HEARING AID COMPATIBILITY RF EMISSIONS TEST REPORT

FCC ID	:	**2ALJJP65R**
Equipment	:	**4G LTE Smartphone**
Brand Name	:	**PCD, LLC**
Model Name	:	**P65**
WD Emission Result	:	**PASS**
Applicant	:	**PCD, LLC** **7651 Southland Blvd. Orlando. FL 32809 USA**
Manufacturer	:	**PCD, LLC** **7651 Southland Blvd. Orlando. FL 32809 USA**
Standard	:	**FCC 47 CFR §20.19** **ANSI C63.19-2019**
Date Tested	:	**Jun. 12, 2024 ~ Jun. 12, 2024**

We, Sporton International Inc. (Shenzhen), would like to declare that the tested sample provide by manufacturer and the test data has been evaluated in accordance with the test procedures given in ANSI C63.19-2019 / 47 CFR Part 20.19 and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International Inc. (Shenzhen), the test report shall not be reproduced except in full.

Si Zhang

Approved by: Si Zhang

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People's Republic of China

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History of this test report

Report No.	Version	Description	Issued Date
HA452122A	Rev. 01	Initial issue of report	Jun. 28, 2024
HA452122A	Rev. 02	Disabled WLAN 5.3/5.5/5.8GHz by software	Jul. 03, 2024

1. General Information

Product Feature & Specification	
Applicant Name	PCD, LLC
Equipment Name	4G LTE Smartphone
Brand Name	PCD, LLC
Model Name	P65
IMEI Code	352472095163866
FCC ID	2ALJJP65R
HW	A301E_M_V1.0
SW	PCD_P65_CLARO_PR_V1.0
EUT Stage	Identical Prototype
Frequency Band	GSM850: 824 MHz ~ 849 MHz GSM1900: 1850MHz ~ 1910 MHz WCDMA Band II: 1850 MHz ~ 1910 MHz WCDMA Band IV: 1710 MHz ~ 1755 MHz WCDMA Band V: 824 MHz ~ 849 MHz LTE Band 2: 1850 MHz ~ 1910 MHz LTE Band 4: 1710 MHz ~ 1755 MHz LTE Band 5: 824 MHz ~ 849 MHz LTE Band 7: 2500 MHz ~ 2570 MHz LTE Band 12: 699 MHz ~ 716 MHz LTE Band 13: 777 MHz ~ 787 MHz LTE Band 66: 1710 MHz ~ 1780 MHz LTE Band 41: 2496 MHz ~ 2690 MHz WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz WLAN 5.2GHz Band: 5180 MHz ~ 5240 MHz Bluetooth: 2402 MHz ~ 2480 MHz
Mode	GSM/GPRS/EGPRS AMR / RMC 12.2Kbps HSDPA HSUPA HSPA+ (16QAM uplink is supported) LTE: QPSK, 16QAM WLAN 2.4GHz : 802.11b/g/n HT20/ HT40 WLAN 5GHz : 802.11a/n/ac HT20/HT40/VHT20/VHT40/VHT80 Bluetooth BR/EDR/LE

2. Testing Location

Sporton International Inc. (Shenzhen) is accredited to ISO/IEC 17025:2017 by American Association for Laboratory Accreditation with Certificate Number 5145.01.

Testing Laboratory			
Test Firm	Sporton International Inc. (Shenzhen)		
Test Site Location	1/F, 2/F, Bldg 5, Shiling Industrial Zone, Xinwei Village, Xili, Nanshan, Shenzhen, 518055 People's Republic of China TEL: +86-755-86379589 FAX: +86-755-86379595		
Test Site No.	**Sporton Site No.**	**FCC Designation No.**	**FCC Test Firm Registration No.**
	SAR05-SZ	CN1256	421272

3. Applied Standards

- FCC CFR47 Part 20.19
- ANSI C63.19-2019
- FCC KDB 285076 D01 HAC Guidance v06r04
- FCC KDB 285076 D03 HAC FAQ v01r06

4. Air Interfaces

Air Interface	Band MHz	Type	C63.19 RF_{AIL} Tested	Simultaneous Transmitter	Name of Voice Service	Power State Compliance
GSM	GSM850	VO	Yes	WLAN, BT	CMRS Voice	Head[3]
	GSM1900			WLAN, BT		
	EDGE850	VD	Yes	WLAN, BT	Google Meet	
	EDGE1900			WLAN, BT		
WCDMA	Band II	VO	No[1]	WLAN, BT	CMRS Voice	Head[3]
	Band IV			WLAN, BT		
	Band V			WLAN, BT		
	HSPA	VD	No[1]	WLAN, BT	Google Meet	
LTE FDD	Band 2	VD	No[1]	WLAN, BT	VoLTE / Google Meet	Head[3]
	Band 4			WLAN, BT		
	Band 5			WLAN, BT		
	Band 7			WLAN, BT		
	Band 12			WLAN, BT		
	Band 13			WLAN, BT		
	Band 66			WLAN, BT		
LTE TDD	Band 41	VD	Yes	WLAN, BT	VoLTE / Google Meet	
Wi-Fi	2450	VD	No[1]	GSM, WCDMA, LTE, BT	VoWiFi / Google Meet	Head[3]
	5200			GSM, WCDMA, LTE, BT		
BT	2450	DT	No	GSM, WCDMA, LTE, WLAN2.4GHz/5GHz	NA	NA

Type Transport:
VO= Voice only
DT= Digital Transport only (no voice)
VD= CMRS and IP Voice Service over Digital Transport

Remark:
1. The air interface max power plus MIF is complies with ANSI C63.19-2019 Table 4.1 RF_{AIPL}
2. Because features of Google Meet allow the option of voice-only communications, Meet has been tested for HAC/T-Coil compatibility to ensure the best user experience.
3. The GSM/UMTS/LTE and WIFI set to highest device transmit power in a held to the ear mode.

5. WD Emission Requirements

The WD's conducted power must be at or below either the stated RFAIPL (Table 4.1) or the stated peak power level (Table 4.2), or the average near-field emissions over the measurement area must be at or below the stated RFAIL (Table 4.3), or the stated peak field strength (Table 4.4). The WD may demonstrate compliance by meeting any of these four requirements, but it must do so in each of its operating bands at its established worst-case normal speech-mode operating condition.

Table 4.1 - Wireless device RF audio interference power level	
Frequency range (MHz)	RF_{AIPL} (dBm)
< 960	29
960 - 2000	26
> 2000	25

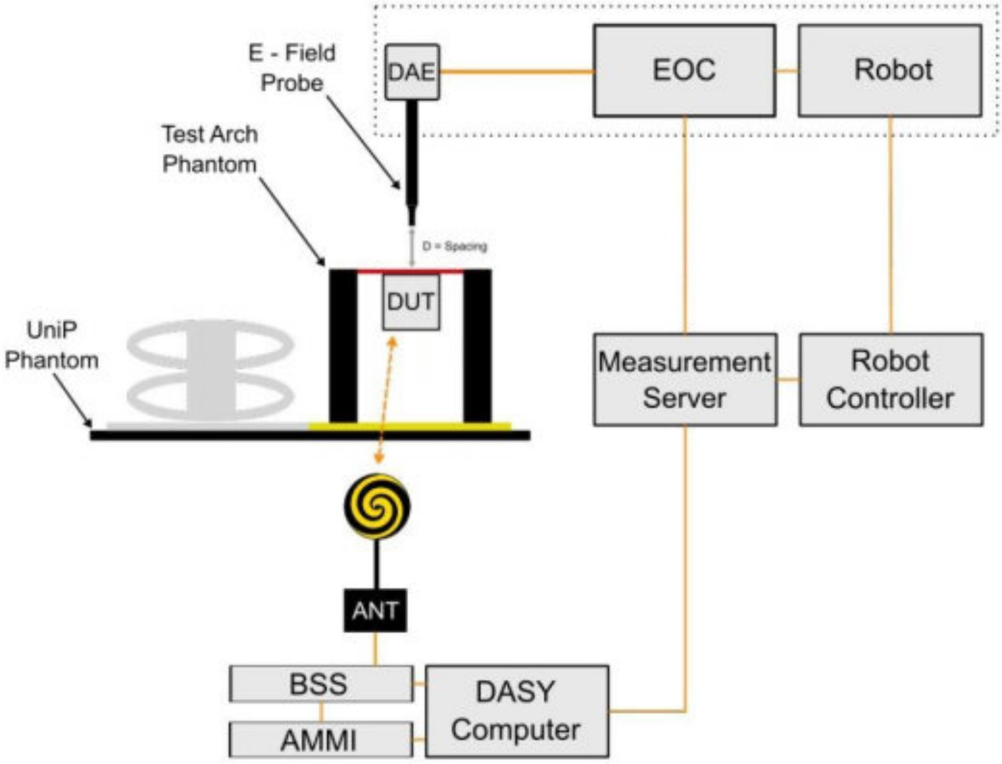
Table 4.2 - Wireless device RF peak power level	
Frequency range (MHz)	$RF_{Peak\ Power}$ (dBm)
< 960	35
960 - 2000	32
> 2000	31

Table 4.3 - Wireless device RF audio interference level	
Frequency range (MHz)	RF_{AIL} [dB(V/m)]
< 960	39
960 - 2000	36
> 2000	35

Table 4.4 - Wireless device RF peak near-field level	
Frequency range (MHz)	RF_{Peak} [dB(V/m)]
< 960	45
960 - 2000	42
> 2000	41

6. System Description and Operation

<System Components>



Remark:

A typical al DASY system for HAC measurements consists of

- 6-axis robotic arm (Staubli TX2-60L/ TX2-90XL) for positioning the probe
- Mounting Platform for keeping the phantoms at a field location relative to the robot
- Measurement Server for handling all time-critical tasks, such as measurement data acquisition and supervision of safety features
- EOC (Electrical to Optical Converter) for converting the optical signal from the Data Acquisition Electronics (DAE) to electrical before being transmitted to the measurement server
- LB (Light Beam unit) for probe alignment (measurement of the exact probe length and eccentricity)
- Test Arch for Device Under Test (DUT) testing
- DAE that reads the probe voltages and transmits them to the DASY PC. It is also used to detect probe touch and collision signals
- Device Holder for positioning the DUT beneath the phantom
- ANT (wideband Antenna) for broadcasting the downlink signals emitted by base station simulators (BSS) to the WD
- Operator PC for running the DASY software to define/execute the measurements.

The following components are needed for RFail measurements only:

- Modulation Interference Factor (MIF)
- Isotropic E-field, free-space probe (e.g., EF3DVx)
- Radiofrequency (RF) emission calibration dipoles for system check / validation purposes.

