Hearing Aid Compatibility RF Emissions Test Report

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Statement of Compliance: RIM Testing Services (RTS) declares that the product was tested in accordance with the appropriate measurement standards, guidelines and recommended practices.

This wireless portable device has been shown to be in compliance with FCC 20.19 (10-1-04 Edition), Hearing Aid-Compatible Mobile Handsets.

	Signatures	Date
Tested and documented by:		
Daoud Attayi Compliance Specialist	Daoud Attayi	22-July-2005
Lauren Weber Compliance Specialist	Lauren Weber	27-June-2005
Approved by:		
Paul G. Cardinal, Ph.D. Manager, RIM Testing Services	Paul G Cardinal	28-June-2005

CONTENTS

1.0 Introduction

This test report documents the measurement of the near electric and magnetic fields generated by a wireless communication device in the region where a hearing aid would be used. The measurement procedures of ANSI C63.19-2001 were followed along with the guidance provided by the FCC at the May 2005 TCBC workshop with the document "Hearing Aid Compatibility: RF Emissions Measurements TCB Review Guidance, 12 May 2005".

The electric and magnetic fields from a wireless device are scanned using a SPEAG DASY4 automated system with HAC extension and free-space probes (ER3DVx and H3DVx) in a 5cm x 5cm area, 10mm above the wireless device's acoustic output. The area is divided into 9 sub-grids and the maximum values of the electrical and a magnetic field scans are evaluated automatically according to the rules defined in the standard and the device is assigned a certain category. Should the wireless device's maximum T-Coil output occur in a location other than the centre of acoustic output, then the RF field scans are repeated with the measurement area centered on the maximum T-Coil output.

The DASY4 HAC Extension consists of the following parts: the Test Arch phantom, three validation dipoles, dipole and DUT holders, magnetic and electric field probes and DASY4 software.

The specially designed Test Arch allows high precision positioning of both the device and any of the validation dipoles. The broadband dipoles are calibrated at a single frequency and are used for system performance checks.

In order to correlate the usability of a hearing aid with a wireless device (WD), the WD's radio frequency (RF) and audio band emissions are measured. ANSI C63.19 requires:

● Radio frequency (RF) measurements of the near-field electric and magnetic fields emitted by a WD in the vicinity of the audio output to categorize these emissions for correlation with the RF immunity of the microphone mode of operation of a hearing aid.
● Audio frequency magnetic field measurements of a WD emitted in the vicinity of the audio output to categorize these emissions for correlation with the T-Coil mode of operation of a hearing aid.

Hence, the following measurements are made for the WDs:
1. RF E-Field emissions.
2. RF H-Field emissions.
3. T-Coil mode, magnetic signal strength in the audio band.
4. T-Coil mode, magnetic signal and noise articulation index.
5. T-Coil mode, magnetic signal frequency response through the audio band.

2.0 Applicable standards

[1] ANSI C63.19-2001, Rev. 3.6 (which will become ANSI C63.19-2005), American National Standard for Methods of Measurement of Compatibility between Wireless Communication Devices and Hearing Aids.

[2] FCC 47CFR § 20.19 (10-1-04 Edition), Hearing Aid-Compatible Mobile Handsets.

3.0 Equipment unit tested

3.1 Picture of Handheld

Figure 1. BlackBerry Wireless Handheld

3.2 Handheld description

Handheld Model	R6230GE
FCC ID	L6AR6230GE
Serial Number / PIN Number	201F95F9
Prototype or Production Unit	Production
Mode(s) of Operation in North America	GSM 1900
Transmitting Frequency Range (s)	1850.2 – 1909.8 MHz
Nominal maximum conducted RF Output Power *	29.70 dBm *
Tolerance of Power Calibration	± 0.30 dB
Duty Cycle	1: 8

Table 1. Test device characterization

* The measured conducted power presented in the EMC, SAR and HAC reports are within 0.2 dB of each other. The differences are due to the use of different test equipment.

