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TEST REPORT ON HAC

Model Tested:	**SM-G531M/DS**
FCC ID (Requested):	**A3LSMG531M**
Job No:	**AM-040**
Report No:	**AM-040-M1**
Date issued:	**2015-05-28**
Result Summary:	**M3 – 2011 (RF-Emission)**

- Abstract –
This document reports on HAC Tests carried out in accordance with ANSI C63.19(2011) §6.3, §7.3; FCC Rule Part(s) FCC 47 CFR §20.19

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1. GENERAL INFORMATION

FCC ID :	A3LSMG531M
Model Name :	SM-G531M/DS
Additional Model:	SM-G531M
Serial Number :	AM-040-B
Manufacturer :	SAMSUNG Electronics
Address :	129, Samsung-ro, Suwon-si, Gyeonggi-do, 443-742, Korea
Test Standard :	ANSI C63.19 - 2011
Test Dates :	2015.05.18 ~ 19
Tested for :	Certification

2. DESCRIPTION OF DEVICE

Support Bands :	GSM 850/1900, WCDMA 850/1700/1900 LTE 2/4/5/17, WLAN 2.4GHz, Bluetooth
HAC test Configuration :	GSM 850, Ch.128/190/251, BT off, WLAN off, LTE off GSM1900, Ch.512/661/810, BT off, WLAN off, LTE off
EUT Type :	Portable Handset
Antenna Configuration :	Internal Antenna

Indicating Operating modes for Air Interfaces/Bands

Air- Interface	Band(MHz)	Type Transport	HAC Tested	Simultaneous Transmissions Not to be tested	Voice Over Digital Transport OTT Capability	WIFI Low Power	Additional GSM Power Reduction
GSM	850	VO	Yes	Yes: WIFI or BT	N/A	N/A	No
	190						No
	GPRS/EDGE	DT	No	Yes: WIFI or BT	Yes	N/A	N/A
WCDMA	850	VD	No_2	Yes: WIFI or BT	N/A	N/A	N/A
	1700						N/A
	1900						N/A
	HSPA	DT	No	Yes: WIFI or BT	Yes	N/A	N/A
LTE	700	VD	No_2	Yes: WIFI or BT	Yes	N/A	N/A
	850						N/A
	1700						N/A
	1900						N/A
WiFi	2450	DT	No	Yes: GSM,WCDMA or LTE	Yes	N/A	N/A
BT	2450	DT	No	Yes: GSM,WCDMA or LTE	N/A	N/A	N/A

Type Transport
VO = Voice Only
DT = Digital Data – Not intended for CMRS Service
VD = CMRS and Data Transport

Notes:
1. The 3GPP VoLTE CMRS service is defined by GSMA in PRD IR.92 for IP voice service and Digital Transport
2. Evaluated for MIF and Low-power exemption

3. DESCRIPTION OF TEST EQUIPMENT

3.1 HAC Measurement Setup

Robotic System

Measurements are performed using the DASY4 (or DASY5) automated dosimetric assessment system. Which is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland and consists of high precision robotics system (Stäubli), robot controller, measurement server, Samsung computer, near-field probe, probe alignment sensor, and the HAC phantom. The robot is a six-axis industrial robot performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF) (see Fig. 3.1).

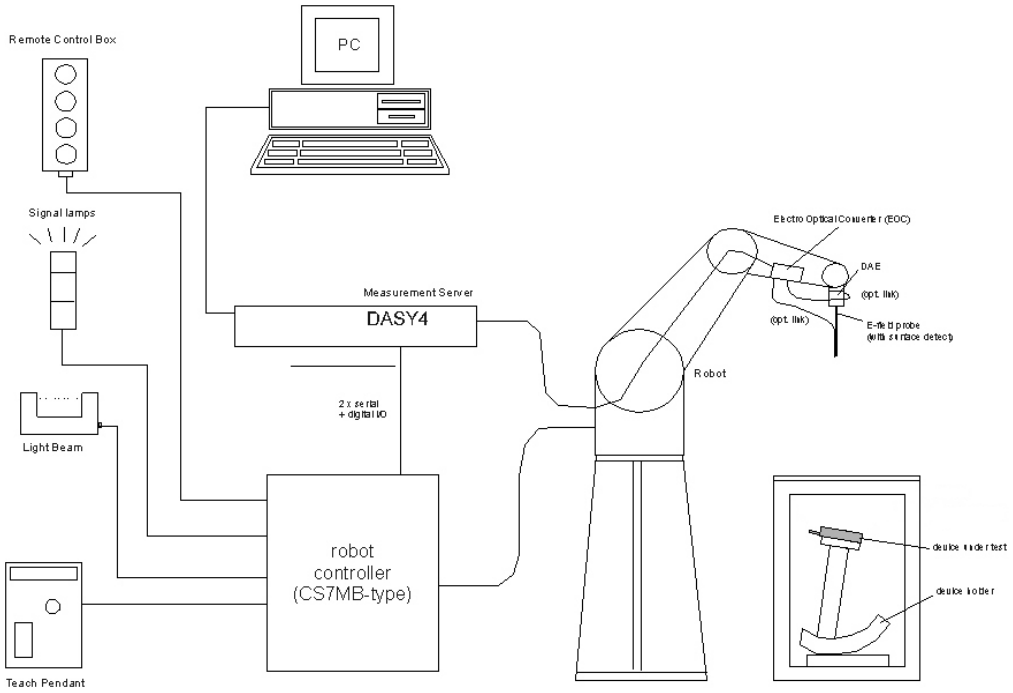


Figure 3.1 SPEAG Robotic System Description

System Hardware

A cell controller system contains the power supply, robot controller, teach pendant (Joystick), and a remote control is used to drive the robot motors. The PC consists of the Samsung computer with Windows operating system and RF Measurement Software DASY4 (or DASY5) with HAC extension, LCD monitor, mouse and keyboard. The Stäubli Robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit that performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the measurement server.

System Electronics

The DAE4(or DAE3) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16-bit AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer.

3.2 Probe Description

ER3DV6 E-Field Probe Description

Construction: One dipole parallel, two dipoles normal to probe axis
Built-in shielding against static charges

Figure 3.2 E-field Probe

Calibration: In air from 100 MHz to 3.0 GHz
(absolute accuracy ±6.0%, k=2)

Frequency: 100 MHz to > 6 GHz;
Linearity: ± 0.2 dB (100 MHz to 3 GHz)

Directivity ± 0.2 dB in air (rotation around probe axis)
± 0.4 dB in air (rotation normal to probe axis)

Dynamic Range 2V/m to 1000V/m
(M3 or better device readings fall well below diode compression point)

Linearity : ±0.2dB

Dimensions Overall length: 330 mm (Tip: 16 mm)
Tip diameter: 8 mm (Body: 12 mm)
Distance from probe tip to dipole centers: 2.5 mm

3.3 Test Arch Phantom

Enables easy and well defined positioning of the phone and calibration dipoles as well as simple teaching of the robot (See Figure 3.4)

Dimensions: 370 x 370 x 370 mm

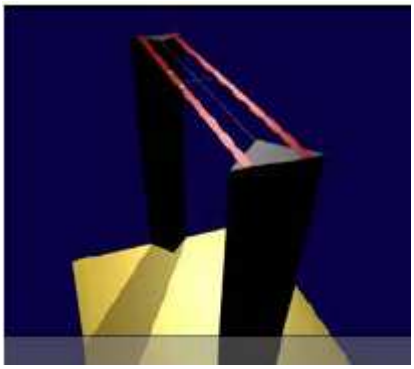


Figure 3.4 Test Arch Phantom

3.4 Validation Dipole

The reference dipole should have a return loss better than –20 dB (measured in the setup) at the resonant frequency to reduce the uncertainty in the power measurement.

Application	- Free space antenna - Hearing Aid susceptibility measurements according to ANSI C 63.19 - Validation of Hearing Aid RF setup for wireless device emission measurement according to ANSI C63.19
Frequency	835, 1880 MHz
Return Loss	< -20 dB at specified validation position
Dimensions	835MHz : 166.0 x 330 mm 1880MHz : 80.8 x 330 mm