<EF3DV3 E-Field Probe Specification>

Construction	One dipole parallel, two dipoles normal to probe axis Interleaved sensors Built-in shielding against static charges PEEK enclosure material
Calibration	In air from 30 MHz to 6.0 GHz (absolute accuracy ±5.1%, k=2)
Frequency	30 MHz – 6 GHz Linearity: ±0.2 dB (100 MHz – 3 GHz)
Directivity	± 0.2 dB in air (rotation around probe axis) ± 0.4 dB in air (rotation normal to probe axis)
Dynamic Range	2 – >1000 V/m
Linearity	± 0.2 dB
Dimensions	Overall length: 337 mm (tip: 20 mm) Tip diameter: 3.9 mm (body: 12 mm) Distance from probe tip to dipole centers: 1.5 mm Sensor displacement to probe's calibration point: <0.7 mm

Voltage to E-field Conversion

The measured voltage is first linearized to a quantity proportional to the square of the E-field using the (a, b, c, d) set of parameters specific to the communication system and sensor :

$$V_{compi} = U_i + U_i^2 \cdot \frac{10^{\frac{d}{10}}}{dcp_i}$$

where V_{compi} = compensated signal of channel i (μV) (i = x, y, z)
U_i = input signal of channel i (μV) (i = x, y, z)
d = PMR factor d (dB) (Probe parameter)
dcp_i = diode compression point of channel i (μV) (Probe parameter, i = x, y, z)

$$V_{compi\,dB\sqrt{\mu V}} = 10 + \log_{10}(V_{compi})$$

$$corr_i = a_i \cdot e - \left(\frac{V_{compi\,dB\sqrt{\mu V}}^{-b_i}}{C_i}\right)^2$$

where $coor_i$ = correction factor of channel i (dB) (i = x, y, z)
$V_{compi\ dB\sqrt{\mu V}}$ = compensated voltage of channel i (dB√μV) (i = x, y, z)
a_i = PMR factor a of channel i (dB) (Probe parameter, i = x,y,z)
b_i = PMR factor b of channel i (dB√μV) (Probe parameter, i = x,y,z)
c_i = PMR factor c of channel i (Probe parameter, i = x,y,z)

The voltage $V_{idB\sqrt{\mu V}}$ is the linearized voltage in dB√μV :

$$V_{i\,dB\sqrt{\mu V}} = V_{compi\,dB\sqrt{\mu V}} - corr_i$$

where $V_{i\ dB\sqrt{\mu V}}$ = linearized voltage of channel i (dB√μV) (i = x,y,z)
$V_{compi\ dB\sqrt{\mu V}}$ = compensated voltage of channel i (dB√μV) (i = x,y,z)
$Corr_i$ = correction factor of channel i (dB) (i = x,y,z)

Finally, the linearized voltage is converted in µV :

$$\mathbf{V_i} = \mathbf{10}^{\frac{\mathbf{V_{i\,dB\sqrt{\mu V}}}}{\mathbf{10}}}$$

where V_i = linearized voltage of channel i (µV) (i = x,y,z)
$V_{i\ dB\sqrt{\mu V}}$ = linearized voltage of channel i (dB√µV (i = x,y,z)

The E-field data for each channel are calculated using the linearized voltage :

$$\text{E-field Probes :}\ \mathbf{E_i} = \sqrt{\frac{\mathbf{V_i}}{\mathbf{Norm_i \cdot ConvF}}}$$

where V_i = compensated signal of channel i, (i = x, y, z)
$Norm_i$ = sensor sensitivity (µV/(V/m)^2 of channel i (i = x, y, z)
ConvF = sensitivity enhancement in solution
E_i = electric field strength of channel i in V/m

The RMS value of the field components gives the total field strength (Hermitian magnitude) :

$$\mathbf{E_{tot}} = \sqrt{\mathbf{E_x^2} + \mathbf{E_y^2} + \mathbf{E_z^2}}$$

Averaged E-field Calculation

The averaged E-field is defined by

$$\mathbf{E_{avg}} = \frac{\mathbf{1}}{\mathbf{n}} \cdot \sum_{\mathbf{i=1}}^{\mathbf{n}} \mathbf{E_i}$$

where n = = the number of measurement grid point
E_i = the E-field measured at point i

RFail Calculation

The RFail is finally computed with

$$\boldsymbol{RFail[dB(V/m)]} = \mathbf{20} \cdot \mathbf{log_{10}}\left(\boldsymbol{E_{avg}}\right) + \boldsymbol{MIF}$$

where RFail = the Radio Frequency Audio Interference Level in dB(V/m)
E_{avg} = the averaged E-field in (V/m) calculated
MIF = the Modulation Interference Factor in dB.

7. RF Emissions Test Procedure

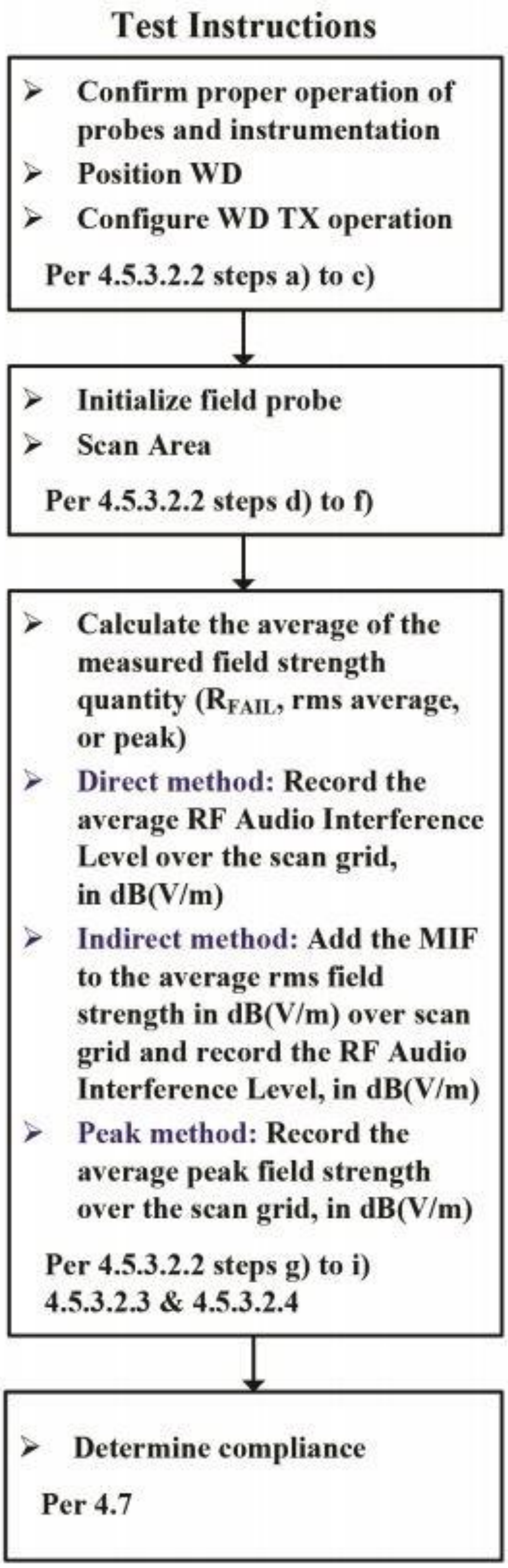
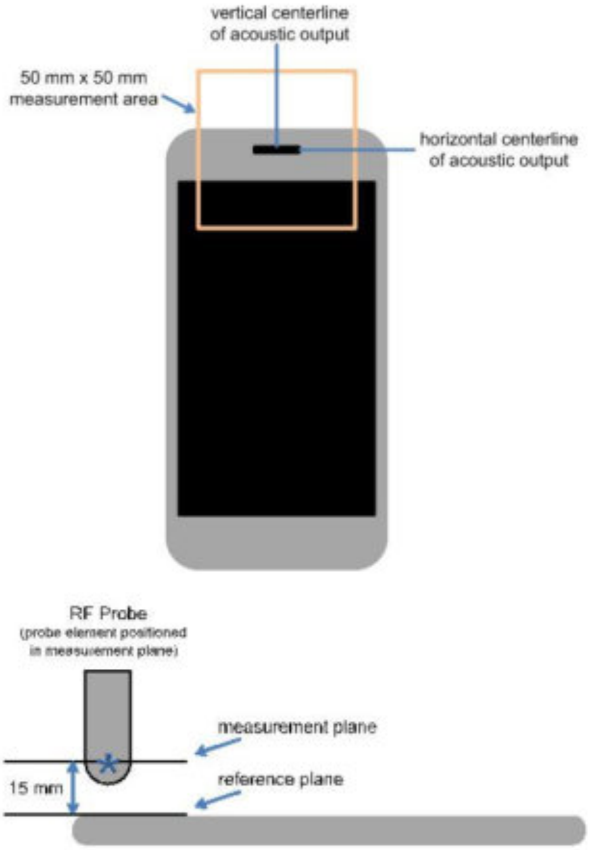
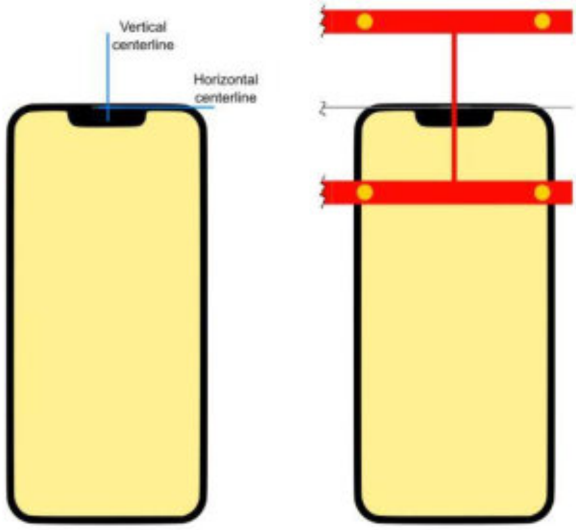


Figure of WD near-field emission scan flowchart according to ANSI C63.19:2019



The references and reference plane that shall be used in the WD emissions measurement



Device Under Test Positioning under the Test Arch

Test procedure: Indirect measurement—preferred

a. The measurement procedure using a probe and instrumentation chain with a response of <10 kHz (see ANSI C63.19-2019 section4.5.1) is identical to the direct measurement method of ANSI C63.19-2019 section4.5.3.2.2: however, because of the bandwidth limitations, it cannot include the direct use of the spectral and temporal weighting functions. The output of such measurement systems must be readings of steady state rms field strength in dB(V/m).
b. The RF audio interference level in dB(V/m) is obtained by adding the Modulation Interference Factor (in decibels) to the average steady state rms field strength reading over the measurement area, in dB(V/m), from Step c). Use this result to determine the WD's compliance per ANSI C63.19-2019 section4.7.
c. Scan the entire 50 mm by 50 mm measurement area in equally spaced step sizes and record the reading at each measurement point. The step size shall meet the specification for step size in ANSI C63.19:2019 section 4.5.3.
d. Calculate the average of the measurements taken in Step c
e. Convert the average value found in Step d) to RF audio interference level, in volts per meter, by taking the square root of the reading and then dividing it by the measurement system transfer function, as established in ANSI C63.19:2019 section4.5.3.2.1 pre-test procedure. Convert the result to dB(V/m) by taking the base-10 logarithm and multiplying it by 20. Expressed as a formula