3.3 Batteries

1. BAT-03087-002; Rated capacity: 1000 mAh
2. BAT-03487-002; Rated capacity: 1000 mAh

3.4 Antenna description

Type	Internal fixed antenna
Location	Top back centre
Configuration	Internal fixed antenna

Table 2. Antenna description

4.0 List of test equipment

Manufacturer	Test Equipment	Model Number	Serial Number	Calibration Due Date
SCHMID & Partner Engineering AG	Data Acquisition Electronics (DAE3)	DAE3 V1	472	03-Jan-06
SCHMID & Partner Engineering AG	3-Dimensional E-Field Probe for Near-Field	ER3DV6	2285	10-Dec-05
SCHMID & Partner Engineering AG	3-Dimensional H-Field Probe for Near-Field	H3DV6	6105	10-Dec-05
Rohde & Schwarz	Digital communication tester	CMU 200	104805	30-April-06
TEM Consulting, LP	T-Coil radial / axial probe	SBI 1092	N/A	04-Nov-05
Agilent	Multimeter	34401A	US36042322	26-July-05
Agilent	Signal Generator	8648C	4037U03155	01-Aug-05
Agilent	Signal Generator	E4433B	US38440672	27-July-05
Agilent	Spectrum Analyzer	8563E	3745A08112	20-July-05
Giga-tronics	Power Meter	8541C	1837762	03-Dec-05
Giga-tronics	Power Sensor	80401A	1835838	03-Dec-05
SCHMID & Partner Engineering AG	Validation Dipole	CD 1880 V3	1008	23-Feb-06

Table 3. List of test equipment

5.0 Measurement procedures

5.1 System Validation

The test setup should be validated when first configured and verified periodically thereafter to ensure proper function. The procedure consists of two parts: dipole validation and determination of probe modulation factor.

5.1.1 Dipole Validation

The HAC validation dipole antenna serves as a known source for an electrical and magnetic RF output. Figure 2 shows the setup used for the dipole validation.

1. The dipole antenna was placed in the position normally occupied by the WD.
2. The dipole was energized with a 20 dBm un-modulated continuous-wave signal.
3. The length of the dipole was scanned with both E-field and H-field probes and the maximum value for each scan was recorded.
4. The readings were compared with the values provided by the probe manufacturer and were found to agree within the allowed tolerance of 10%.

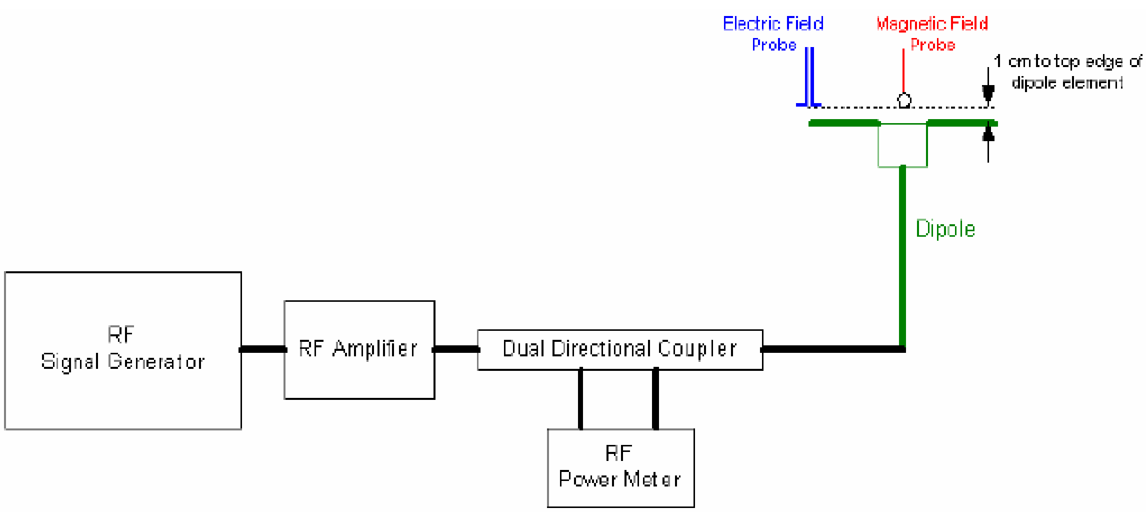


Figure 2: Dipole Validation Procedure

5.1.2 RF Field Probe Modulation Factor

Probe Modulation Factor characterizes the responses of the E-field and H-field probes and their instrumentation chain to a modulated signal. This factor is the ratio of the responses to fields produced by CW and modulated signals having equal peak amplitude.