3.5 Equipment Calibration

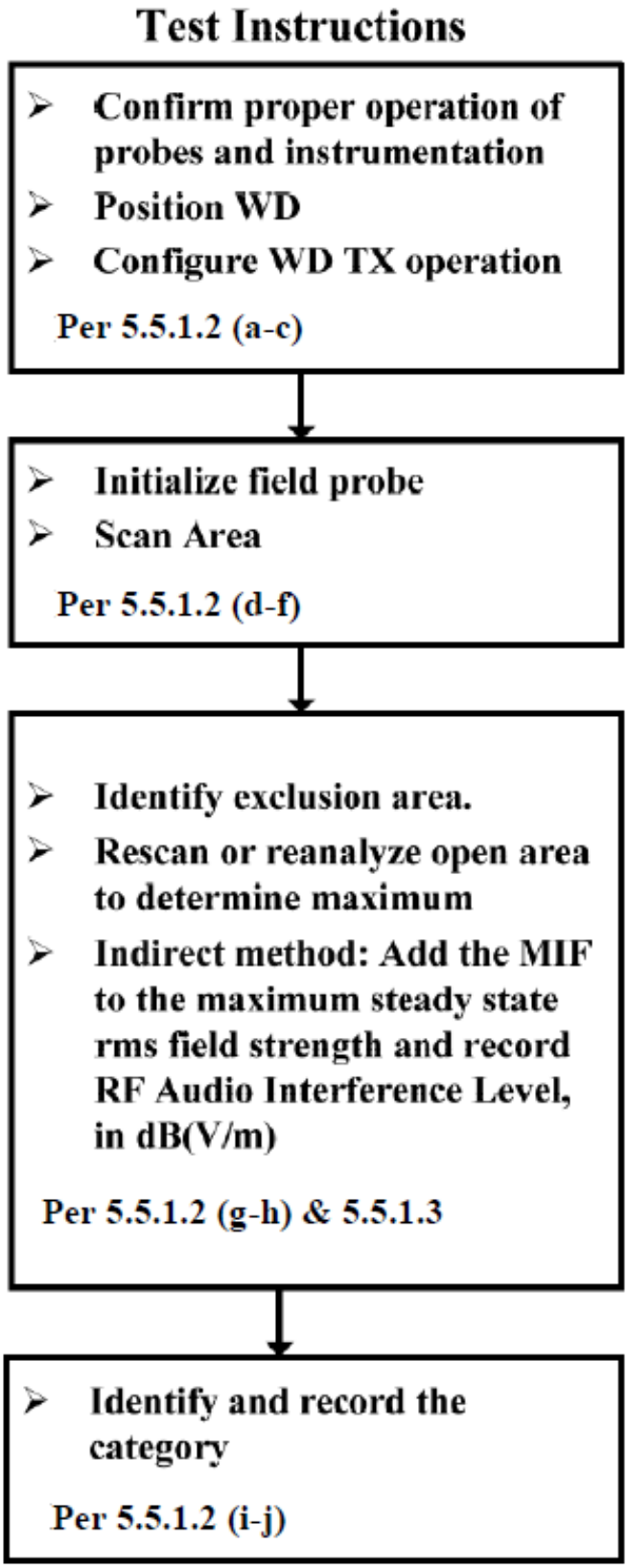
Table 3.2 Test Equipment Calibration

Model	Cal. Due Date	Serial No.
SPEAG DAE4	2016.01.21	1241
E-Field Probe ER3DV6	2016.04.29	2384
Validation Dipole CD835 V3	2017.02.17	1105
Validation Dipole CD1880 V3	2017.01.20	1016
Stäubli Robot TX90XL	-	F10/5FN5A1/A/01
HAC Phantom	-	1078
E4438C Signal Generator	2016.02.03	MY45094010
BBS3Q7ECK Power Amp	2016.02.04	1024
N1912A P-Series Power Meter	2016.02.02	MY45100306
N1912A Wideband Power Sensor	2016.02.02	MY45240464
N1912A Wideband Power Sensor	2016.02.02	MY45240463
N1912A P-Series Power Meter	2016.02.02	MY52370011
E-Series Power meter	2016.02.02	MY52360008
DASY52 S/W (ver 52.8.8)	-	-
778D Directional Coupler	2016.02.02	20412
E5515C Base Station Simulator	2015.11.06	MY50261069
CMW500 Base Station Simulator	2015.08.25	141228
Audio Interference Analyzer (AIA)	-	1035

NOTE:

The E-field probe was calibrated by SPEAG.

4. HAC MEASUREMENT PROCEDURE



The evaluation was performed using the following procedure.

1. Confirm proper operation of the field probe, probe measurement system, and other instrumentation.

2. WD is positioned in its intended test position, acoustic output point of the device perpendicular to the field probe.

3. The WD operation for maximum rated RF output power was configured and confirmed with the base station simulator, at the test channel and other normal operating parameters as intended for the test. The battery was ensured to be fully charged before each test.

4. The center sub-grid was centered over the center of the acoustic output (also audio band magnetic output, if applicable). The WD audio output was positioned tangent (as physically possible) to the measurement plane.

5. A surface calibration was performed before each setup change to ensure repeatable spacing and proper maintenance of the measurement plane using the HAC Phantom.

6. The measurement system measured the field strength at the reference location.

7. Measurements at 2mm increments in the 5 x 5 cm region were performed and recorded. A 360° rotation about the azimuth axis at the maximum interpolated position was measured. For the worst-case condition,
the peak reading from this rotation was used in re-evaluating the HAC category.

8. The system performed a drift evaluation by measuring the field at the reference location.

9. Steps 1-8 were done for the E-Field measurements.

10. The HAC measurement software calculates a reference point at the start and end of the test to check for power drifts. If conducted power deviations of more than 5% occurred, the tests were repeated.

5. DESCRIPTION OF TEST POSITION

5.1 Measurement reference and plane

1. The grid is 5 cm by 5 cm area that is divided into 9 evenly sized blocks or sub-grids.

2. The grid is centered on the audio frequency output transducer of the WD (speaker or T- coil).

3. The grid is in a reference plane, which is defined as the planar area that contains the highest point in the area of the phone that normally rests against the user's ear. It is parallel to the centerline of the receiver area of the phone and is defined by the points of the receiver-end of the WD handset, which, in normal handset use, rest against the ear.

4. The measurement plane is parallel to, and 1.5 cm in front of, the reference plane.

Figure 5.1 Wireless Device and Measurement Plane

6. Measurement Uncertainty

Source of Uncertainty		Value	probability distribution	Divisor	c_i E	u_i (y) E	$(u_i (y))^2$ E	V_i or V_{eff} E	$u_i(y)^4/V_{eff}$ E
Measurement System			normal	2.000	1	**5.05**	**25.50**	∞	**0**
Probe Calibration		**10.10**	normal	2.000	1	**0.25**	**0.06**	∞	**0**
Axial Isotropy		**0.50**	normal	2.000	1	**0.30**	**0.09**	∞	**0**
Linearity		**0.60**	rectangular	1.732	1	**9.53**	**90.75**	∞	**0**
Sensor Displacement		**16.50**	rectangular	1.732	1	**1.39**	**1.92**	∞	**0**
Boundary Effects		**2.40**	rectangular	1.732	1	**4.16**	**17.28**	∞	**0**
Phantom Boundary Effects		**7.20**	rectangular	1.732	1	**5.77**	**33.33**	∞	**0**
Scaling with PMR calibration		**10.00**	rectangular	1.732	1	**0.14**	**0.02**	∞	**0**
System Detection Limit		**0.25**	rectangular	1.732	1	**0.17**	**0.03**	∞	**0**
Readout Electronics		**0.30**	rectangular	1.732	1	**1.50**	**2.25**	∞	**0**
Integration time		**2.60**	normal	1.000	1	**0.21**	**0.04**	**4**	**0.000490149**
System repeatability		**0.21**	normal	1.000	1	**2.48**	**6.17**	**2**	**19.04220248**
RF Reflections		**2.48**	rectangular	1.732	1	**0.69**	**0.48**	∞	**0**
Probe Positioner		**1.20**	rectangular	1.732	1	**2.71**	**7.36**	∞	**0**
Probe Positioning		**4.70**	normal	1.000	1	**3.53**	**12.46**	**4**	**38.8185072**
Variability between 2mm & 5mm		**3.53**	rectangular	1.732	1	**0.58**	**0.33**	∞	**0**
Extrap. And Interpolation		**1.00**							
Test Sample Related			rectangular	1.732	1	**2.71**	**7.36**	∞	**0**
Device Positioning Vertical		**4.70**	rectangular	1.732	1	**0.58**	**0.33**	∞	**0**
Device Positioning Lateral		**1.00**	normal	1.000	1	**0.61**	**0.37**	**8**	**0.016816497**
Device Holder and Phantom		**0.61**	rectangular	1.732	1	**2.89**	**8.33**	∞	**0**
Power Drift		**5.00**							
Phantom and Setup Related			rectangular	1.732	1	**1.39**	**1.92**	∞	**0**
Phantom Thickness		**2.40**	normal	2.000	1	**5.05**	**25.50**	∞	**0**
$u_c(F_S)$	**Combined Standard Uncertainty**		**normal**			**14.71**	**216.41**	**809**	**57.87801633**
$U(F_S)$	**Expanded Uncertainty(on Power)**		**normal k=**	**2.00**		**29.42**			
$U(F_S)$	**Expanded Uncertainty(on Field)**		**normal k=**	**2.00**		**14.71**			

7. SYSTEM VERIFICATION

7.1 Test System Validation

Prior to assessment, the system is verified to the ±10% of the specification at 835MHz and 1880MHz by using the system validation kit(s). (see Appendix C, Graphic Plot Attached)

Table 7.2 System Validation Results

Frequency	Targeted E-field (V/m)	Measured E-field (V/m)	Deviation (%)	Date
835 MHz	106.8	108.2	1.32	2015.05.18
1880 MHz	90.4	92.5	2.29	2015.05.18

*Validation was measured with input power 100 mW.

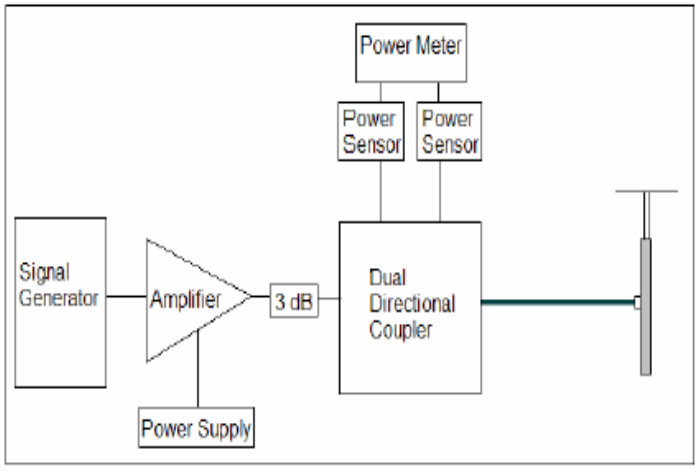


Figure 7.1 Dipole Validation Test Setup

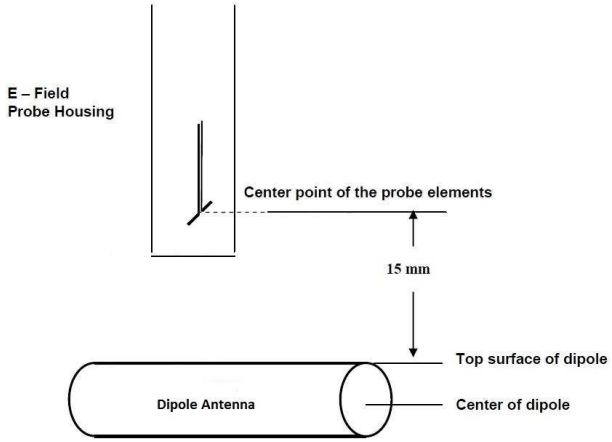


Figure 7.2 Separation Distance from Dipole to Field Probe

Validations of the DASY4(or DASY5) test system were performed using the measurement equipment listed in Section 3.2. All validations occur in free space using the DASY4(or DASY5) test arch. Note that the 15mm probe to dipole separation is measured from the top edge of the dipole to the calibration reference point of the probe. SPEAG uses the center point of the probe sensor(s) as the reference point when establishing targets for their dipoles. Therefore, because SPEAG's dipoles and targets are used, it is appropriate to measure the 15mm separation distance to the center of the sensors as they do. This reference point was used for validation only. Validations were performed at 1880 MHz. These frequencies are within each operating band and are within 2MHz of the mid-band frequency of the test device. The obtained results from the validations are displayed in the table 7.2.

8. MODULATION INTERFERENCE FACTOR

For any specific fixed and repeatable modulated signal, a modulation interference factor (MIF, expressed in dB) may be determined 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 and conducted power measurements. 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.

8.1 Calibrated Modulation Interference Factors

Manufacturer (SPEAG) provides the probe calibration services about MIF for various modulations.
Test lab can use MIF value from manufacturer.

