



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

 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%.

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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	87.1 V/m = 38.80 dBV/m
Maximum measured above low end	100 mW input power	86.1 V/m = 38.70 dBV/m
Averaged maximum above arm	100 mW input power	86.6 V/m ± 12.8 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters

Frequency	Return Loss	Impedance
1730 MHz	28.3 dB	54.0 Ω + 0.2 jΩ
1880 MHz	21.6 dB	55.0 Ω + 7.1 jΩ
1900 MHz	22.6 dB	56.8 Ω + 4.1 jΩ
1950 MHz	34.0 dB	52.0 Ω - 0.1 jΩ
2000 MHz	19.4 dB	47.1 Ω + 10.1 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.

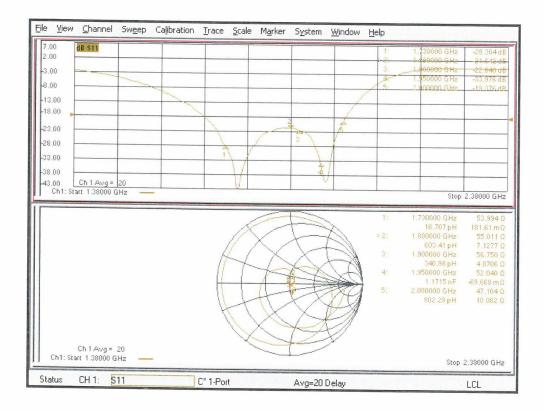
After long term use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

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Impedance Measurement Plot



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DASY5 E-field Result

Date: 24.08.2021

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:

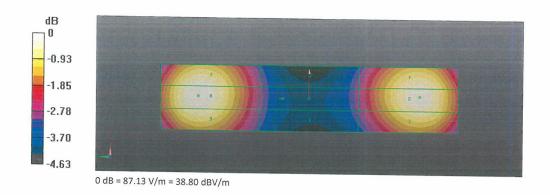
- Probe: EF3DV3 SN4013; ConvF(1, 1, 1) @ 1880 MHz; Calibrated: 28.12.2020
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 23.12.2020
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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 = 155.6 V/m; Power Drift = 0.00 dB Applied MIF = 0.00 dB RF audio interference level = 38.80 dBV/m Emission category: M2

MIF scaled E-field

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Grid 1 M2	Grid 2 M2	Grid 3 M2
38.62 dBV/m	38.7 dBV/m	38.43 dBV/m
Grid 4 M2	Grid 5 M2	Grid 6 M2
35.91 dBV/m	35.94 dBV/m	35.82 dBV/m
Grid 7 M2	Grid 8 M2	Grid 9 M2
38.69 dBV/m	38.8 dBV/m	38.53 dBV/m



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Dipole 2450 MHz

	Switzerland	SC MRA	Schweizerischer Kalibrierdienst Service suisse d'étalonnage Servizio svizzero di taratura Swiss Calibration Service
ccredited by the Swiss Accreditation he Swiss Accreditation Service in	s one of the signatories	s to the EA	ccreditation No.: SCS 0108
lient CTTL (Auden)	ognition of calibration of		: CD2450V3-1021_Aug2
CALIBRATION C	ERTIFICATI		. 05240040-1021_Augz
Object	CD2450V3 - SN:	1021	
Calibration procedure(s)	QA CAL-20.v7 Calibration Proce	edure for Validation Sources in ai	r
Calibration date:	August 24, 2021		
All calibrations have been conducte	ed in the closed laborator	y facility: environment temperature $(22 \pm 3)^{\circ}$	
All calibrations have been conducte	ed in the closed laborator		
All calibrations have been conducte Calibration Equipment used (M&TE Primary Standards	ed in the closed laborator	y facility: environment temperature (22 \pm 3)°(C and humidity < 70%.
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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	85.9 V/m = 38.68 dBV/m
Maximum measured above low end	100 mW input power	84.5 V/m = 38.54 dBV/m
Averaged maximum above arm	100 mW input power	85.2 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	63.1 Ω + 4.0 jΩ
2350 MHz	29.5 dB	52.5 Ω - 2.4 jΩ
2450 MHz	29.8 dB	53.2 Ω - 1.1 jΩ
2550 MHz	31.8 dB	50.7 Ω - 2.5 jΩ
2650 MHz	18.6 dB	61.1 Ω - 6.8 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.