   RF audio interference level in db(V/M) 20 * log($R_{ave}^{1/2}$ / TF)

   where

   R_{ave} is the average reading
f. Compare this RF audio interference level to the limits in ANSI C63.19:2019 section4.7 and record the result
g. Per ANSI C63.19-2019 section4.6, WDs capable of operating multiple transmitters shall be subject to emissions requirements for all such transmitters expected to be operated when the WD is in voice mode operation positioned at a user's ear. Each qualified transmitter is tested individually using the method of Clause 4. Other WD transmitters shall be temporarily disabled or reduced in power level such that their average antenna input power is at least 6 dB lower than the average antenna input power of the transmitter under test. The transmitter under test is set to the fixed and repeatable combination of power and modulation characteristic that is representative of the worst case (highest interference potential) likely to be encountered while the WD is experiencing normal voice mode operation. The limiting measurement for device qualification is the highest RF audio interference potential measured for any of the WD transmitters. If the highest interference measurement is from a transmitter that is not required for normal voice mode operation, a secondary rating may be given that applies when that transmitter is disabled

8. Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	835MHz Calibration Dipole	CD835V3	1171	2022/3/1	2025/2/27
SPEAG	1880MHz Calibration Dipole	CD1880V3	1155	2022/3/1	2025/2/27
SPEAG	Data Acquisition Electronics	DAE4	715	2024/1/25	2025/1/24
SPEAG	Isotropic E-Field Probe	EF3DV3	4053	2023/9/15	2024/9/14
SPEAG	Test Arch Phantom	N/A	N/A	NCR	NCR
SPEAG	Phone Positioner	N/A	N/A	NCR	NCR
Anritsu	Radio Communication Analyzer	MT8820C	6201381766	2023/7/20	2024/7/19
R&S	Power Sensor	NRP50S	101254	2024/4/8	2025/4/7
Anritsu	Power Meter	ML2495A	1349001	2023/10/16	2024/10/15
Anritsu	Signal Generator	MG3710A	6201502524	2023/9/27	2024/9/26
AR	Amplifier	5S1G4	0333096	2024/4/8	2025/4/7
Mini-Circuits	Amplifier	ZVE-3W-83+	599201528	2024/4/8	2025/4/7
MCL	Attenuation1	BW-S10W5+	N/A	NA	NA
MCL	Attenuation3	BW-S10W5+	N/A	NA	NA
R&S	Spectrum Analyzer	FSP7	100818	2023/7/5	2024/7/4
Anymetre	Thermo-Hygrometer	JR593	2020062101	2023/7/8	2024/7/7

Note:

1. NCR: “No-Calibration Required”
2. The dipole calibration interval can be extended to 3 years with justification. The dipoles are also not physically damaged, or repaired during the interval. The justification data in appendix C can be found which the return loss is < -20dB, within 20% of prior calibration, the impedance is within 5 ohm of prior calibration for each dipole.

9. System Validation

Obtaining accurate measurements and relevant quantities in Module HAC depends on the proper functioning of many components and the correct parameter settings. Faulty results due to drift, failures, or incorrect parameters might not be recognized, as the differences might not be obvious in the measurements.
SPEAG DASY incorporates a system check, also called system verification procedure, to test for the proper functioning of the system based on the tests described in ANSI C63.19-2019: the RF interference potential test setup is verified with RF Emission Calibration Dipoles.

<Test Setup>

1. Set the RF signal generator for either CW. Set its output power so the peak power applied to the antenna is equal to that recorded for the real or emulated signal using the WD modulation format
2. Average input power P = 100 mW (20 dBm) after adjustment for return loss. An input power that generates field levels similar to those from the WD or other suitable level may also be used
3. The test fixture should meet the two-wavelength separation criterion
4. The probe-to-dipole separation, which is measured from closest surface of the dipole to the center point of the probe sensor element, should be 15 mm

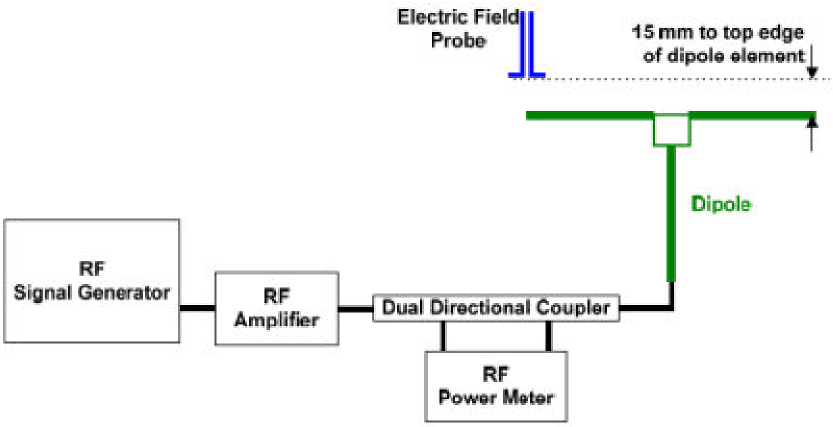


Figure of Setup Diagram

<Validation Procedure>

Place a dipole antenna meeting the requirements given in ANSI C63.19: 2019 D.11 in the position normally occupied by the WD. The dipole antenna serves as a known source for an electrical and magnetic output. Position the E-field probe so that:

a. The probe and its cable are parallel to the coaxial feed of the dipole antenna
b. The probe cable and the coaxial feed of the dipole antenna approach the measurement area from opposite directions; and
c. The center point of the probe element(s) is 15 mm from the closest surface of the dipole elements

Scan the length of the dipole with the E-field probe and record the two maximum values found near the dipole ends. Average the two readings and compare the reading to expected value in the calibration certificate or expected value in this standard.

Frequency (MHz)	Input Power (dBm)	Target Value (V/m)	Emax (V/m)	Deviation (%)	Date	Dipole S/N	Probe S/N	DAE S/N
835	20	107.7	108	0.28	Jun. 12, 2024	1171	4053	715
1880	20	85.1	85.6	0.59	Jun. 12, 2024	1155	4053	715

10. Modulation Interference Factor

For any specific fixed and repeatable modulated signal, a Modulation Interference Factor (MIF, expressed in decibels) may be developed that relates its interference potential to its steady state rms signal level or average power level. This factor is a function only of the audio frequency amplitude modulation characteristics of the signal and is the same for field strength or conducted power measurements. It is important to emphasize that the MIF is valid only for a specific repeatable audio frequency amplitude modulation characteristic. Any change in modulation characteristic requires determination and application of a new MIF.
MIF may be determined using a radiated RF field, a conducted RF signal, or, in a preliminary stage, a mathematical analysis of a modeled RF signal.

a. Verify the slope accuracy and dynamic range capability over the desired operating frequency band of a fast probe or sensor, square-law detector, as specified in ANSI C63.19: 2019 D.3, and weighting system as specified in ANSI C63.19: 2019 D.4 and ANSI C63.19: 2019 D.5. For the probe and instrumentation included in the measurement of MIF, additional calibration and application of calibration factors are not required.
b. Using RF illumination, or conducted coupling, apply the specific modulated signal in question to the measurement system at a level within its confirmed operating dynamic range
c. Measure the steady-state rms level at the output of the fast probe or sensor
d. Measure the steady-state average level at the weighting output
e. Without changing the square-law detector or weighting system, and using RF illumination, or conducted coupling, substitute for the specific modulated signal a 1 kHz, 80% amplitude modulated carrier at the same frequency and adjust its strength until the level at the weighting output equals the Step d) measurement
f. Without changing the carrier level from Step e), remove the 1 kHz modulation and again measure the steady-state rms level indicated at the output of the fast probe or sensor.
g. The MIF for the specific modulation characteristic is given by the ratio of the Step f) measurement to the Step c) measurement, expressed in decibels (20*log(step6/step3)

In practice, Step e) and Step f) need not be repeated for each MIF determination if the relationship between the two measurements has been pre-established for the measurement system over the operating frequency and dynamic ranges. In such cases, only the modulation characteristic being tested needs to be available during WD testing Since indirect measurement procedure was using for RF audio interference power level evaluation, the MIF values applied in this test report were provided by the HAC equipment provider of SPEAG, and the worst values for all air interface are listed below to be determine the Wireless device RF audio interference power level.

UID	Communication System Name	MIF(dB)
10021	GSM-FDD(TDMA,GMSK)	3.63
10025	EDGE-FDD (TDMA, 8PSK, TN 0)	3.75
10460	UMTS-FDD(WCDMA, AMR)	-25.43
10225	UMTS-FDD (HSPA+)	-20.39
10170	LTE-FDD(SC-FDMA,1RB,20MHz,16-QAM)	-9.76
10173	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM)	-1.44
10061	IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps)	-2.02
10077	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 54 Mbps)	0.12
10427	IEEE 802.11n (HT Greeneld, 150 Mbps, 64-QAM)	-13.44
10069	IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps)	-3.15
10616	IEEE 802.11ac WiFi (40MHz, MCS0, 90pc duty cycle)	-5.57

11. Evaluation of WD RF interference potential

General Note:

1. In this report, max conducted power from each air interface was first used to evaluate whether it complies with ANSI C63.19-2019 Table 4.1 RF_{AIPL}, compliance with table 4.1 means compliance with WD emission requirements. the RF_{AIPL} evaluation refer to section 11.1 for detail.
2. If there some air interface were not meet ANSI C63.19-2019 table 4.1 requirement, these air interfaces were further evaluation ANSI C63.19-2019 Table 4.3 RFAIL requirement. And the RFAIL evaluation result refer to section 13.

11.1 Evaluation RF_{AIPL}

<WWAN Max Tune-up Limit>

Frequency Band		Average Power (dBm)
GSM	GSM850	33.00
	EDGE850	29.00
	GSM1900	30.50
	EDGE1900	28.50
WCDMA	Band II	24.50
	HSPA	23.50
	Band IV	24.50
	HSPA	23.50
	Band V	24.00
	HSPA	23.00
FDD LTE	LTE Band 2	24.00
	LTE Band 4	24.00
	LTE Band 5	24.00
	LTE Band 7	24.00
	LTE Band 12	24.00
	LTE Band 13	24.00
	LTE Band 66	24.00
FDD TDD	LTE Band 41	24.00

<WLAN Max Tune-up Limit>

Frequency Band		Average Power (dBm)
WLAN2.4GHz	802.11b	18.00
	802.11g	16.00
	802.11n-HT20	14.00
	802.11n-HT40	14.00
WLAN5GHz	802.11a	14.00
	802.11n-HT20	14.00
	802.11n-HT40	14.00
	802.11ac-VHT20	14.00
	802.11ac-VHT40	14.00
	802.11ac-VHT80	14.00

<Evaluation RF audio interference power level>

General Note:

1. Use maximum power plus worst case MIF to determine whether it complies with RF_{AIPL}
2. If maximum power plus worst case MIF does not complies with RF_{AIPL}, then further evaluation RF_{AIL} include in section 13.
3. EDGE data modes is not necessary due the GSM Voice mode is the worst case.
4. According to ANSI C63.19 2019, if maximum power plus worst case MIF is complies with RF_{AIPL}, means compliance with WD emission requirements.