8.2 Measured Modulation Interference Factors

The following procedure was used to measure the MIF suing the SPEAG Audio Interference Analyzer.

1. The device was placed into a simulated call using a base station simulator or set to transmit using test software for a given mode.
2. The device was then set to continuously transmit at maximum power.
3. Using a coupler or divider if needed, the device output signal was connected to the RF In port of the AIA (Audio Interference Analyzer), which was connected to a desktop computer. Alternatively, a radiated RF signal may be used with the AIA's built-in antenna.
4. The MIF measurement procedure in the DASY software was run, and the resulting MIF value was recorded.
5. Steps 1-4 were repeated for all CMRS air interfaces, frequency bands, and modulations.

8.3 MIF Measurement Block Diagrams

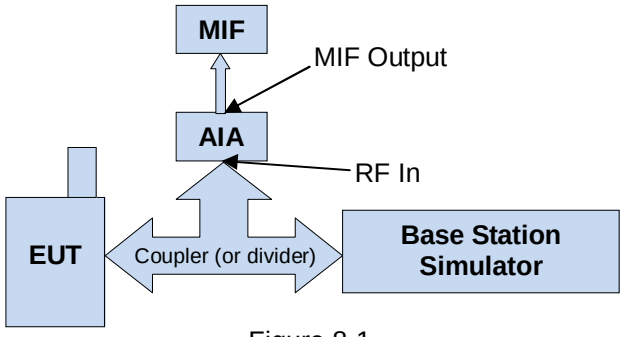


Figure 8-1
MIF Measurement Setup using a Base Station Simulator

8.4 Measured Modulation Interference Factors

Band	Channel	MIF[dB]
GSM850	128	3.48
	190	3.48
	251	3.48
GSM1900	512	3.41
	661	3.41
	810	3.42

Table 8-2 MIF Table for GSM

Mode	WCDMA850 [dB]			WCDMA1700 [dB]			WCDMA1900 [dB]		
	4132	4183	4233	1312	1412	1862	9262	9400	9538
12.2 Kbps RMC	-22.28	-22.78	-22.47	-22.86	-22.92	-22.76	-22.65	-22.81	-22.67
12.2 Kbps AMR	-24.35	-24.99	-24.47	-25.92	-25.74	-25.08	-24.93	-25.29	-25.70

Table 8-3 MIF Table for WCDMA

Note: Measured MIF values may be lower than sample MIF values provided in ANSI C63.19-2011 Annex D.7 Table D.5 due to manufacturing variations for each device, however per Annex D.7, the sample MIF values of Table D.5 are not intended to substitute for measurements of actual devices under test and their respective operating modes.

LTE Band	Frequency	Channel	Bandwidth	Modulation	RB size	RB offset	MIF
2	1880	18900	20	16QAM	1	0	-10.57
4	1732.5	20175	20	16QAM	1	0	-10.36
5	836.5	20525	10	16QAM	1	0	-10.05
17	710	23790	10	16QAM	1	0	-10.11
5	836.5	20525	10	QPSK	1	0	-14.67
5	836.5	20525	10	16QAM	1	25	-10.29
5	836.5	20525	10	16QAM	1	49	-10.20
5	836.5	20525	10	16QAM	25	0	-20.65
5	836.5	20525	10	16QAM	50	0	-21.52
5	836.5	20525	5	16QAM	1	0	-10.58
5	836.5	20525	3	16QAM	1	0	-21.30
5	836.5	20525	1.4	16QAM	1	0	-17.19

Table 8-4 MIF Table for LTE

Note

1. Measured MIF values may be lower than sample MIF values provided in ANSI C63.19-2011 Annex D.7 Table D.5 due to manufacturing variations for each device, however per Annex D.7, the sample MIF values of Table D.5 are not intended to substitute for measurements of actual devices under test and their respective operating modes.
2. All LTE bands were found to have substantially similar MIF values given similar RB and BW configurations.

9. RF Conducted Power Measurement

9.1 Handset Capabilities

The Handset was placed into a simulated call using base station simulator in a shielded chamber. Such as test signals offer a consistent means for testing HAC and are recommended for evaluating HAC. Measurements were taken with a fully charged battery. In order to verify that the device was tested and maintained at full power, this was configured with the base station simulator.

9.2 HAC measurement conditions

Conducted power of all air interfaces were measured with base station simulator and EUT power was set to maximum output power level.

Air Interfaces	Parameter Name	Setting Parameter
GSM	PLC	GSM850: '5', GSM1900: '0'
WCDMA	TPC	All up bits
LTE	TPC	Max Power

Table 9-1 Power Control Parameters and setting by Air Interface

9.3 RF conducted Power measurement Block Diagram

Power Measurement were performed using a base station simulator under digital average power.

Figure 9-1 Power Measurement Setup

9.4 GSM and WCDMA Conducted Powers

Mode	Configuration	Maximum Output Power [dBm]		
		Low Channel	Middle Channel	High Channel
GSM 850	CS (1 slot)	31.50	31.60	31.55
GSM 1900	CS (1 slot)	29.16	29.27	29.40
WCDMA 850	12.2 kbps RMC	22.27	22.18	22.21
	12.2 kbps AMR	22.29	22.21	22.24
WCDMA 1700	12.2 kbps RMC	21.68	21.63	21.55
	12.2 kbps AMR	21.64	21.60	21.58
WCDMA 1900	12.2 kbps RMC	22.43	22.34	22.52
	12.2 kbps AMR	22.41	22.26	22.54

9.5 LTE Conducted Powers

LTE Band 2	Frequency	Channel	Bandwidth	Modulation	RB size	RB offset	Conducted Power[dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Low	1860	18700	20	QPSK	1	0	22.67	0	0
	1860	18700	20	QPSK	1	50	22.20	0	0
	1860	18700	20	QPSK	1	99	22.23	0	0
	1860	18700	20	QPSK	50	0	21.38	0-1	1
	1860	18700	20	QPSK	50	25	21.41	0-1	1
	1860	18700	20	QPSK	50	50	21.40	0-1	1
	1860	18700	20	QPSK	100	0	21.38	0-1	1
	1860	18700	20	16QAM	1	0	21.72	0-1	1
	1860	18700	20	16QAM	1	50	21.78	0-1	1
	1860	18700	20	16QAM	1	99	21.86	0-1	1
	1860	18700	20	16QAM	50	0	20.56	0-2	2
	1860	18700	20	16QAM	50	25	20.60	0-2	2
	1860	18700	20	16QAM	50	50	20.57	0-2	2
	1860	18700	20	16QAM	100	0	20.54	0-2	2
Middle	1880	18900	20	QPSK	1	0	22.56	0	0
	1880	18900	20	QPSK	1	50	22.67	0	0
	1880	18900	20	QPSK	1	99	22.70	0	0
	1880	18900	20	QPSK	50	0	21.74	0-1	1
	1880	18900	20	QPSK	50	25	21.65	0-1	1
	1880	18900	20	QPSK	50	50	21.67	0-1	1
	1880	18900	20	QPSK	100	0	21.63	0-1	1
	1880	18900	20	16QAM	1	0	22.11	0-1	1
	1880	18900	20	16QAM	1	50	22.20	0-1	1
	1880	18900	20	16QAM	1	99	22.17	0-1	1
	1880	18900	20	16QAM	50	0	20.72	0-2	2
	1880	18900	20	16QAM	50	25	20.84	0-2	2
	1880	18900	20	16QAM	50	50	20.88	0-2	2
	1880	18900	20	16QAM	100	0	20.82	0-2	2
High	1900	19100	20	QPSK	1	0	22.70	0	0
	1900	19100	20	QPSK	1	50	22.60	0	0
	1900	19100	20	QPSK	1	99	22.62	0	0
	1900	19100	20	QPSK	50	0	21.61	0-1	1
	1900	19100	20	QPSK	50	25	21.59	0-1	1
	1900	19100	20	QPSK	50	50	21.59	0-1	1
	1900	19100	20	QPSK	100	0	21.60	0-1	1
	1900	19100	20	16QAM	1	0	22.20	0-1	1
	1900	19100	20	16QAM	1	50	22.19	0-1	1
	1900	19100	20	16QAM	1	99	22.20	0-1	1
	1900	19100	20	16QAM	50	0	20.80	0-2	2
	1900	19100	20	16QAM	50	25	20.72	0-2	2
	1900	19100	20	16QAM	50	50	20.79	0-2	2
	1900	19100	20	16QAM	100	0	20.76	0-2	2

Table 9-2 Conducted Power Table for LTE Band 2

LTE Band 4	Frequency	Channel	Bandwidth	Modulation	RB size	RB offset	Conducted Power[dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Middle	1732.5	20175	20	QPSK	1	0	22.32	0	0
	1732.5	20175	20	QPSK	1	50	22.21	0	0
	1732.5	20175	20	QPSK	1	99	22.36	0	0
	1732.5	20175	20	QPSK	50	0	21.34	0-1	1
	1732.5	20175	20	QPSK	50	25	21.31	0-1	1
	1732.5	20175	20	QPSK	50	50	21.39	0-1	1
	1732.5	20175	20	QPSK	100	0	21.35	0-1	1
	1732.5	20175	20	16QAM	1	0	22.17	0-1	1
	1732.5	20175	20	16QAM	1	50	22.18	0-1	1
	1732.5	20175	20	16QAM	1	99	22.20	0-1	1
	1732.5	20175	20	16QAM	50	0	20.50	0-2	2
	1732.5	20175	20	16QAM	50	25	20.55	0-2	2
	1732.5	20175	20	16QAM	50	50	20.62	0-2	2
	1732.5	20175	20	16QAM	100	0	20.56	0-2	2

Table 9-3 Conducted Power Table for LTE Band 4

LTE Band 5	Frequency	Channel	Bandwidth	Modulation	RB size	RB offset	Conducted Power[dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Middle	836.5	20525	10	QPSK	1	0	22.75	0	0
	836.5	20525	10	QPSK	1	25	22.58	0	0
	836.5	20525	10	QPSK	1	49	22.63	0	0
	836.5	20525	10	QPSK	25	0	21.43	0-1	1
	836.5	20525	10	QPSK	25	12	21.41	0-1	1
	836.5	20525	10	QPSK	25	25	21.38	0-1	1
	836.5	20525	10	QPSK	50	0	21.41	0-1	1
	836.5	20525	10	16QAM	1	0	22.00	0-1	1
	836.5	20525	10	16QAM	1	25	21.91	0-1	1
	836.5	20525	10	16QAM	1	49	21.98	0-1	1
	836.5	20525	10	16QAM	25	0	20.86	0-2	2
	836.5	20525	10	16QAM	25	12	20.85	0-2	2
	836.5	20525	10	16QAM	25	25	20.86	0-2	2
	836.5	20525	10	16QAM	50	0	20.87	0-2	2

Table 9-4 Conducted Power Table for LTE Band 5

LTE Band17	Frequency	Channel	Bandwidth	Modulation	RB size	RB offset	Conducted Power[dBm]	MPR Allowed per 3GPP [dB]	MPR [dB]
Middle	710	23790	10	QPSK	1	0	22.10	0	0
	710	23790	10	QPSK	1	25	22.05	0	0
	710	23790	10	QPSK	1	49	22.23	0	0
	710	23790	10	QPSK	25	0	21.24	0-1	1
	710	23790	10	QPSK	25	12	20.90	0-1	1
	710	23790	10	QPSK	25	25	20.91	0-1	1
	710	23790	10	QPSK	50	0	20.90	0-1	1
	710	23790	10	16QAM	1	0	21.80	0-1	1
	710	23790	10	16QAM	1	25	21.81	0-1	1
	710	23790	10	16QAM	1	49	21.87	0-1	1
	710	23790	10	16QAM	25	0	20.17	0-2	2
	710	23790	10	16QAM	25	12	20.14	0-2	2
	710	23790	10	16QAM	25	25	20.25	0-2	2
	710	23790	10	16QAM	50	0	20.19	0-2	2

Table 9-5 Conducted Power Table for LTE Band 17

10. Justification of Held to Ear Modes Tested

An RF air interface technology of a device is exempt from testing when its average conducted power plus its MIF is ≤17dBm for all of its operating modes.