The modulation factor was calculated for the following signals: 80%AM, and the modulated signal produced by the WD. This measurement was performed with the field probe attached to the instrumentation that was used with it during the measurement. The ratio of the CW reading to that taken with a modulated field was applied to the readings taken of modulated fields of the specified type.

1. Fix the probe in a set location relative to a field-generating device, such as a reference dipole antenna.
2. Illuminate the probe with a CW signal at the intended measurement frequency.
3. Record the reading of the probe measurement system of the CW signal.
4. Determine the level of the CW signal being used to drive the field-generating device.
5. Substitute a signal using the same modulation as that used by the intended WD for the CW signal and measure Peak Envelope Power using Spectrum Analyzer with 0Hz span.
6. Set the peak amplitude during transmission of the modulated signal to equal the amplitude of the CW signal.
7. Record the reading of the probe measurement system of the modulated signal.
8. The ratio of the CW to modulated signal reading is the modulation factor.

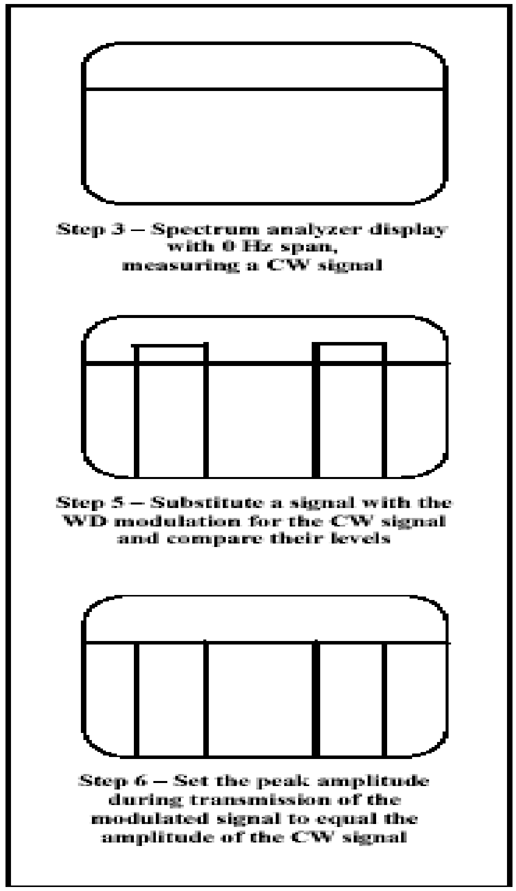


Figure 3: **Setting the RF levels for the probe modulation response procedure. Adjusting the peak amplitude to match a WD modulation to a CW signal.**

Please refer to Annex A.2 for 0Hz-span spectrum analyzer plots.
Please refer to Annex A.3 for probe modulation factor measurement plots.

The results of the dipole validation and probe modulation factor measurements are shown in Table 4.

f (MHz)	Signal Type	Average Power (dBm)	Pulse Average Power (dBm)	Measured E-Field (V/m)	Target E-Field (V/m)	Mod. Factor Ratio	Delta (%)	Crest Factor
1880	CW	20	20	138.20	135.40	-	+2.1	-
1880	80 % AM	14.8	20	85.5	-	1.62	-	-
1880	GSM	10.8	20	48.3	-	2.86	-	8.18
f (MHz)	**Signal Type**	**Average Power (dBm)**	**Pulse Average Power (dBm)**	**Measured H-Field (A/m)**	**Target H-Field (A/m)**	**Mod. Factor Ratio**	**Delta (%)**	**Crest Factor**
1880	CW	20	20	0.423	0.442	-	-4.3	-
1880	80 % AM	14.8	20	0.271	-	1.56	-	-
1880	GSM	10.8	20	0.168	-	2.52	-	6.35

Table 4: Dipole Validation and Modulation Factors

5.1.2.1 Calculation of Modulation Factor and Crest Factor:

1) Modulation Factor = Measured E/H-Field (CW) / Measured E/H-Field (Modulated)

E-Field Probe Modulation Factor for GSM 1900 band = 138.20 / 48.3 = 2.86
H-Field Probe Modulation Factor for GSM 1900 band = 0.423 / 0.168 = 2.52

2) Crest Factor = (Modulation Factor)^2

E-Field Probe Crest Factor for GSM 1900 band = (2.86)^ 2 = 8.18
H-Field Probe Crest Factor for GSM 1900 band = (2.52)^ 2 = 6.35