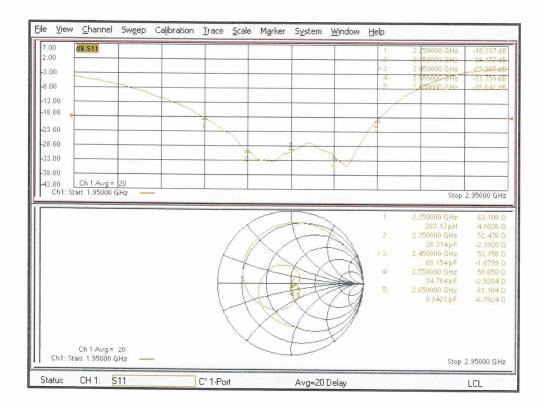
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Impedance Measurement Plot



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DASY5 E-field Result

Date: 24.08.2021

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)

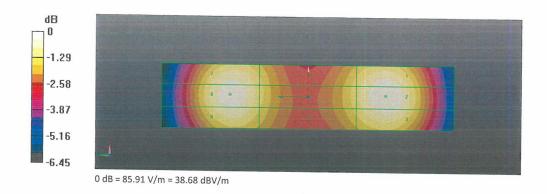
DASY52 Configuration:

- Probe: EF3DV3 SN4013; ConvF(1, 1, 1) @ 2450 MHz; Calibrated: 28.12.2020
- 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 @ 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 = 74.90 V/m; Power Drift = -0.00 dB Applied MIF = 0.00 dB RF audio interference level = 38.68 dBV/m Emission category: M2

MIF scaled E-fi	eld	
	Grid 2 M2 38.68 dBV/m	Grid 3 M2 38.44 dBV/m
	Grid 5 M2 37.71 dBV/m	Grid 6 M2 37.55 dBV/m
Grid 7 M2 38.42 dBV/m		Grid 9 M2 38.3 dBV/m



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Dipole 2600 MHz

outed by the sine	Service (SAS)		editation No.: SCS 0108
Swiss Accreditation Service is o tilateral Agreement for the recogn	ne of the signatories to nition of calibration ce	rtificates	
ent CTTL (Auden)		Certificate No: C	CD2600V3-1017_Aug21
ALIBRATION CE	RTIFICATE		
bject	CD2600V3 - SN: 1	017	
alibration procedure(s) (QA CAL-20.v7 Calibration Procee	dure for Validation Sources in air	
Calibration date:	August 24, 2021		
This calibration certificate document	s the traceability to natio	nal standards, which realize the physical units	s of measurements (SI).
The measurements and the uncertain	inties with confidence pr	obability are given on the following pages and	are part of the certificate.
un un d'ante base conducto	d in the closed laborator	y facility: environment temperature (22 ± 3)°C	and humidity < 70%.
All calibrations have been conducted		, items). e	
Calibration Equipment used (M&TE	critical for calibration)		Scheduled Calibration
Primary Standards	ID #	Cal Date (Certificate No.)	Apr-22
Power meter NRP	SN: 104778	09-Apr-21 (No. 217-03291/03292) 09-Apr-21 (No. 217-03291)	Apr-22
Power sensor NRP-Z91	SN: 103244	09-Apr-21 (No. 217-03291)	Apr-22
Power sensor NRP-Z91	SN: 103245 SN: BH9394 (20k)	09-Apr-21 (No. 217-03243)	Apr-22
Reference 20 dB Attenuator	SN: 310982 / 06327	09-Apr-21 (No. 217-03344)	Apr-22
Type-N mismatch combination	SN: 4013	28-Dec-20 (No. EF3-4013_Dec20)	Dec-21
Probe EF3DV3 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 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) 31-Mar-14 (in house check Oct-20)	In house check: Oct-21
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (III House check Ool-20)	
	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	Saller
			1/1/
Approved by:	Katja Pokovic	Technical Manager	V.HOS
			Issued: August 25, 2021
		in full without written approval of the laborator	





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

- ANSI-C63.19-2019 (ANSI-C63.19-2011) [1]
- 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.

on page 1.	
DASY5	V52.10.4
HAC Test Arch	
15 mm	
dx, dy = 5 mm	
2600 MHz ± 1 MHz	
< 0.05 dB	
	DASY5 HAC Test Arch 15 mm dx, dy = 5 mm 2600 MHz ± 1 MHz

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	85.5 V/m = 38.64 dBV/m
Maximum measured above low end	100 mW input power	85.0 V/m = 38.59 dBV/m
Averaged maximum above arm	100 mW input power	85.2 V/m ± 12.8 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters

Frequency	Return Loss	Impedance	
2450 MHz	24.2 dB	44.3 Ω + 1.2 jΩ	
2550 MHz	22.5 dB	57.0 Ω + 3.9 jΩ	
2600 MHz	20.8 dB	59.5 Ω - 3.2 jΩ	
2650 MHz	19.6 dB	55.3 Ω - 9.7 jΩ	
2750 MHz	15.3 dB	41.0 Ω - 12.9 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.

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Impedance Measurement Plot

		Sw <u>e</u> ep	Caintarou	Trace Drale	M <u>a</u> rker S <u>y</u> stem		L	
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						> 3	middlesses and mile	-20.760 dt
3.00						4		-19.626 dE
8.00		-				5	50000 GHz	-15 346 dF
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						1 mg	240.74 pH	3.8571 0
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				H		5	2.750000 GHz	-9.6706 (40.981 (
				ł		5	2.750000 GHz	-9.6706 (40.981 (
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