See below for measured conducted power for applicable device modes..

10.1 Analysis of RF Air Interface Technologies

1. According to the April 2013 TCB workshop slides, WIFI and other OTT data services are outside the current definition of a managed CMRS service and are currently not required to be evaluated.
2. An analysis was performed, following the guidance of §4.3 and §4.4 of the ANSI standard, of the RF air interface technologies being evaluated. The factors that will affect the RF interference potential were evaluated, and the worst case operating modes were identified and used in the evaluation. A WD's interference potential is a function both WD's average near-field field air interface technologies that have low power have been found to produce sufficiently low RF interference potential, so it is possible to exempt them from the product testing specified in Clause 5 of the ANSI standard. An RF air interface technology of a device is exempt from testing when its average antenna input power plus its MIF is ≤17dBm for all of its operating modes.

   The worst case MIF plus the worst case average antenna input power for all modes are investigated below to determine the testing requirements for this device.

10.2 Evaluate Low Power Exemption

Air Interfaces	Maximum Average Power (dBm)	MIF (dB)	Total (Power + MIF)	Testing Required
GSM850	22.57*	3.48	26.05	Y
GSM1900	20.37*	3.41	23.78	Y
WCDMA - RMC	22.52	-22.28	0.24	N
WCDMA - AMR	22.54	-24.35	-1.81	N
LTE - FDD	22.75	-10.05	12.7	N

Table 10-1 Evaluation for Low Power Exemptions

*Note: C63.19 Footnote 20 (Page.13) indicates the use of a long averaging time for measuring the antenna input power when using this method of exclusion. Therefore, the frame averaged power was calculated for these modes in this investigation.

10.3 Conclusion

Per ANSI C63.19-2011, RF-Emissions testing for this device is required only for GSM voice modes. All other air interfaces are exempt.

11. Test Results

11.1 Measurement Results (E-field)

E-FIELD EMISSIONS:

Ambient Conditions

Date	2015.05.18
Temperature in Lab(°C)	22.0
Humidity in Lab(%)	51

Mode	Channel	Scan Center	Conducted Power [dBm]	Time Avg.Field [V/m]	Time Avg.Field [dBV/m]	Modulation Interference Factor	Audio Interference Lavel [dBV/m]	Category	FCC limit [dBV/m]	FCC Margin[dB]	Excl Blocks per 5.5
E-field Emissions											
GSM850	128	Acoustic	31.50	**21.80**	26.77	3.48	**30.25**	**M4**	45.0	14.75	None
GSM850	190	Acoustic	31.60	**39.90**	32.02	3.48	**35.50**	**M4**	45.0	9.50	None
GSM850	251	Acoustic	31.55	**49.72**	33.93	3.48	**37.41**	**M4**	45.0	7.59	None
GSM1900	512	Acoustic	29.16	**23.80**	27.53	3.41	**30.94**	**M3**	35.0	4.06	None
GSM1900	661	Acoustic	29.27	**21.98**	26.84	3.41	**30.25**	**M3**	35.0	4.75	None
GSM1900	810	Acoustic	29.40	**21.48**	26.64	3.42	**30.06**	**M3**	35.0	4.94	None

11.2 Worst-case Configuration Evaluation

Ambient Conditions

Date	2015.05.18
Temperature in Lab(°C)	22.0
Humidity in Lab(%)	51

Peak Reading 360 degree Probe Rotation at Azimuth axis

Mode	Channel	Scan Center	Conducted Power [dBm]	Time Avg.Field [V/m]	Time Avg.Field [dBV/m]	Modulation Interference Factor	Audio Interference Lavel [dBV/m]	Category	FCC limit [dBV/m]	FCC Margin[dB]	Excl Blocks per 5.5
E-field Emissions											
GSM1900	512	Acoustic	29.16	**24.84**	27.90	3.41	**31.31**	**M3**	35.0	3.69	None

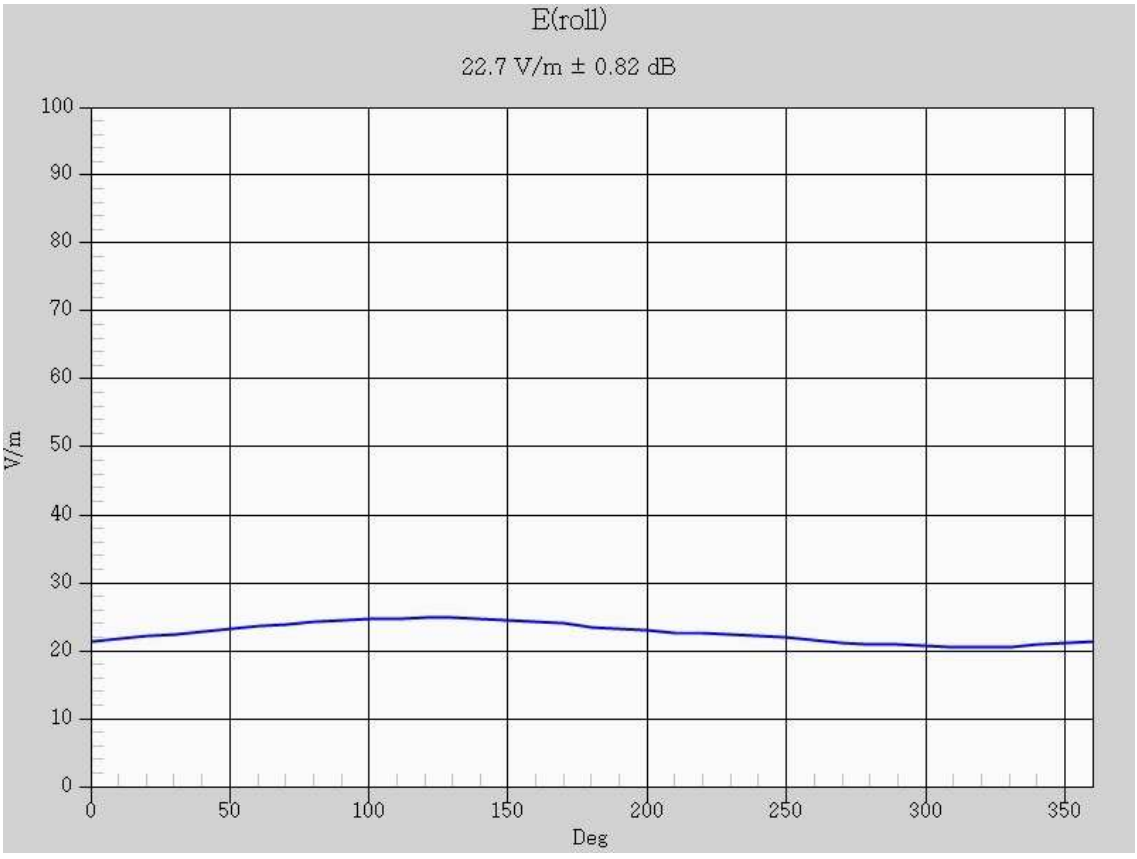


Figure 11-1 Worst-Case Probe Rotation about Azimuth axis

Note: Location of probe rotation is shown in APPENDIX E

13. REFERENCES

[1] ANSI C63.19-2011, American National Standard for Methods of Measurement of Compatibility between Wireless communication devices and Hearing Aids.", New York,NY, IEEE, June. 2011.

[2] FCC Office of Engineering and Technology KDB, “285076 D01 HAC Guidance v04”, October 31, 2013

[3] FCC Office of Engineering and Technology KDB, “285076 D02 T-coil Testing for CMRS IP v01r01”, October 31, 2013

[4] FCC Public Notice DA 06-1215, Wireless Telecommunications Bureau and Office of Engineering and Technology Clarify Use of Revised Wireless Phone Hearing Aid Compatibility Standard, June 6,2006

[5] Berger, H. S., "Compatibility Between Hearing Aids and Wireless Devices," Electronic Industries Forum, Boston, MA, May, 1997

[6] Berger, H. S., "Hearing Aid and Cellular Phone Compatibility: Working Toward Solutions," Wireless Telephones and Hearing Aids: New Challenges for Audiology, Gallaudet University, Washington, D.C., May, 1997 (To be reprinted in the American Journal of Audiology).

[7] Berger, H. S., "Hearing Aid Compatibility with Wireless Communications Devices," IEEE International Symposium on Electromagnetic Compatibility, Austin, TX, August, 1997.

[8] Bronaugh, E. L, "Simplifying EMI Immunity (Susceptibility) Tests in TEM Cells," in the 1990 IEEE International Symposium on Electromagnetic Compatibility Symposium Record, Washington, D.C., August 1990, pp. 488-491

[9] Byrne, D. and Dillon, H., The National Acoustics Laboratory (NAL) New Procedure for Selecting the Gain and Frequency Response of a Hearing Aid, Ear and Hearing 7:257-265, 1986.

[10] Crawford, M. L, "Measurement of Electromagnetic Radiation from Electronic Equipment using TEM Transmission Cells," U.S. Department of Commerce, National Bureau of Standards, NBSIR 73-306, Feb. 1973.