Frequency Band		Average Power (dBm)	Worst Case MIF (dB)	Power + MIF(dB)	C63.19 Lowest RF_{AIPL} (dBm)	C63.19 test required(2019)
GSM	GSM850	33.00	3.63	36.63	29	Yes
	EDGE850	29.00	3.75	32.75	29	NO(3)
	GSM1900	30.50	3.63	34.13	26	Yes
	EDGE1900	28.50	3.75	32.25	26	NO(3)
WCDMA	Band II	24.50	-25.43	-0.93	26	NO
	HSPA	23.50	-20.39	3.11	26	NO
	Band IV	24.50	-25.43	-0.93	26	NO
	HSPA	23.50	-20.39	3.11	26	NO
	Band V	24.00	-25.43	-1.43	29	NO
	HSPA	23.00	-20.39	2.61	29	NO
FDD LTE	LTE Band 2	24.00	-9.76	14.24	26	NO
	LTE Band 4	24.00	-9.76	14.24	26	NO
	LTE Band 5	24.00	-9.76	14.24	29	NO
	LTE Band 7	24.00	-9.76	14.24	29	NO
	LTE Band 12	24.00	-9.76	14.24	29	NO
	LTE Band 13	24.00	-9.76	14.24	29	NO
	LTE Band 66	24.00	-9.76	14.24	26	NO
FDD TDD	LTE Band 41	24.00	-1.44	22.56	25	NO

<WLAN Ant>

Frequency Band		Average Power (dBm)	Worst Case MIF (dB)	Power + MIF(dB)	C63.19 Lowest RF_{AIPL} (dBm)	C63.19 test required(2019)
WLAN2.4GHz	802.11b	18.00	-2.02	15.98	25	NO
	802.11g	16.00	0.12	16.12	25	NO
	802.11n-HT20	14.00	-13.44	0.56	25	NO
	802.11n-HT40	14.00	-13.44	0.56	25	NO
WLAN5GHz	802.11a	14.00	-3.15	10.85	25	NO
	802.11n-HT20	14.00	-13.44	0.56	25	NO
	802.11n-HT40	14.00	-13.44	0.56	25	NO
	802.11ac-VHT20	14.00	-5.57	8.43	25	NO
	802.11ac-VHT40	14.00	-5.57	8.43	25	NO
	802.11ac-VHT80	14.00	-5.57	8.43	25	NO

12. Conducted RF Output Power (Unit: dBm)

<GSM>

Average Antenna Input Power(dBm)						
Band	GSM850			GSM1900		
Channel	128	189	251	512	661	810
Frequency (MHz)	824.2	836.4	848.8	1850.2	1880.0	1909.8
GSM (GMSK, 1 Tx slot)	31.24	31.33	31.31	29.14	28.91	28.81

13. RF_{AIL} Test Results

General Note:

1. The HAC measurement system applies MIF value onto the measured RMS E-field, which is indirect method in ANSI C63.19-2019 version, and reports the RF audio interference level.
2. Phone Condition: Mute on; Backlight off; Max Volume.

Plot No.	Air Interface	Modulation / Mode	Channel	Average Antenna Input Power (dBm)	MIF	RF_{AIL} (dBV/m)
1	GSM850	Voice	128	31.24	3.63	31.03
2	GSM850	Voice	189	31.33	3.63	31.11
3	GSM850	Voice	251	31.31	3.63	31.09
4	GSM1900	Voice	512	29.14	3.63	23.69
5	GSM1900	Voice	661	28.91	3.63	23.74
6	GSM1900	Voice	810	28.81	3.63	24.86

Test Engineer : Hank Huang, Kevin Xu, David Dai

14. Uncertainty Assessment

The component of uncertainly may generally be categorized according to the methods used to evaluate them. The evaluation of uncertainly by the statistical analysis of a series of observations is termed a Type A evaluation of uncertainty. The evaluation of uncertainty by means other than the statistical analysis of a series of observation is termed a Type B evaluation of uncertainty. Each component of uncertainty, however evaluated, is represented by an estimated standard deviation, termed standard uncertainty, which is determined by the positive square root of the estimated variance.
The combined standard uncertainty of the measurement result represents the estimated standard deviation of the result. It is obtained by combining the individual standard uncertainties of both Type A and Type B evaluation using the usual "root-sum-squares" (RSS) methods of combining standard deviations by taking the positive square root of the estimated variances. Expanded uncertainty is a measure of uncertainty that defines an interval about the measurement result within which the measured value is confidently believed to lie. It is obtained by multiplying the combined standard uncertainty by a coverage factor. For purpose of this document, a coverage factor two is used, which corresponds to confidence interval of about 95 %. The DASY uncertainty Budget is showed below Table.
The judgment of conformity in the report is based on the measurement results excluding the measurement uncertainty.

Error Description	Uncertainty Value (±%)	Probability Distribution	Divisor	Ci (Eav)	Standard Uncertainty (E) (±%)
Measurement System					
Probe Calibration	5.1	Normal	1	1	5.1
Axial Isotropy	4.7	Rectangular	√3	1	2.7
Sensor Displacement	7.2	Rectangular	√3	0.5	2.1
Boundary Effects	2.4	Rectangular	√3	1	1.4
Phantom Boundary Effects	7.2	Rectangular	√3	1	4.2
Linearity	4.7	Rectangular	√3	1	2.7
Scaling with PMR Calibration	10.0	Rectangular	√3	1	5.8
System Detection Limit	1.0	Rectangular	√3	1	0.6
Readout Electronics	0.3	Normal	1	1	0.3
Response Time	0.8	Rectangular	√3	0	0.0
Integration Time	2.6	Rectangular	√3	0	0.0
RF Ambient Conditions	3.0	Rectangular	√3	1	1.7
RF Reflections	12.0	Rectangular	√3	1	6.9
Probe Positioner	1.2	Rectangular	√3	1	0.7
Probe Positioning	3.0	Rectangular	√3	1	1.7
Extrap. and Interpolation	1.0	Rectangular	√3	1	0.6
Test Sample Related					
Device Positioning Vertical	4.7	Rectangular	√3	1	2.7
Device Positioning Lateral	1.0	Rectangular	√3	1	0.6
Device Holder and Phantom	2.4	Rectangular	√3	1	1.4
Power Drift	5.0	Rectangular	√3	1	2.9
Phantom and Setup Related					
Phantom Thickness	2.4	Rectangular	√3	1	1.4
Combined Std. Uncertainty					13.1%
Coverage Factor for 95 %					K=2
Expanded STD Uncertainty					26.3%
Declaration of Conformity: The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.					
Comments and Explanations: The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.					

Uncertainty Budget of HAC free field assessment

15. References

[1] ANSI C63.19:2019, “American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids”, Aug. 2019.
[2] FCC KDB 285076 D01v06r04, “Equipment Authorization Guidance for Hearing Aid Compatibility”, Sep 2023.
[3] FCC KDB 285076 D03v01r06, “Hearing aid compatibility frequently asked questions”, Jul. 2022
[4] SPEAG DASY System Handbook

Appendix A. Plots of System Performance Check

The plots are shown as follows.

HAC_E_Dipole_835

Measurement performed on June 12, 2024

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
EF3DV3 - SN4053	September 15, 2023	DAE4 Sn715	January 25, 2024

Communication Systems

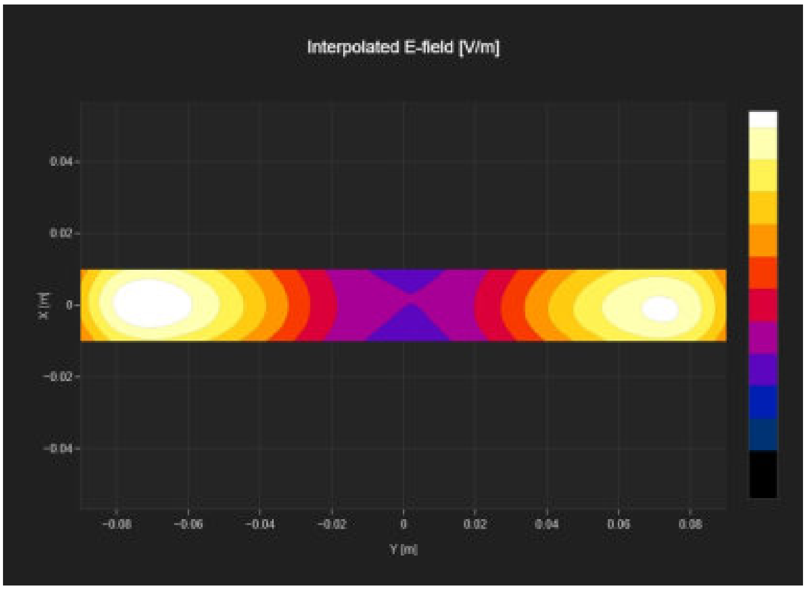
Band Name	Communication Systems Name	Channel	Frequency [MHz]
CD835	CW	50	835.0

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
20.0	180.0	5.0	5.0	15.0

Results

Dipole Type	Dipole Serial Number	Emax [V/m]	Drift [dB]
CD835	1171	108	0.12



HAC_E_Dipole_1880

Measurement performed on June 12, 2024

Device Under Test

Manufacturer	Model	Dimensions [mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
EF3DV3 - SN4053	September 15, 2023	DAE4 Sn715	January 25, 2024

Communication Systems

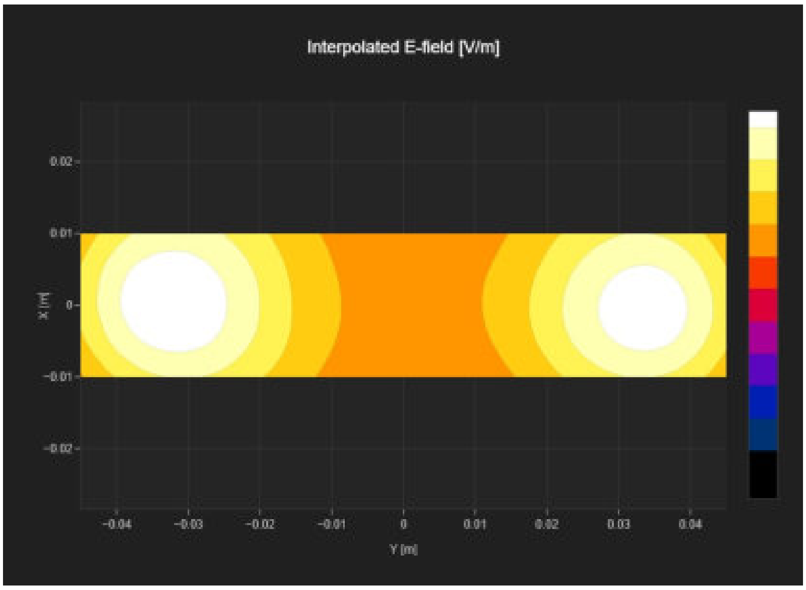
Band Name	Communication Systems Name	Channel	Frequency [MHz]
CD1880	CW	50	1880.0

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
20.0	90.0	5.0	5.0	15.0

Results

Dipole Type	Dipole Serial Number	Emax [V/m]	Drift [dB]
CD1880	1155	85.6	0.08



Appendix B. Plots of RF Emission Measurement

The plots are shown as follows.