5.3 Near-Field RF Emission

The following procedure was used to measure RF near E-field and H-field emissions:

1. Proper operation of the field probe, probe measurement system, other instrumentation, and the positioning system was confirmed.
2. The WD was oriented in its intended test position with the reference plane in the horizontal plane, and was secured in the device holder to maintain position accuracy (see Figure 4).
3. The WD was configured for maximum rated RF output power, at the desired channel and other normal operating parameters, (e.g. – test mode) as intended for the test. A fully charged battery was used for each test.
4. The SPEAG DASY4 system measures power drift as a part of each scan. Power drift was maintained below 5 % or 0.25 dB. If the drift was found to be higher, the measurement was repeated.
5. The measurements were performed with the backlight off. After establishing a call, WD's backlight turns off automatically after a short moment.
5. The 5cm x 5cm measurement grid was centered on the center of the acoustic output or the T-Coil output, as appropriate. The field probe was located at the initial position at the center of the measurement grid.
6. A surface verification was performed before each setup change to ensure repeatable spacing and proper maintenance of the measurement plane.
7. The electric field probe, and separately the magnetic field probe were used to measure the highest field strength in the 5cm x 5cm reference plane.
8. The entire 5cm x 5cm region was scanned with a 5mm step size. The reading was recorded at each measurement location. The probe was rotated 360° about the azimuth axis at the maximum interpolated position. The maximum and delta reading from this rotation was recorded and the maximum field was recalculated.
9. Around the center sub-grid, five contiguous sub-grids were identified with the lowest maximum field strength readings. Please note that a maximum of five sub-grids can be excluded for both E- and H-field measurements.
10. The highest field reading was identified within the non-excluded sub-grids
11. The highest field strength reading identified was converted to peak V/m or A/m, as appropriate. This conversion was done using the appropriate factors derived from the probe modulation factor.
12. The peak reading was compared to the categories defined in C63.19 using the appropriate AWF (see tables 5 and 6 in this report).

If a WD has more than one antenna position, it is necessary to test the WD only in the condition of maximum antenna efficiency, i.e. antenna extended.

Table 5 shows the ANSI C63.19 M-rating categories for Wireless Device RF emissions. Table 6 outlines the Articulation Weighting Factors for various cellular technologies.

Category	Telephone RF Parameters				
Near Field	AWF	E-Field Emissions (Peak)		H-Field Emissions (Peak)	
Category M1	0	199.5 – 354.8	V/m	0.60 – 1.07	A/m
	-5	149.6 – 266.1	V/m	0.45 – 0.80	A/m
Category M2	0	112.2 – 199.5	V/m	0.34 – 0.60	A/m
	-5	84.1 – 149.6	V/m	0.25 – 0.45	A/m
Category M3	0	63.1 – 112.2	V/m	0.19 – 0.34	A/m
	-5	47.3 – 84.1	V/m	0.14 – 0.25	A/m
Category M4	0	<63.1	V/m	<0.19	A/m
	-5	<47.3	V/m	<0.14	A/m