[11] Crawford, M. L, and Workman, J. L, "Using a TEM Cell for EMC Measurements of Electronic Equipment," U.S. Department of Commerce, National Bureau of Standards. Technical Note 1013, July 1981.

[12] EHIMA GSM Project, Development phase, Project Report (1st part) Revision A. Technical-Audiological Laboratory and Telecom Denmark, October 1993.

[13] EHIMA GSM Project, Development phase, Part II Project Report. Technical-Audiological Laboratory and Telecom Denmark, June 1994.

[14] EHIMA GSM Project Final Report, Hearing Aids and GSM Mobile Telephones: Interference Problems, Methods of Measurement and Levels of Immunity. Technical-Audiological Laboratory and Telecom Denmark, 1995.

[15] HAMPIS Report, Comparison of Mobile phone electromagnetic near field with an upscaled electromagnetic far field, using hearing aid as reference, 21 October 1999.

[16] Hearing Aids/GSM, Report from OTWIDAM, Technical-Audiological Laboratory and Telecom Denmark, April 1993.

[17] EEE 100, The Authoritative Dictionary of IEEE Standards Terms, Seventh Edition.

[18] Joyner, K. H, et. al., Interference to Hearing Aids by the New Digital Mobile Telephone System, Global System for Mobile (GSM) Communication Standard, National Acoustic Laboratory, Australian Hearing Series, Sydney 1993.

[19] Joyner, K. H., et. al., Interference to Hearing Aids by the Digital Mobile Telephone System, Global System for Mobile Communications (GSM), NAL Report #131, National Acoustic Laboratory Australian Hearing Series, Sydney, 1995.

[20] Keeker, W. T., Crawford, M. L., and Wilson, W. A., "Contruction of a Transverse Electromagnetic Cell", U.S. Department of Commerce, National Bureau of Standards, Technical Note 1011, Nov. 1978.

[21] Konigstein, D., and Hansen, D., "A New Family of TEM Cells with enlarged bandwidth and Optimized working Volume," in the Proceedings of the 7th International Symposium on EMC, Zurich, Switzerland, March 1987; 50:9, pp. 127-132.

[22] Kuk, F., and Hjorstgaard, N. K., "Factors affecting interference from digital cellular telephones, " Hearing Journal, 1997; 50:9, pp 32-34.

[23] Ma, M. A., and Kanda, M., "Electromagnetic Compatibility and Interference Metrology," U.S. Department of Commerce, National Bureau of Standards, Technical Note 1099, July 1986, pp.17-43.

[24] Ma, M. A., Sreenivashiah, I. , and Chang, D. C, "A Method of Determining the Emission and Susceptibility Levels of Electrically Small Objects Using a TEM Cell," U.S. Department of Commerce, National Bureau of Standards, Technial Note 1040, July 1981.

[25] McCandless, G. A., and Lyregaard, P. E., Prescription of Gain/Output (POGO) for Hearing Aids, Hearing Instruments 1:16-21, 1983

[26] Skopec, M., "Hearing Aid Electromagnetic Interference from Digital Wireless Telephones, "IEEE Transactions on Rehabilitation Engineering, vol. 6, no. 2, pp. 235-239, June 1998.

[27] Technical Report, GSM 05.90, GSM EMC Considerations, European Telecommunications Standards Institute, January 1993.

[28] Victorian, T. A., "Digital Cellular Telephone Interference and Hearing Aid Compatibility—an Update," Hearing Journal 1998; 51:10, pp. 53-60

[29] Wong, G. S. K., and Embleton, T. F. W., eds., AIP Handbook of Condenser Microphones: Theory, Calibration and Measurements, AIP Press.

[30] CTIA Test Plan for HAC Rev 3.0,November 2013

APPENDIX A

Probe Modulation Factor

Measurement procedure

1. Modulated signal measurement: Connect the modulated signal with the correct frequency via the cable to the dipole.
2. Run the multimeter in the procedure with the corresponding modulation setting in continuous mode.
3. Adjust the signal amplitude to acheive the same field level display in the multimeter as during the WD field scan. Read the multimeter display and note it together with the probe ID, modulation type and frequency.
4. Read the peak envelope on the monitor in order to adjust the CW signal later to the same level.
5. Switch the signal source off and verify that the ambient and instrumentation noise level is at least 10dB lower.
6. CW measurement: Change the signal to CW at the same center frequency, without touching or moving the dipole or probe in the setup.
7. Adjust the CW signal amplitude to the same peak level on the monitor.
8. Run the multimeter in the CW procedure in continuous mode.
9. Read the multimeter display and note it together with the probe ID, modulation type and frequency.
10. Calculate the Probe Modulation Factor as the ratio between the CW multimeter field reading and the reading for the applicable modulation.
11. Perform the above setup and procedure for E-field and H-field probes.

Spectrum Analyzer setting.

1. Frequency Setting

ex) 835 MHz, 1880MHz, 2450 MHz

2. RBW/VBW/SPAN/Detector Setting.

	CW	GSM	CDMA	WCDMA	AM 80%
RBW	Same with modulated signal	1 MHz	3 MHz	5 MHz	1 MHz
VBW	Same with modulated signal	1 MHz	3 MHz	5 MHz	1 MHz
SPAN	0MHz	0 MHz	0 MHz	0 MHz	0 MHz
DETECTOR	Same with modulated signal	Peak	Average	Average	Peak

3. Trigger: Video or IF trigger, adjusted to give a stable display of the transmission
4. Sweep rate: Sufficiently rapid to permit the transmit pulse to be resolved accurately.

APPENDIX B

ANSI C63.19 (2011)- Telephone near-field categories.

Category	Telephone RF Parameters <960MHz	
Near Field	**E-Field Emissions**	
Category M1	50 to 55	**dB (V/m)**
Category M2	45 to 50	**dB (V/m)**
Category M3	40 to 45	**dB (V/m)**
Category M4	<40	**dB (V/m)**
Category	**Telephone RF Parameters >960MHz**	
Near Field	**E-Field Emissions**	
Category M1	40 to 45	**dB (V/m)**
Category M2	35 to 40	**dB (V/m)**
Category M3	30 to 35	**dB (V/m)**
Category M4	<30	**dB (V/m)**

Table B.1 Telephone near-field categories in dB units.

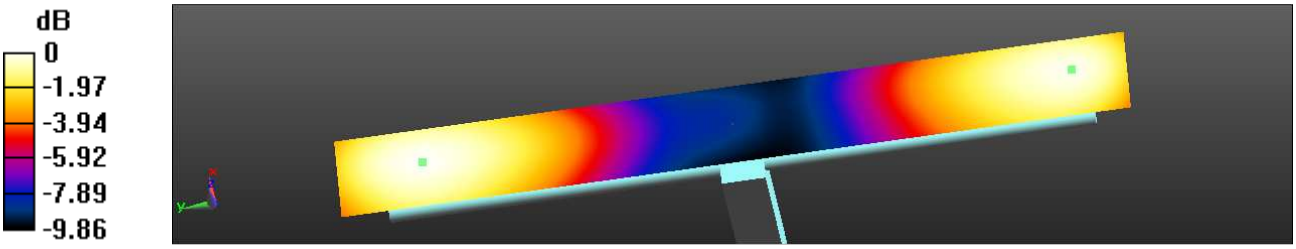
APPENDIX C

The Validation Measurements

DUT: CD835V3; Type: CD835V3; Serial: 1105
Communication System: UID 0, CW (0); Communication System Band: CW; Frequency: 835 MHz; MIF: 0 dB
Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY Configuration:

- Probe: ER3DV6 - SN2384; ConvF(1, 1, 1); Calibrated: 2015-04-29;
- Sensor-Surface: 0mm (Fix Surface), z = 9.7
- Electronics: DAE4 Sn1241; Calibrated: 2015-01-21
- Phantom: HAC Test Arch_2013_07_30; Type: SD HAC P01 BA; Serial: 1078
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

835MHz E-Field Validation @ 100mW (2015.05.18)/E Scan15mm above Dipole/Hearing Aid Compatibility Test (41x181x1)/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 = 119.1 V/m; Power Drift = 0.05 dB
Applied MIF = 0.00 dB
Average value of Peak (interpolated) = 108.2 V/m

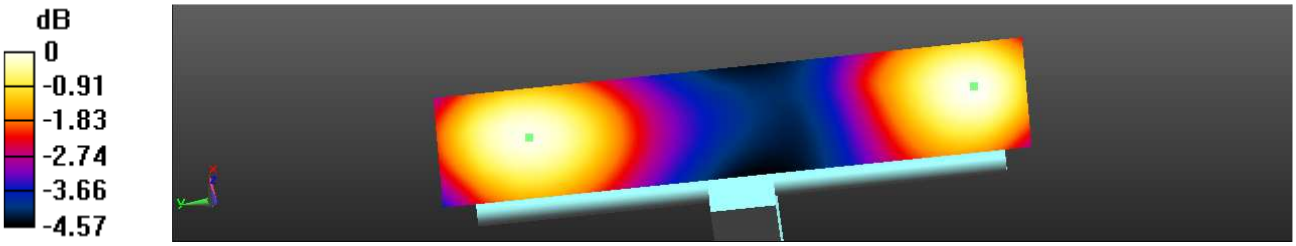


0 dB = 108.7 V/m = 40.72 dBV/m

DUT: CD1880V3; Type: CD1880V3; Serial: 1016
Communication System: UID 0, CW (0); Communication System Band: CW; Frequency: 1880 MHz; MIF: 0 dB
Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY Configuration:

- Probe: ER3DV6 - SN2384; ConvF(1, 1, 1); Calibrated: 2015-04-29;
- Sensor-Surface: 0mm (Fix Surface), z = 9.7
- Electronics: DAE4 Sn1241; Calibrated: 2015-01-21
- Phantom: HAC Test Arch_2013_07_30; Type: SD HAC P01 BA; Serial: 1078
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

1880MHz E-Field Validation @ 100mW (2015.05.18)/E Scan 15mm above Dipole/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 = 141.2 V/m; Power Drift = -0.04 dB
Applied MIF = 0.00 dB
Average value of Peak (interpolated) = 92.5 V/m



0 dB = 92.76 V/m = 39.35 dBV/m

APPENDIX D

Plots of The HAC Measurements

E-field (GSM850_1900) -2011

DUT: SM-G531M/DS; Type: Mobile Phone; Serial: AM-040-B
Communication System: UID 0, GSM850 (0); Communication System Band: GSM850; Frequency: 848.8 MHz; MIF: 3.48 dB
Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY Configuration:

- Probe: ER3DV6 - SN2384; ConvF(1, 1, 1); Calibrated: 2015-04-29;
- Sensor-Surface: (Fix Surface), z = 8.7
- Electronics: DAE4 Sn1241; Calibrated: 2015-01-21
- Phantom: HAC Test Arch_2013_07_30; Type: SD HAC P01 BA; Serial: 1078
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

GSM E-Field Test SM-G531M_DS (Job No_ AM-040)/Ch.0251, Ant. Intenna, Bat.
Standard/Hearing Aid Compatibility Test (101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 54.61 V/m; Power Drift = 0.06 dB
Applied MIF = 3.48 dB
RF audio interference level = 37.41 dBV/m
Emission category: M4

MIF scaled E-field

Grid 1 **M4** **37.13 dBV/m**	Grid 2 **M4** **37.21 dBV/m**	Grid 3 **M4** **35.8 dBV/m**
Grid 4 **M4** **37.28 dBV/m**	Grid 5 **M4** **37.41 dBV/m**	Grid 6 **M4** **36.09 dBV/m**
Grid 7 **M4** **37.18 dBV/m**	Grid 8 **M4** **37.36 dBV/m**	Grid 9 **M4** **36.32 dBV/m**

Cursor:
Total = 37.41 dBV/m
E Category: M4
Location: -5, -1.5, 8.7 mm

0 dB = 74.18 V/m = 37.41 dBV/m

E-field (GSM850_1900) -2011

DUT: SM-G531M/DS; Type: Mobile Phone; Serial: AM-040-B
Communication System: UID 0, GSM1900 (0); Communication System Band: GSM1900; Frequency: 1850.2 MHz; MIF: 3.41 dB
Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY Configuration:

- Probe: ER3DV6 - SN2384; ConvF(1, 1, 1); Calibrated: 2015-04-29;
- Sensor-Surface: (Fix Surface), z = 8.7
- Electronics: DAE4 Sn1241; Calibrated: 2015-01-21
- Phantom: HAC Test Arch_2013_07_30; Type: SD HAC P01 BA; Serial: 1078
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

GSM E-Field Test SM-G531M_DS (Job No_ AM-040)/Ch.0512, Ant, Intenna, Bat.
Standard/Hearing Aid Compatibility Test (101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 9.973 V/m; Power Drift = -0.10 dB
Applied MIF = 3.41 dB
RF audio interference level = 30.94 dBV/m
Emission category: M3

MIF scaled E-field

Grid 1 **M4** **28.16 dBV/m**	Grid 2 **M4** **28.65 dBV/m**	Grid 3 **M4** **27.9 dBV/m**
Grid 4 **M4** **26.69 dBV/m**	Grid 5 **M4** **26.68 dBV/m**	Grid 6 **M4** **24.32 dBV/m**
Grid 7 **M3** **30.63 dBV/m**	Grid 8 **M3** **30.94 dBV/m**	Grid 9 **M4** **29.75 dBV/m**

Cursor:
Total = 30.94 dBV/m
E Category: M3
Location: -2.5, -25, 8.7 mm

0 dB = 35.23 V/m = 30.94 dBV/m

APPENDIX E

Probe Calibration(E-field)

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: Samsung (Dymstec)

Certificate No: ER3-2384_Apr15

CALIBRATION CERTIFICATE

Object: ER3DV6 - SN:2384

Calibration procedure(s): QA CAL-02.v8, QA CAL-25.v6
Calibration procedure for E-field probes optimized for close near field evaluations in air

Calibration date: April 29, 2015

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 E4419B	GB41293874	01-Apr-15 (No. 217-02128)	Mar-16
Power sensor E4412A	MY41498087	01-Apr-15 (No. 217-02128)	Mar-16
Reference 3 dB Attenuator	SN: S5054 (3c)	01-Apr-15 (No. 217-02129)	Mar-16
Reference 20 dB Attenuator	SN: S5277 (20x)	01-Apr-15 (No. 217-02132)	Mar-16
Reference 30 dB Attenuator	SN: S5129 (30b)	01-Apr-15 (No. 217-02133)	Mar-16
Reference Probe ER3DV6	SN: 2328	08-Oct-14 (No. ER3-2328_Oct14)	Oct-15
DAE4	SN: 789	16-Mar-15 (No. DAE4-789_Mar15)	Mar-16
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-14)	In house check: Oct-15

	Name	Function	Signature
Calibrated by:	Israe Elnaouq	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: April 29, 2015

OK to use
2015.5.18

Glossary:

NORMx,y,z	sensitivity in free space
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., ϑ = 0 is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

a) IEEE Std 1309-2005, " IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", December 2005
b) CTIA Test Plan for Hearing Aid Compatibility, April 2010.

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 for XY sensors and ϑ = 90 for Z sensor (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart).
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z: A, B, C, D* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- *Spherical isotropy (3D deviation from isotropy)*: in a locally homogeneous field realized using an open waveguide setup.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle*: The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

Probe ER3DV6

SN:2384

Manufactured: June 1, 2006
Calibrated: April 29, 2015

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

DASY/EASY - Parameters of Probe: ER3DV6 - SN:2384

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)	1.53	1.75	1.88	± 10.1 %
DCP (mV)[B]	100.0	98.0	101.0	

Modulation Calibration Parameters

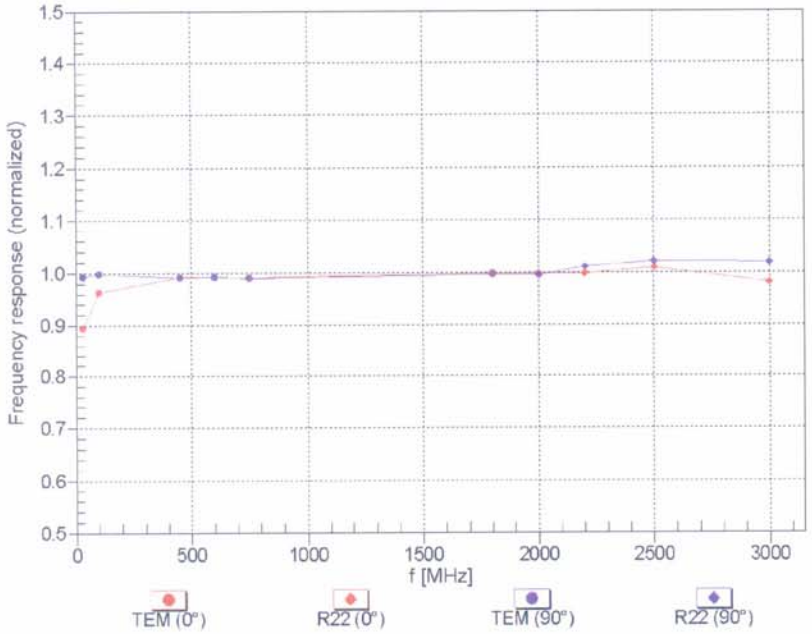
UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	192.2	±1.9 %
		Y	0.0	0.0	1.0		156.7	
		Z	0.0	0.0	1.0		154.2	
10011-CAB	UMTS-FDD (WCDMA)	X	3.12	65.7	18.0	2.91	113.2	±0.7 %
		Y	3.30	66.8	18.7		130.3	
		Z	3.18	66.2	18.2		122.5	
10012-CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)	X	2.85	68.2	18.7	1.87	114.7	±0.9 %
		Y	2.53	65.7	17.5		133.0	
		Z	3.05	68.8	18.8		125.5	
10039-CAB	CDMA2000 (1xRTT, RC1)	X	4.71	66.2	18.9	4.57	116.2	±1.2 %
		Y	4.91	67.1	19.5		134.3	
		Z	4.70	66.3	18.8		124.6	
10061-CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps)	X	8.59	86.8	26.6	3.60	146.1	±1.2 %
		Y	4.86	76.7	23.0		118.8	
		Z	9.51	84.4	24.8		119.5	
10077-CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 54 Mbps)	X	13.01	77.1	29.0	11.00	134.0	±3.8 %
		Y	11.98	74.7	27.9		108.2	
		Z	13.45	76.6	28.1		112.7	
10081-CAB	CDMA2000 (1xRTT, RC3)	X	4.11	66.9	19.2	3.97	149.6	±0.7 %
		Y	4.00	66.2	18.9		129.3	
		Z	3.82	65.4	18.3		115.4	
10100-CAB	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	6.39	67.4	19.9	5.67	120.5	±2.2 %
		Y	6.82	69.1	21.0		147.4	
		Z	6.40	67.5	19.8		129.9	
10108-CAC	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	6.43	67.6	20.2	5.80	124.7	±2.5 %
		Y	6.76	68.9	21.1		145.0	
		Z	6.30	67.1	19.8		128.3	

10110-CAC	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, QPSK)	X	6.05	66.8	19.7	5.75	117.6	±2.2 %
		Y	6.36	68.1	20.6		141.7	
		Z	5.94	66.4	19.4		125.0	
10295-AAB	CDMA2000, RC1, SO3, 1/8th Rate 25 fr.	X	15.79	99.4	40.8	12.49	95.6	±3.3 %
		Y	14.46	99.1	41.6		109.2	
		Z	20.46	99.3	38.3		136.1	

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%.