1_GSM850_GSM Voice_Ch128_E

Measurement performed on June 12, 2024

Device Under Test

Manufacturer	Model	Dimensions[mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
EF3DV3 - SN4053	September 15, 2023	DAE4 Sn715	January 25, 2024

Communication Systems

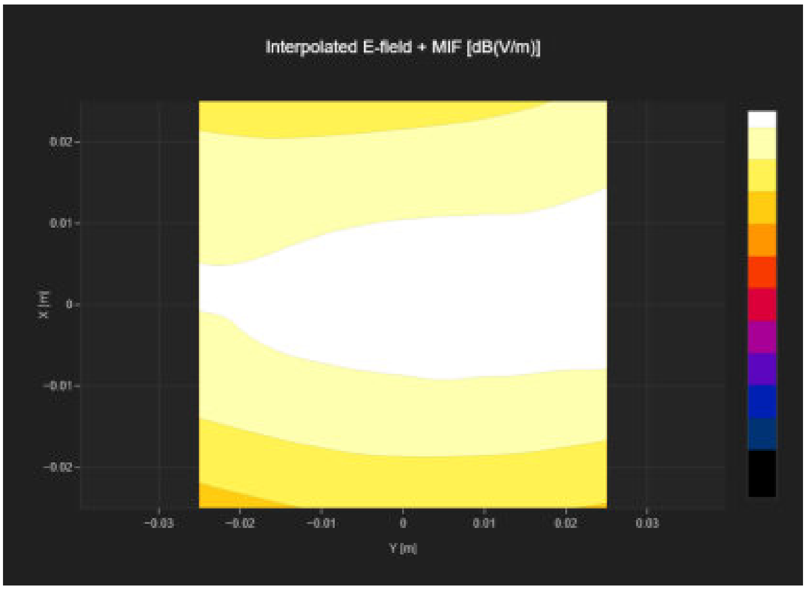
Band Name	Communication Systems Name	Channel	Frequency [MHz]
GSM 850	GSM-FDD (TDMA, GMSK)	128	824.2

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
50.0	50.0	10.0	10.0	15.0

Results

Emax [dB(V/m)]	Eavg50x50 max [dB(V/m)]	MIF [dB]	RFail [dB(V/m)]
28.75	27.4	3.63	31.03



2_GSM850_GSM Voice_Ch189_E

Measurement performed on June 12, 2024

Device Under Test

Manufacturer	Model	Dimensions[mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
EF3DV3 - SN4053	September 15, 2023	DAE4 Sn715	January 25, 2024

Communication Systems

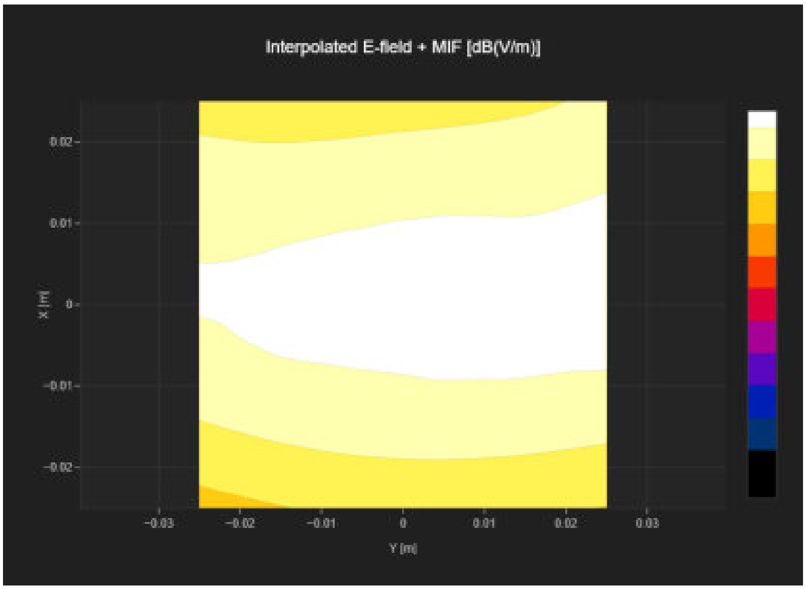
Band Name	Communication Systems Name	Channel	Frequency [MHz]
GSM 850	GSM-FDD (TDMA, GMSK)	189	836.4

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
50.0	50.0	10.0	10.0	15.0

Results

Emax [dB(V/m)]	Eavg50x50 max [dB(V/m)]	MIF [dB]	RFail [dB(V/m)]
28.83	27.48	3.63	31.11



3_GSM850_GSM Voice_Ch251_E

Measurement performed on June 12, 2024

Device Under Test

Manufacturer	Model	Dimensions[mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
EF3DV3 - SN4053	September 15, 2023	DAE4 Sn715	January 25, 2024

Communication Systems

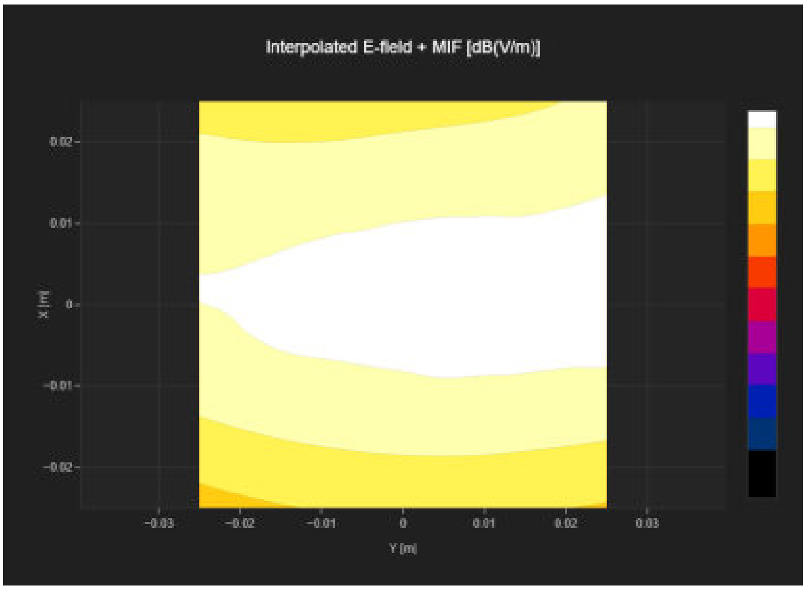
Band Name	Communication Systems Name	Channel	Frequency [MHz]
GSM 850	GSM-FDD (TDMA, GMSK)	251	848.8

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
50.0	50.0	10.0	10.0	15.0

Results

Emax [dB(V/m)]	Eavg50x50 max [dB(V/m)]	MIF [dB]	RFail [dB(V/m)]
28.81	27.46	3.63	31.09



4_GSM1900_GSM Voice_Ch512_E

Measurement performed on June 12, 2024

Device Under Test

Manufacturer	Model	Dimensions[mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
EF3DV3 - SN4053	September 15, 2023	DAE4 Sn715	January 25, 2024

Communication Systems

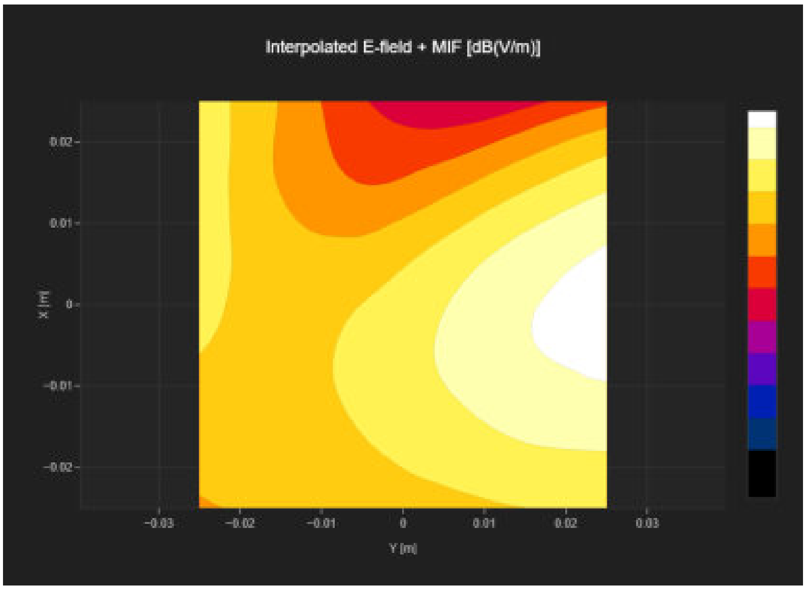
Band Name	Communication Systems Name	Channel	Frequency [MHz]
PCS 1900	GSM-FDD (TDMA, GMSK)	512	1850.2

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
50.0	50.0	10.0	10.0	15.0

Results

Emax [dB(V/m)]	Eavg50x50 max [dB(V/m)]	MIF [dB]	RFail [dB(V/m)]
24.14	20.06	3.63	23.69



5_GSM1900_GSM Voice_Ch661_E

Measurement performed on June 12, 2024

Device Under Test

Manufacturer	Model	Dimensions[mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
EF3DV3 - SN4053	September 15, 2023	DAE4 Sn715	January 25, 2024

