frequency	Return Loss	Impedance
3300 MHz	18.4 dB	63.0 Ω + 3.8 jΩ
3400 MHz	23.3 dB	55.5 Ω - 4.7 jΩ
3500 MHz	23.9 dB	52.6 Ω - 6.0 jΩ
3600 MHz	21.4 dB	46.9 Ω - 7.6 jΩ
3700 MHz	20.4 dB	41.5 Ω - 1.9 jΩ

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.

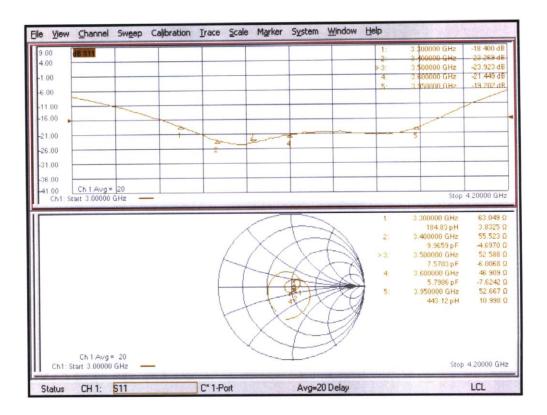
Certificate No: CD3500V3-1008_Aug22

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Impedance Measurement Plot



Certificate No: CD3500V3-1008_Aug22

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Date: 25.08.2022

Test Laboratory: SPEAG Lab2

DUT: HAC Dipole 3500 MHz; Type: CD3500V3; Serial: CD3500V3 - SN: 1008

Communication System: UID 0 - CW ; Frequency: 3500 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:

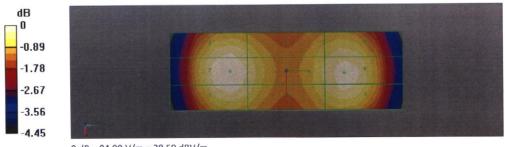
- Probe: EF3DV3 SN4013; ConvF(1, 1, 1) @ 3500 MHz; Calibrated: 28.12.2021
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 22.12.2021
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole E-Field measurement @ 3500MHz/E-Scan - 3500MHz d=15mm/Hearing Aid Compatibility Test (41x121x1):

Interpolated grid: dx=0.5000 mm, dy=0.5000 mm Device Reference Point: 0, 0, -6.3 mm Reference Value = 37.02 V/m; Power Drift = -0.03 dB Applied MIF = 0.00 dB RF audio interference level = 38.59 dBV/m Emission category: M2

MIF scaled E-field

Grid 1 M2	Grid 2 M2	Grid 3 M2
38.46 dBV/m	38.59 dBV/m	38.37 dBV/m
Grid 4 M2	Grid 5 M2	Grid 6 M2
38.17 dBV/m	38.26 dBV/m	38.09 dBV/m
Grid 7 M2	Grid 8 M2	Grid 9 M2
38.37 dBV/m	38.45 dBV/m	38.22 dBV/m



0 dB = 84.99 V/m = 38.59 dBV/m

Certificate No: CD3500V3-1008_Aug22





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

Appendix to test report No.I23Z60483-SEM01/02

The photos of HAC test