[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)

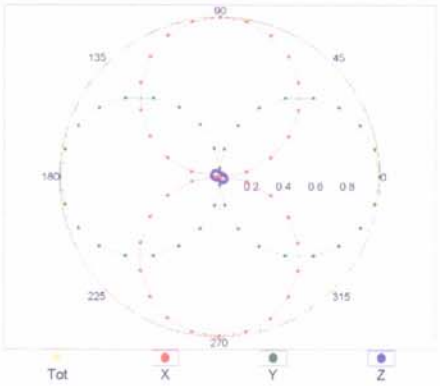


Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

Receiving Pattern (ϕ), ϑ = 0°

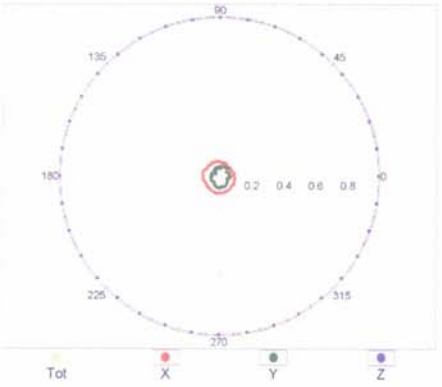
f=600 MHz,TEM,0°

f=2500 MHz,R22,0°

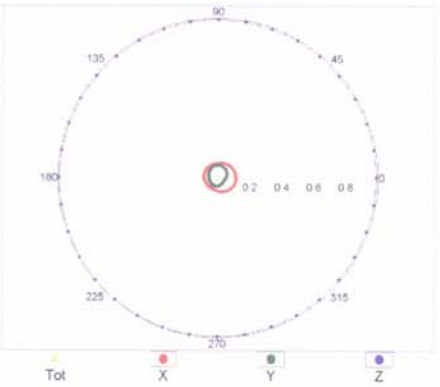


Receiving Pattern (ϕ), ϑ = 90°

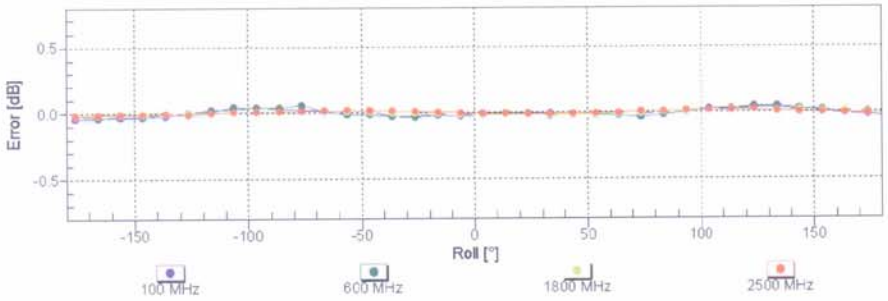
f=600 MHz,TEM,90°



f=2500 MHz,R22,90°

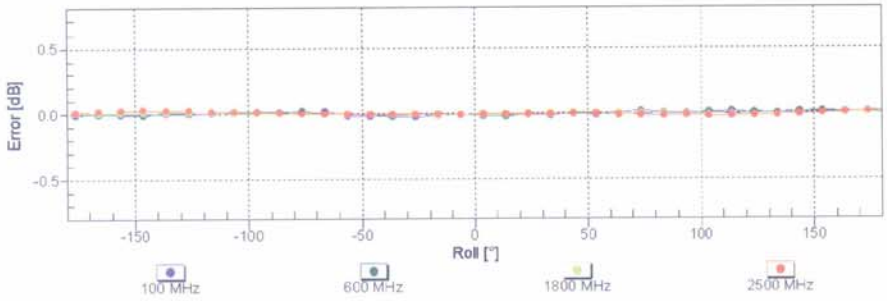


Receiving Pattern (ϕ), ϑ = 0°



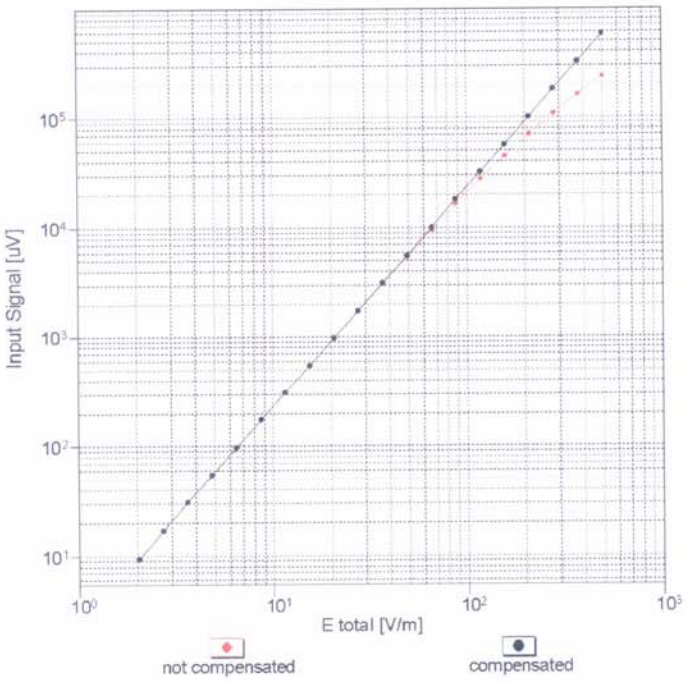
Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

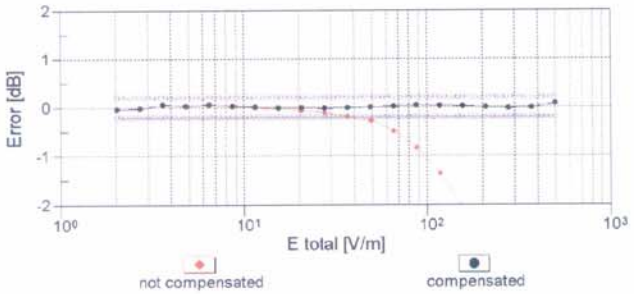
Receiving Pattern (ϕ), ϑ = 90°



Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(E-field)
(TEM cell , f = 900 MHz)

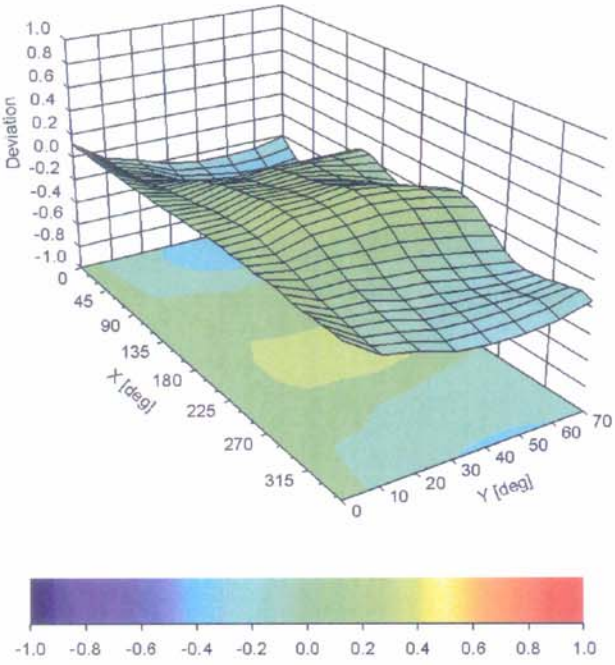




Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Deviation from Isotropy in Air

Error (ϕ, ϑ), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

DASY/EASY - Parameters of Probe: ER3DV6 - SN:2384

Other Probe Parameters

Sensor Arrangement	Rectangular
Connector Angle (°)	-16.3
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	8 mm
Probe Tip to Sensor X Calibration Point	2.5 mm
Probe Tip to Sensor Y Calibration Point	2.5 mm
Probe Tip to Sensor Z Calibration Point	2.5 mm

APPENDIX F

Calibration of The Validation Dipole

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 Samsung (Dymstec)

Certificate No: CD835V3-1105_Feb15

CALIBRATION CERTIFICATE

Object	CD835V3 - SN: 1105
Calibration procedure(s)	QA CAL-20.v6 Calibration procedure for dipoles in air
Calibration date:	February 17, 2015

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 EPM-442A	GB37480704	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	US37292783	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	MY41092317	07-Oct-14 (No. 217-02021)	Oct-15
Reference 10 dB Attenuator	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Probe ER3DV6	SN: 2336	31-Dec-14 (No. ER3-2336_Dec14)	Dec-15
Probe H3DV6	SN: 6065	31-Dec-14 (No. H3-6065_Dec14)	Dec-15
DAE4	SN: 781	12-Sep-14 (No. DAE4-781_Sep14)	Sep-15

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter Agilent 4419B	SN: GB42420191	09-Oct-09 (in house check Sep-14)	In house check: Sep-16
Power sensor HP E4412A	SN: US38485102	05-Jan-10 (in house check Sep-14)	In house check: Sep-16
Power sensor HP 8482A	SN: US37295597	09-Oct-09 (in house check Sep-14)	In house check: Sep-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-14)	In house check: Oct-15
RF generator R&S SMT-06	SN: 832283/011	27-Aug-12 (in house check Oct-13)	In house check: Oct-16

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Fin Bomholt	Deputy Technical Manager	

O.K. to use
2015.3.6

Issued: February 19, 2015

References

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

Methods Applied and Interpretation of Parameters:

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

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Phantom	HAC Test Arch	
Distance Dipole Top - Probe Center	15mm	
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	107.0 V/m = 40.59 dBV/m
Maximum measured above low end	100 mW input power	106.6 V/m = 40.56 dBV/m
Averaged maximum above arm	100 mW input power	**106.8 V/m ± 12.8 % (k=2)**

Appendix (Additional assessments outside the scope of SCS0108)

Antenna Parameters

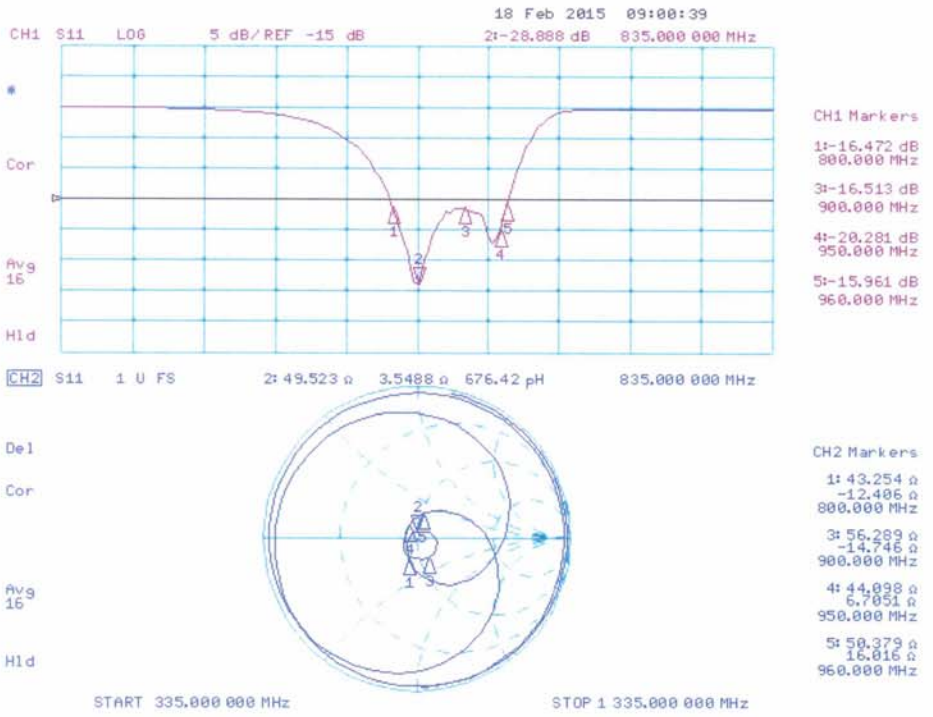
Frequency	Return Loss	Impedance
800 MHz	16.5 dB	43.3 Ω - 12.4 jΩ
835 MHz	28.9 dB	49.5 Ω + 3.5 jΩ
900 MHz	16.5 dB	56.3 Ω - 14.7 jΩ
950 MHz	20.3 dB	44.1 Ω + 6.7 jΩ
960 MHz	16.0 dB	50.4 Ω + 16.0 jΩ