Communication Systems

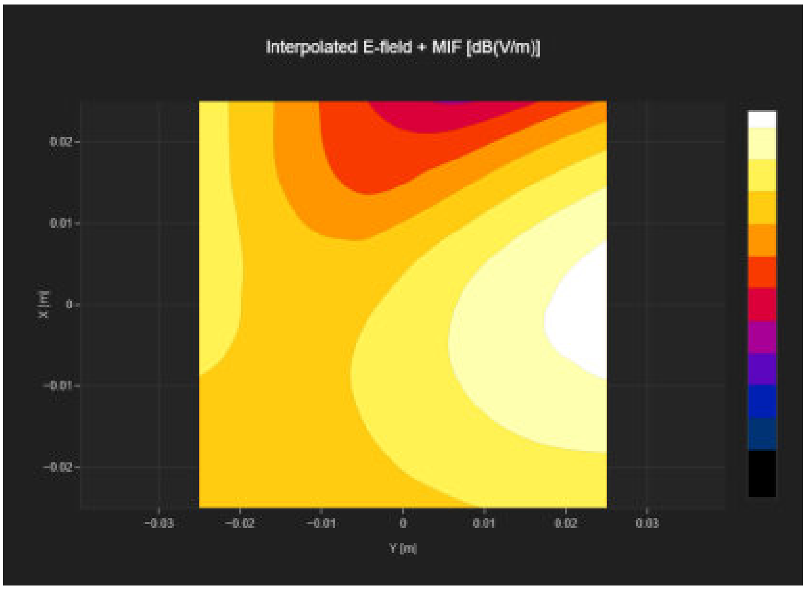
Band Name	Communication Systems Name	Channel	Frequency [MHz]
PCS 1900	GSM-FDD (TDMA, GMSK)	661	1880.0

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
50.0	50.0	10.0	10.0	15.0

Results

Emax [dB(V/m)]	Eavg50x50 max [dB(V/m)]	MIF [dB]	RFail [dB(V/m)]
24.19	20.11	3.63	23.74



6_GSM1900_GSM Voice_Ch810_E

Measurement performed on June 12, 2024

Device Under Test

Manufacturer	Model	Dimensions[mm]	Speaker Position [mm]
		146.2 x 71.8 x 7.5	144.3

Hardware Setup

Probe Name	Probe Calibration Date	DAE Name	DAE Calibration Date
EF3DV3 - SN4053	September 15, 2023	DAE4 Sn715	January 25, 2024

Communication Systems

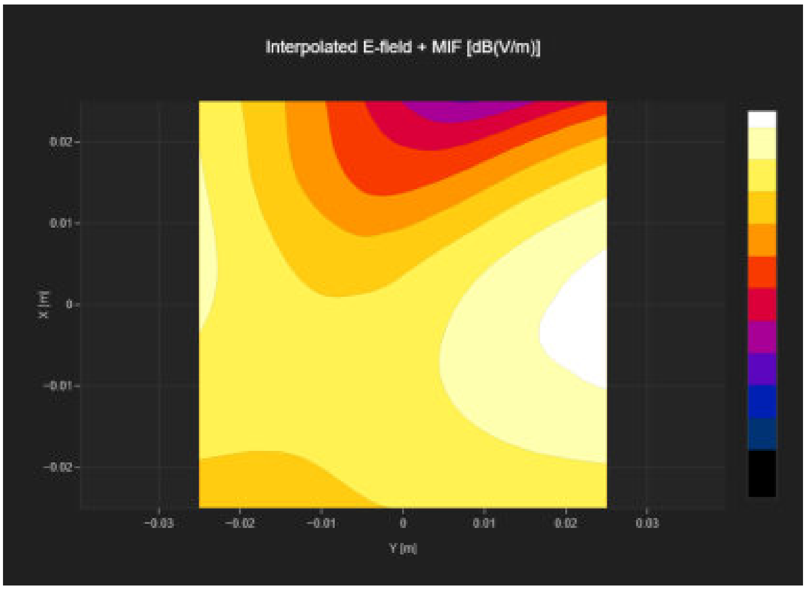
Band Name	Communication Systems Name	Channel	Frequency [MHz]
PCS 1900	GSM-FDD (TDMA, GMSK)	810	1909.8

Grid Settings

Extent X [mm]	Extent Y [mm]	Step X [mm]	Step Y [mm]	Distance [mm]
50.0	50.0	10.0	10.0	15.0

Results

Emax [dB(V/m)]	Eavg50x50 max [dB(V/m)]	MIF [dB]	RFail [dB(V/m)]
25.05	21.23	3.63	24.86



Appendix C. DASY Calibration Certificate

The DASY calibration certificates are shown as follows.

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

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

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

Accreditation No.: SCS 0108

Client **Sporton**

Certificate No: CD835V3-1171_Mar22

CALIBRATION CERTIFICATE

Object	CD835V3 - SN: 1171
Calibration procedure(s)	QA CAL-20.v7 Calibration Procedure for Validation Sources in air
Calibration date:	March 01, 2022

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-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	
Approved by:	Niels Kuster	Quality Manager	

Issued: March 2, 2022

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 ± 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	110.3 V/m = 40.85 dBV/m
Maximum measured above low end	100 mW input power	105.1 V/m = 40.43 dBV/m
Averaged maximum above arm	100 mW input power	**107.7 V/m ± 12.8 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters

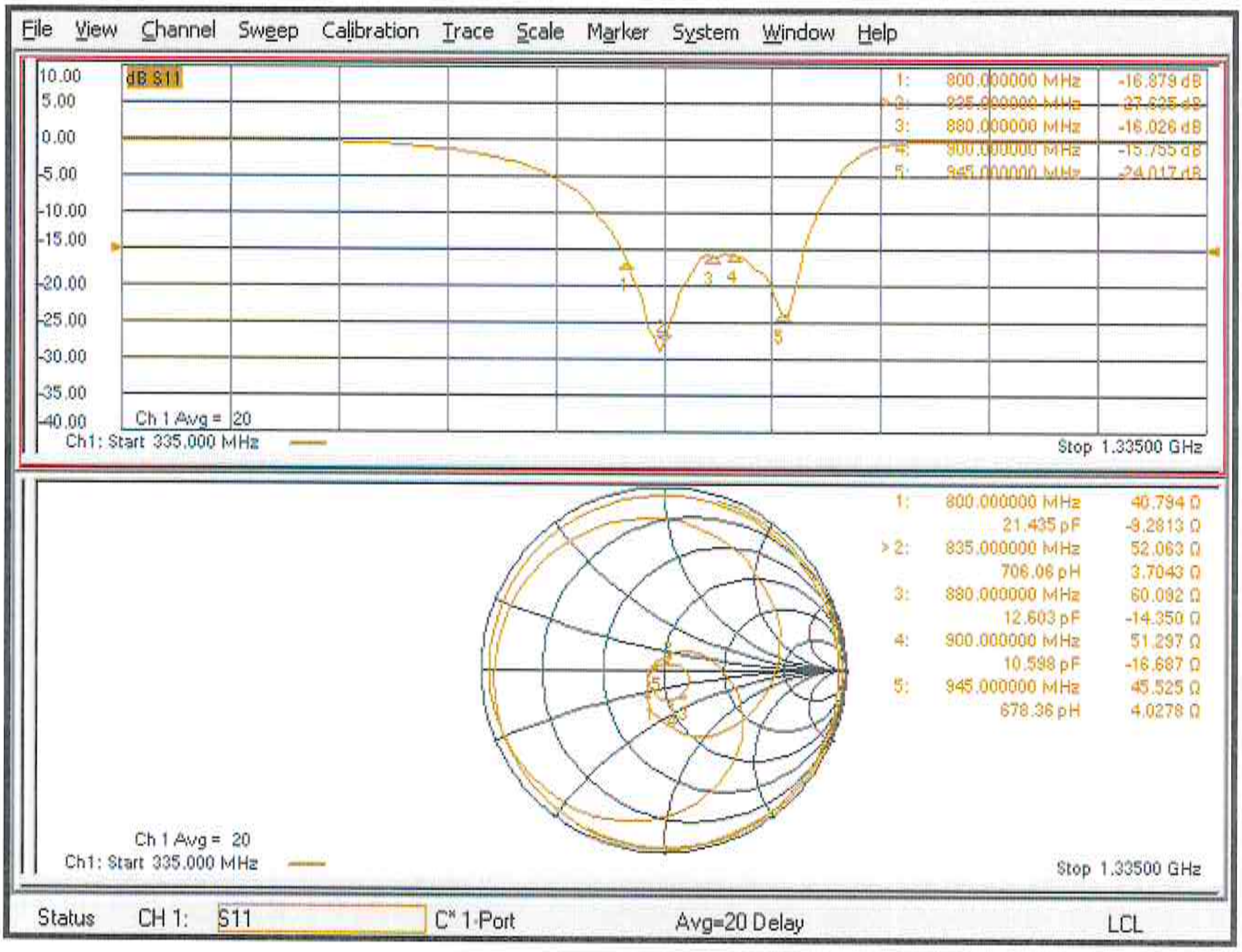
Frequency	**Return Loss**	**Impedance**
800 MHz	16.9 dB	40.8 Ω - 9.3 jΩ
835 MHz	27.6 dB	52.1 Ω + 3.7 jΩ
880 MHz	16.0 dB	60.1 Ω - 14.4 jΩ
900 MHz	15.8 dB	51.3 Ω - 16.7 jΩ
945 MHz	24.0 dB	45.5 Ω + 4.0 jΩ

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.

Impedance Measurement Plot



DASY5 E-field Result

Date: 01.03.2022

Test Laboratory: SPEAG Lab2

DUT: HAC-Dipole 835 MHz; Type: CD835V3; Serial: CD835V3 - SN: 1171

Communication System: UID 0 - CW ; Frequency: 835 MHz
Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

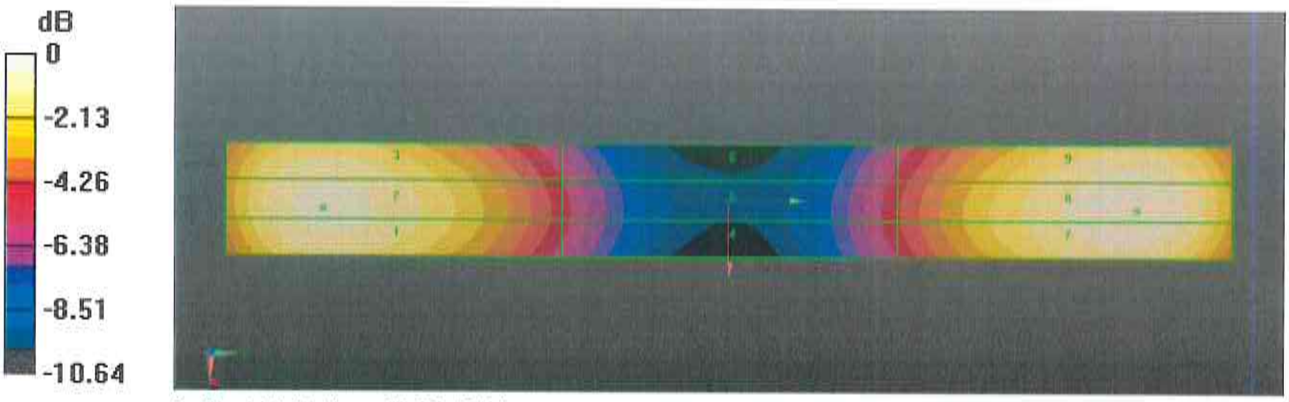
DASY52 Configuration:

- Probe: EF3DV3 - SN4013; ConvF(1, 1, 1) @ 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 = 132.7 V/m; Power Drift = 0.00 dB
Applied MIF = 0.00 dB
RF audio interference level = 40.85 dBV/m
Emission category: M3

MIF scaled E-field

Grid 1 **M3** **40.39 dBV/m**	Grid 2 **M3** **40.43 dBV/m**	Grid 3 **M3** **40.11 dBV/m**
Grid 4 **M4** **35.79 dBV/m**	Grid 5 **M4** **35.81 dBV/m**	Grid 6 **M4** **35.5 dBV/m**
Grid 7 **M3** **40.79 dBV/m**	Grid 8 **M3** **40.85 dBV/m**	Grid 9 **M3** **40.53 dBV/m**



0 dB = 110.3 V/m = 40.85 dBV/m

CD835V3, Serial No. 1171 Extended Dipole Calibrations

If dipoles are verified in return loss (<-20dB, within 20% of prior calibration),and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and thecalibration interval can be extended.