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: 17.02.2015

Test Laboratory: SPEAG Lab2

DUT: HAC-Dipole 835 MHz; Type: CD835V3; Serial: CD835V3 - SN: 1105

Communication System: UID 0 - CW ; Frequency: 835 MHz
Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

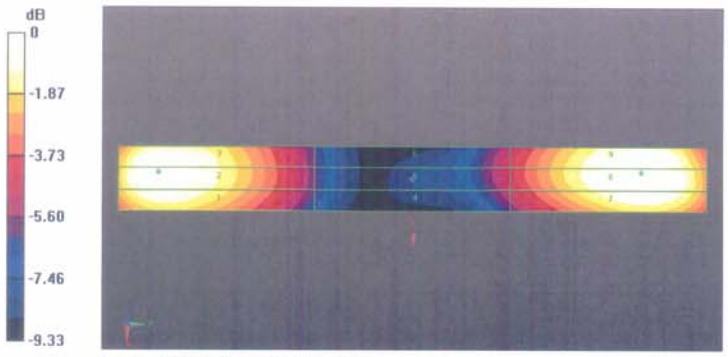
DASY52 Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 31.12.2014;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 12.09.2014
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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 = 121.9 V/m; Power Drift = -0.01 dB
Applied MIF = 0.00 dB
RF audio interference level = 40.59 dBV/m
Emission category: M3

MIF scaled E-field

Grid 1 **M3** **40.16 dBV/m**	Grid 2 **M3** **40.59 dBV/m**	Grid 3 **M3** **40.55 dBV/m**
Grid 4 **M4** **35.7 dBV/m**	Grid 5 **M4** **36.1 dBV/m**	Grid 6 **M4** **36.08 dBV/m**
Grid 7 **M3** **40.21 dBV/m**	Grid 8 **M3** **40.56 dBV/m**	Grid 9 **M3** **40.54 dBV/m**



0 dB = 107.0 V/m = 40.59 dBV/m

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 Samsung (Dymstec)

Certificate No: CD1880V3-1016_Jan15

CALIBRATION CERTIFICATE

Object	CD1880V3 - SN: 1016
Calibration procedure(s)	QA CAL-20.v6 Calibration procedure for dipoles in air
Calibration date:	January 20, 2015

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 EPM-442A	GB37480704	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	US37292783	07-Oct-14 (No. 217-02020)	Oct-15
Power sensor HP 8481A	MY41092317	07-Oct-14 (No. 217-02021)	Oct-15
Reference 10 dB Attenuator	SN: 5047.2 / 06327	03-Apr-14 (No. 217-01921)	Apr-15
Probe ER3DV6	SN: 2336	31-Dec-14 (No. ER3-2336_Dec14)	Dec-15
Probe H3DV6	SN: 6065	31-Dec-14 (No. H3-6065_Dec14)	Dec-15
DAE4	SN: 781	12-Sep-14 (No. DAE4-781_Sep14)	Sep-15

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter Agilent 4419B	SN: GB42420191	09-Oct-09 (in house check Sep-14)	In house check: Sep-16
Power sensor HP E4412A	SN: US38485102	05-Jan-10 (in house check Sep-14)	In house check: Sep-16
Power sensor HP 8482A	SN: US37295597	09-Oct-09 (in house check Sep-14)	In house check: Sep-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-14)	In house check: Oct-15
RF generator R&S SMT-06	SN: 832283/011	27-Aug-12 (in house check Oct-13)	In house check: Oct-16

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Fin Bomholt	Deputy Technical Manager	

O.K to use
2015.1.28

Issued: January 20, 2015

References

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

Methods Applied and Interpretation of Parameters:

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

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Measurement Conditions

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

DASY Version	DASY5	V52.8.8
Phantom	HAC Test Arch	
Distance Dipole Top - Probe Center	10 mm	
Scan resolution	dx, dy = 5 mm	
Frequency	1730 MHz ± 1 MHz 1880 MHz ± 1 MHz	
Input power drift	< 0.05 dB	

Maximum Field values at 1730 MHz

E-field 15 mm above dipole surface	condition	Interpolated maximum
Maximum measured above high end	100 mW input power	100.2 V/m = 40.02 dBV/m
Maximum measured above low end	100 mW input power	94.6 V/m = 39.52 dBV/m
Averaged maximum above arm	100 mW input power	**97.4 V/m ± 12.8 % (k=2)**

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	91.6 V/m = 39.24 dBV/m
Maximum measured above low end	100 mW input power	89.2 V/m = 39.00 dBV/m
Averaged maximum above arm	100 mW input power	**90.4 V/m ± 12.8 % (k=2)**

Appendix (Additional assessments outside the scope of SCS0108)

Antenna Parameters

Nominal Frequencies

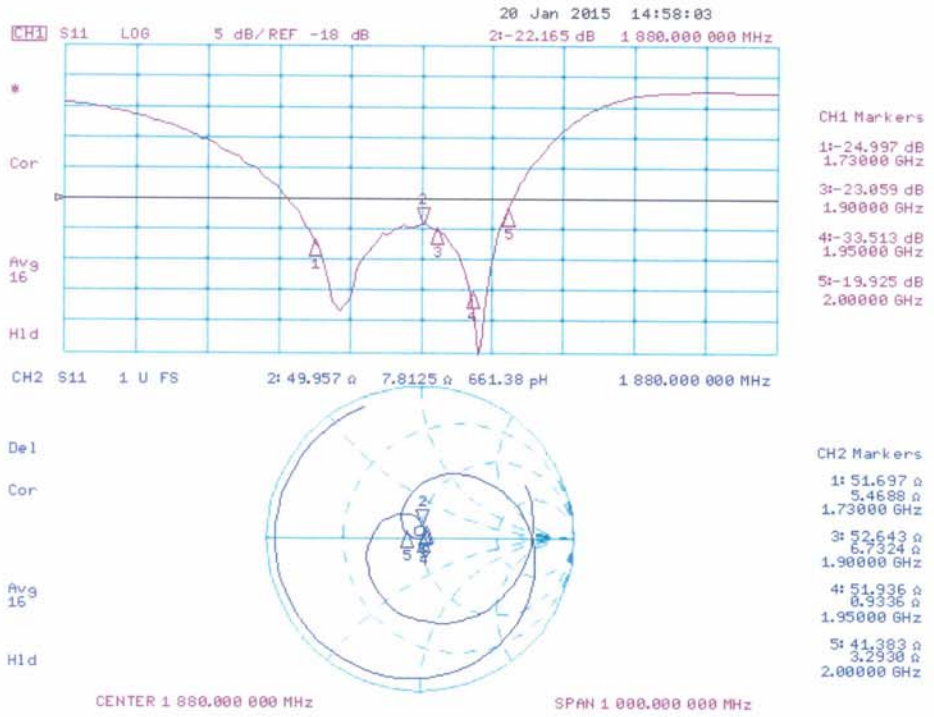
Frequency	Return Loss	Impedance
1730 MHz	25.0 dB	51.7 Ω + 5.5 jΩ
1880 MHz	22.2 dB	50.0 Ω + 7.8 jΩ
1900 MHz	23.1 dB	52.6 Ω + 6.7 jΩ
1950 MHz	33.5 dB	51.9 Ω + 0.9 jΩ
2000 MHz	19.9 dB	41.4 Ω + 3.3 jΩ

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.

Impedance Measurement Plot



DASY5 E-field Result

Date: 20.01.2015

Test Laboratory: SPEAG Lab2

DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: CD1880V3 - SN: 1016

Communication System: UID 0 - CW ; Frequency: 1880 MHz, Frequency: 1730 MHz
Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 31.12.2014;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 12.09.2014
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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 = 147.7 V/m; Power Drift = -0.01 dB
Applied MIF = 0.00 dB
RF audio interference level = 39.24 dBV/m
Emission category: M2

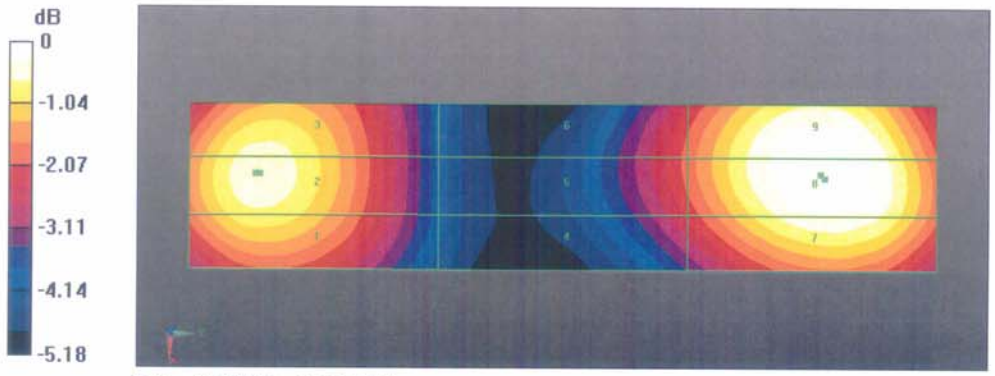
MIF scaled E-field

Grid 1 **M2** **38.69 dBV/m**	Grid 2 **M2** **39 dBV/m**	Grid 3 **M2** **38.92 dBV/m**
Grid 4 **M2** **36.63 dBV/m**	Grid 5 **M2** **36.94 dBV/m**	Grid 6 **M2** **36.93 dBV/m**
Grid 7 **M2** **38.93 dBV/m**	Grid 8 **M2** **39.24 dBV/m**	Grid 9 **M2** **39.19 dBV/m**

Dipole E-Field measurement @ 1880MHz/E-Scan - 1730MHz 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 = 160.8 V/m; Power Drift = -0.04 dB
Applied MIF = 0.00 dB
RF audio interference level = 40.02 dBV/m
Emission category: M1

MIF scaled E-field

Grid 1 **M2** **39.18 dBV/m**	Grid 2 **M2** **39.52 dBV/m**	Grid 3 **M2** **39.44 dBV/m**
Grid 4 **M2** **37.49 dBV/m**	Grid 5 **M2** **37.95 dBV/m**	Grid 6 **M2** **37.94 dBV/m**
Grid 7 **M2** **39.62 dBV/m**	Grid 8 **M1** **40.02 dBV/m**	Grid 9 **M2** **39.98 dBV/m**



0 dB = 91.62 V/m = 39.24 dBV/m