CD835V2 – serial no. 1171						
800 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2022.3.1	-16.879		40.794		-9.2813	
2023.2.28	-17.080	1.19	41.897	-1.103	-10.825	1.5437
2024.2.28	-14.585	-13.59	42.233	-1.439	-11.139	1.8577

CD835V2 – serial no. 1171						
835 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2022.3.1	-27.635		52.063		3.7043	
2023.2.28	-24.451	-11.52	50.213	1.85	5.5208	-1.8165
2024.2.28	-28.425	2.86	50.016	2.047	5.1415	-1.4372

CD835V2 – serial no. 1171						
880 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2022.3.1	-16.026		60.092		-14.350	
2023.2.28	-17.952	12.02	60.424	-0.332	-12.463	-1.887
2024.2.28	-17.573	9.65	63.502	-3.41	-10.769	-3.581

CD835V2 – serial no. 1171						
900 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance	Delta (ohm)	Imaginary Impedance	Delta (ohm)

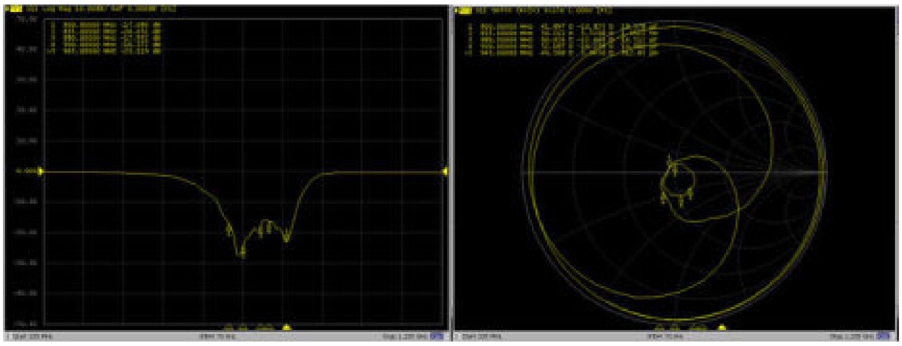
			(ohm)		(ohm)	
2022.3.1	-15.755		51.297		-16.687	
2023.2.28	-16.372	3.92	52.087	-0.79	-16.238	-0.449
2024.2.28	-15.091	-4.21	51.659	-0.362	-16.630	-0.057
CD835V2 – serial no. 1171						
945 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2022.3.1	-24.017		45.525		4.0278	
2023.2.28	-23.119	-3.74	46.568	-1.043	3.0450	0.9828
2024.2.28	-21.176	-11.83	44.255	1.27	2.3676	1.6602

<Justification of the extended calibration>

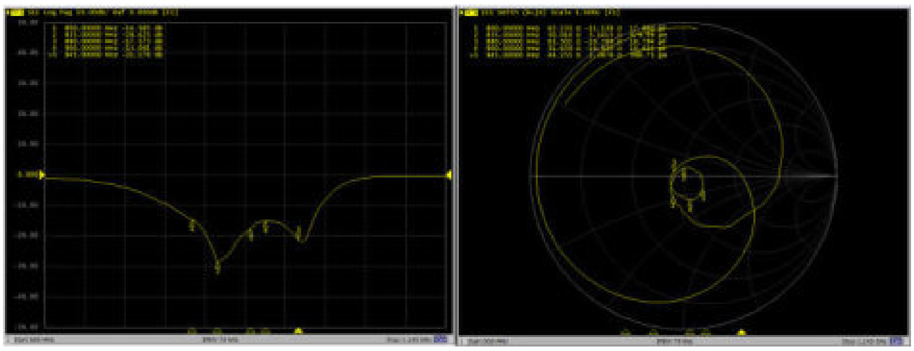
The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

Dipole Verification Data> CD835V3, serial no. 1171

800 MHz-835MHz-880MHz-900MHz-945MHz – Head – 2023.2.28



800 MHz-835MHz-880MHz-900MHz-945MHz – Head – 2024.2.28



Calibration Laboratory of
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S **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

Client **Sporton**

Certificate No: CD1880V3-1155_Mar22

CALIBRATION CERTIFICATE

Object	CD1880V3 - SN: 1155
Calibration procedure(s)	QA CAL-20.v7 Calibration Procedure for Validation Sources in air
Calibration date:	March 01, 2022

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-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	
Approved by:	Niels Kuster	Quality Manager	

Issued: March 2, 2022

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	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	86.3 V/m = 38.72 dBV/m
Maximum measured above low end	100 mW input power	83.9 V/m = 38.48 dBV/m
Averaged maximum above arm	100 mW input power	**85.1 V/m ± 12.8 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters

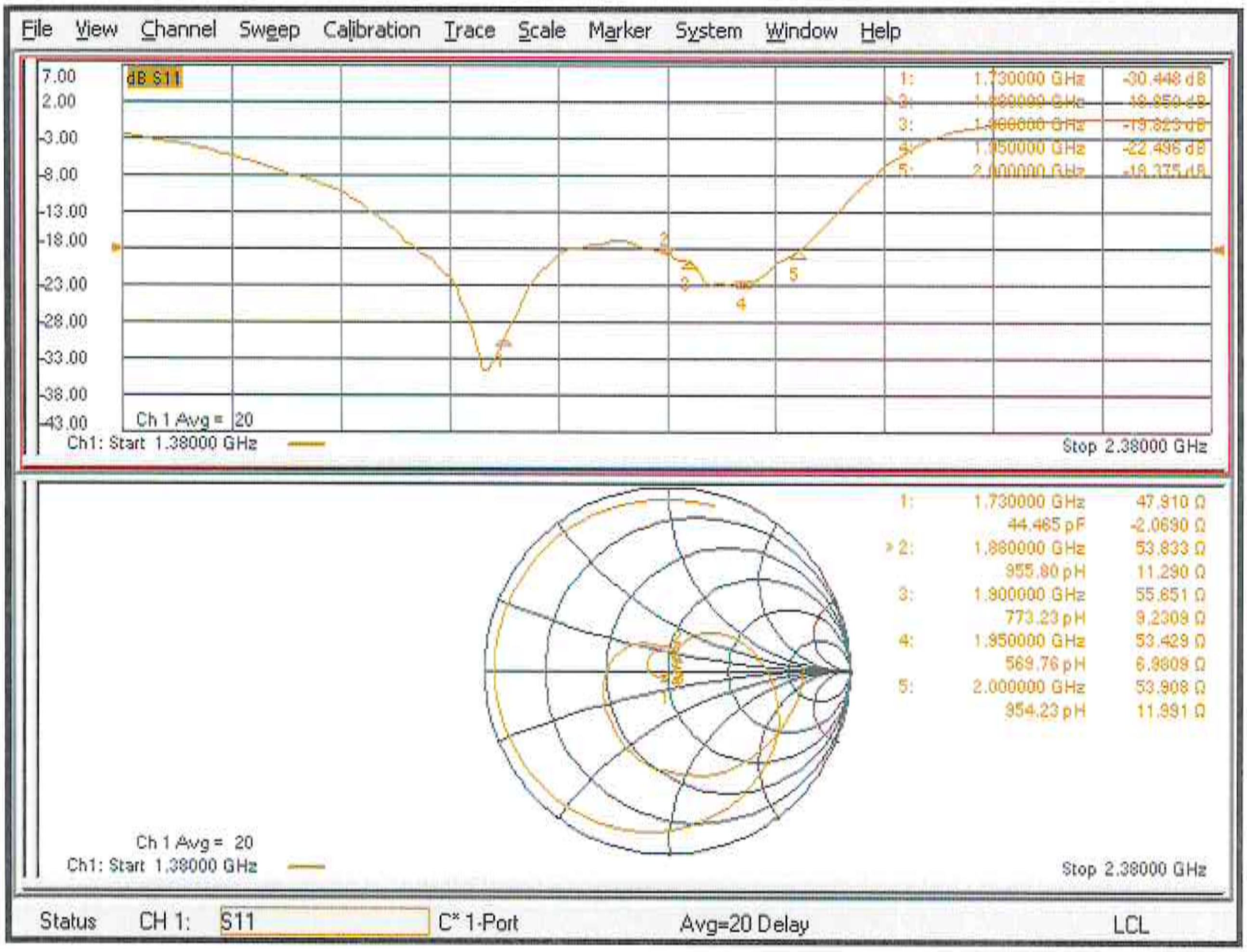
Frequency	**Return Loss**	**Impedance**
1730 MHz	30.4 dB	47.9 Ω - 2.1 jΩ
1880 MHz	18.9 dB	53.8 Ω + 11.3 jΩ
1900 MHz	19.8 dB	55.7 Ω + 9.2 jΩ
1950 MHz	22.5 dB	53.4 Ω + 7.0 jΩ
2000 MHz	18.4 dB	53.9 Ω + 12.0 jΩ

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.

Impedance Measurement Plot



DASY5 E-field Result

Date: 01.03.2022

Test Laboratory: SPEAG Lab2

DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: CD1880V3 - SN: 1155

Communication System: UID 0 - CW ; Frequency: 1880 MHz
Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 0$ kg/m^3
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

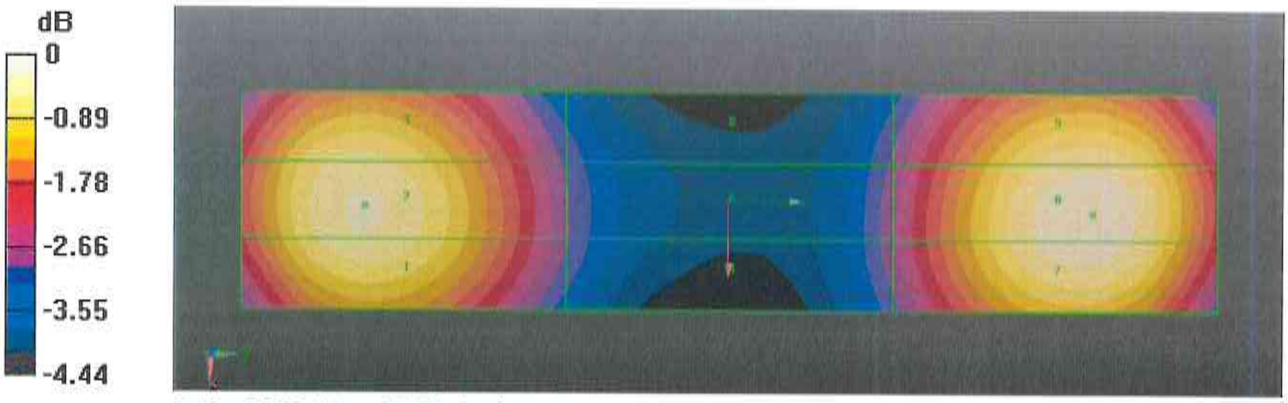
DASY52 Configuration:

- Probe: EF3DV3 - SN4013; ConvF(1, 1, 1) @ 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 = 151.0 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** **38.48 dBV/m**	Grid 3 **M2** **38.24 dBV/m**
Grid 4 **M2** **35.98 dBV/m**	Grid 5 **M2** **35.98 dBV/m**	Grid 6 **M2** **35.82 dBV/m**
Grid 7 **M2** **38.65 dBV/m**	Grid 8 **M2** **38.72 dBV/m**	Grid 9 **M2** **38.39 dBV/m**



0 dB = 86.33 V/m = 38.72 dBV/m

CD1880V3, Serial No. 1155 Extended Dipole Calibrations

If dipoles are verified in return loss (<-20dB, within 20% of prior calibration),and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and thecalibration interval can be extended.

CD1880V2 – serial no. 1155						
1730 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2022.3.1	-30.448		47.910		-2.0690	
2023.2.28	-30.309	-0.46	51.112	-3.202	-3.2774	1.2084
2024.2.28	-31.827	4.53	51.537	-3.627	-2.0768	0.0078

CD1880V2 – serial no. 1155						
1880 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2022.3.1	-18.850		53.833		11.290	
2023.2.28	-18.930	0.42	50.740	3.093	11.505	-0.215
2024.2.28	-17.881	-5.14	51.346	2.487	12.967	-1.677

CD1880V2 – serial no. 1155						
1900 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2022.3.1	-19.823		55.651		9.2309	
2023.2.28	-18.739	-5.47	55.953	-0.302	10.564	-1.3331
2024.2.28	-17.911	-9.65	55.171	0.48	12.431	-3.2001

CD1880V2 – serial no. 1155						
1950 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance	Delta (ohm)	Imaginary Impedance	Delta (ohm)

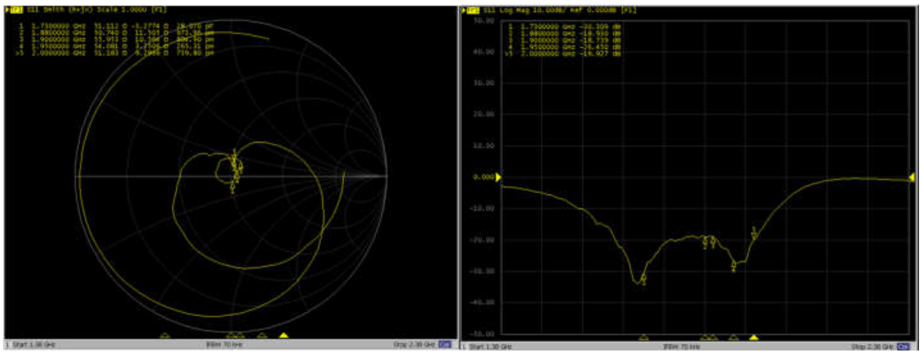
			(ohm)		(ohm)	
2022.3.1	-22.496		53.429		6.9809	
2023.2.28	-26.450	17.58	54.081	-0.652	3.2506	3.7303
2024.2.28	-22.388	-0.48	56.236	-2.807	5.1400	1.8409
CD1880V2 – serial no. 1155						
2000 Head						
Date of Measurement	Return-Loss (dB)	Delta (%)	Real Impedance (ohm)	Delta (ohm)	Imaginary Impedance (ohm)	Delta (ohm)
2022.3.1	-18.375		53.908		11.991	
2023.2.28	-19.927	8.45	51.183	2.725	9.2966	2.6944
2024.2.28	-18.654	1.52	50.503	3.405	11.813	0.178

<Justification of the extended calibration>

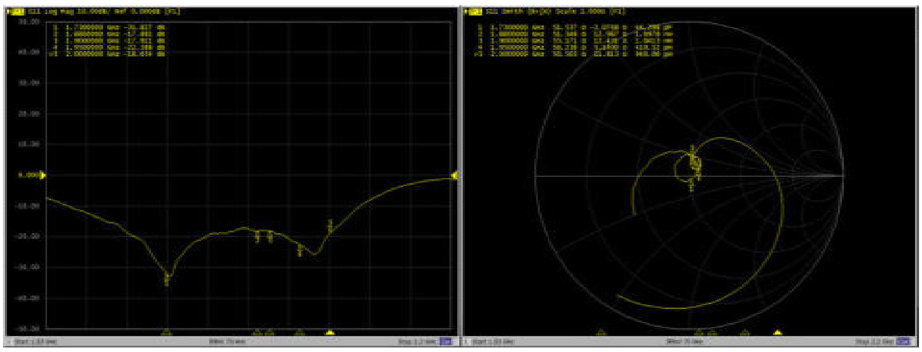
The return loss is < -20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

Dipole Verification Data> CD1880V3, serial no. 1155

1730MHz-1880MHz-1900MHz-1950MHz-2000MHz – Head – 2023.2.28



1730MHz-1880MHz-1900MHz-1950MHz-2000MHz – Head – 2024.2.28



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IMPORTANT NOTICE

USAGE OF THE DAE4

The DAE unit is a delicate, high precision instrument and requires careful treatment by the user. There are no serviceable parts inside the DAE. Special attention shall be given to the following points:

Battery Exchange: The battery cover of the DAE4 unit is closed using a screw, over tightening the screw may cause the threads inside the DAE to wear out.

Shipping of the DAE: Before shipping the DAE to SPEAG for calibration, remove the batteries and pack the DAE in an antistatic bag. This antistatic bag shall then be packed into a larger box or container which protects the DAE from impacts during transportation. The package shall be marked to indicate that a fragile instrument is inside.

E-Stop Failures: Touch detection may be malfunctioning due to broken magnets in the E-stop. Rough handling of the E-stop may lead to damage of these magnets. Touch and collision errors are often caused by dust and dirt accumulated in the E-stop. To prevent E-stop failure, the customer shall always mount the probe to the DAE carefully and keep the DAE unit in a non-dusty environment if not used for measurements.

Repair: Minor repairs are performed at no extra cost during the calibration. However, SPEAG reserves the right to charge for any repair especially if rough unprofessional handling caused the defect.

DASY Configuration Files: Since the exact values of the DAE input resistances, as measured during the calibration procedure of a DAE unit, are not used by the DASY software, a nominal value of 200 MOhm is given in the corresponding configuration file.

Important Note:
Warranty and calibration is void if the DAE unit is disassembled partly or fully by the Customer.

Important Note:
Never attempt to grease or oil the E-stop assembly. Cleaning and readjusting of the E-stop assembly is allowed by certified SPEAG personnel only and is part of the calibration procedure.

Important Note:
To prevent damage of the DAE probe connector pins, use great care when installing the probe to the DAE. Carefully connect the probe with the connector notch oriented in the mating position. Avoid any rotational movement of the probe body versus the DAE while turning the locking nut of the connector. The same care shall be used when disconnecting the probe from the DAE.

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Accreditation No.: SCS 0108

Client **Sporton**
Shenzhen City

Certificate No: DAE4-715_Jan24

CALIBRATION CERTIFICATE

Object: DAE4 - SD 000 D04 BM - SN: 715

Calibration procedure(s): QA CAL-06.v30
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: January 25, 2024

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	29-Aug-23 (No:37421)	Aug-24
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Auto DAE Calibration Unit	SE UWS 053 AA 1001	23-Jan-24 (in house check)	In house check: Jan-25
Calibrator Box V2.1	SE UMS 006 AA 1002	23-Jan-24 (in house check)	In house check: Jan-25

	Name	Function	Signature
Calibrated by:	Dominique Steffen	Laboratory Technician	
Approved by:	Sven Kühn	Technical Manager	i.V.

Issued: January 25, 2024

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

Glossary

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

Methods Applied and Interpretation of Parameters

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

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100…+300 mV

Low Range: 1LSB = 61nV , full range = -1…….+3mV

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

Calibration Factors	X	Y	Z
High Range	405.105 ± 0.02% (k=2)	404.650 ± 0.02% (k=2)	404.469 ± 0.02% (k=2)
Low Range	3.99033 ± 1.50% (k=2)	3.97774 ± 1.50% (k=2)	3.96836 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	203.0 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	200018.39	-6.26	-0.00
Channel X	+ Input	19995.66	-0.19	-0.00
Channel X	- Input	-20013.22	3.32	-0.02
Channel Y	+ Input	200017.85	-7.17	-0.00
Channel Y	+ Input	19995.83	0.00	0.00
Channel Y	- Input	-20016.14	0.14	-0.00
Channel Z	+ Input	200021.69	-3.47	-0.00
Channel Z	+ Input	19993.70	-2.15	-0.01
Channel Z	- Input	-20018.02	-1.56	0.01

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	1990.83	0.10	0.00
Channel X	+ Input	189.88	-0.67	-0.35
Channel X	- Input	-209.77	-0.44	0.21
Channel Y	+ Input	1990.52	-0.31	-0.02
Channel Y	+ Input	189.68	-1.07	-0.56
Channel Y	- Input	-210.58	-1.34	0.64
Channel Z	+ Input	1990.54	-0.22	-0.01
Channel Z	+ Input	190.19	-0.40	-0.21
Channel Z	- Input	-210.34	-1.05	0.50

2. Common mode sensitivity

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

	Common mode Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
Channel X	200	4.65	2.39
	- 200	-1.26	-3.25
Channel Y	200	-5.14	-5.20
	- 200	4.22	3.81
Channel Z	200	6.53	6.30
	- 200	-6.69	-7.47

3. Channel separation

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

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	-1.22	-3.07
Channel Y	200	7.72	-	0.57
Channel Z	200	6.06	5.42	-