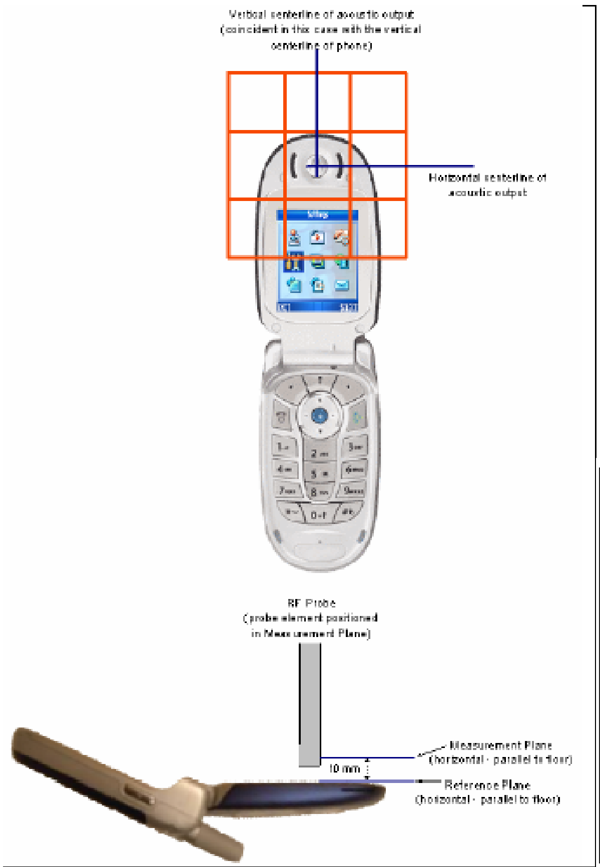
Category	Telephone RF Parameters				
Near Field	AWF	E-Field Emissions (Peak)		H-Field Emissions (Peak)	
Category M1	0	46 – 51	dB (V/m)	-4.4 – 0.6	dB (A/m)
	-5	43.5 – 48.5	dB (V/m)	-6.9 – -1.9	dB (A/m)
Category M2	0	41 – 46	dB (V/m)	-9.4 – -4.4	dB (A/m)
	-5	38.5 – 43.5	dB (V/m)	-11.9 – -6.9	dB (A/m)
Category M3	0	36 – 41	dB (V/m)	-14.4 – -9.4	dB (A/m)
	-5	33.5 – 38.5	dB (V/m)	-16.9 – -11.9	dB (A/m)
Category M4	0	<36	dB (V/m)	<-14.4	dB (A/m)
	-5	<33.5	dB (V/m)	<-16.9	dB (A/m)

Table 5: Wireless Device near-field categories

Standard	Technology	AWF (dB)
TIA/EIA/IS-2000	CDMA	0
TIA/EIA-136	TDMA (50 Hz)	0
J-STD-007	GSM (217)	-5
T1/T1P1/3GPP	UMTS (WCDMA)	0
iDEN™	TDMA (22 and 11 Hz)	0

Table 6: Articulation Weighting Factor (AWF)

Figures 4 and 5 show the orientation of the WD in the reference plane.



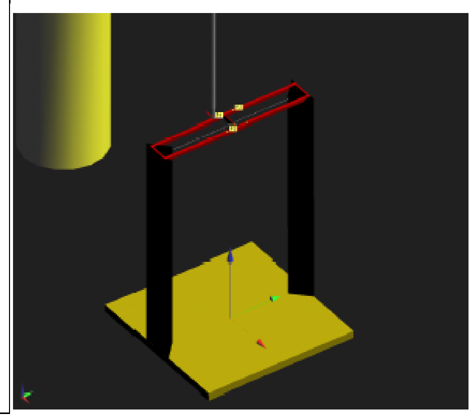


Figure 4: WD reference plane for RF emission measurements **Figure 5: HAC Phantom/Test Arch**

5.4 Wireless Device Audio Band, Magnetic Signal Test

This section of the test report shows the measurement method for locating the center of the T-Coil only.

The Audio Band Magnetic Field or T-Coil output of a wireless device is measured using an EM Scan automated system from TEM Consulting. This consists of a Magnetic Field T-Coil Axial Probe, Sound Level Meter, Voltmeter and accompanying software. The scan is performed in a 5cm x 5cm area, 10mm above the acoustic output. The location of the maximum field strength is referred to as the centre of the T-Coil.

The measurement shall not include undesired properties from the WD's RF field. By replacing the antenna with a coaxial cable providing a conducted connection, undesired RF emissions from the WD's transmitter can be excluded.

ANSI C63.19 describes the procedure as follows:

1. Position the WD in the test setup and connect the WD RF connector to a base station simulator or a non-radiating load.
2. Set the reference drive level for the system with the maximum volume control setting or as specified by the manufacturer. The drive level is set such that the reference input level is input to the base station simulator (or manufacturer's test mode equivalent) in the 1 kHz, 1/3 octave band. This drive level shall be used for the audio band signal test (ABM1 at f). Either a sine wave at 1025 Hz or a voice-like signal shall be used for the reference audio signal. If interference is found at 1025 Hz an alternate reference audio signal frequency may be used. The same drive level will be used for the ABM1 frequency response measurements at each 1/3-octave band center frequency.

The following reference input levels that correlate to a normal speech input level shall be used for the standard transmission protocols.

STANDARD	TECHNOLOGY	INPUT (dBm0)
TIA/EIA/IS-2000	CDMA	-18 dBm0
TIA/EIA/IS-136	TDMA (50 Hz)	-18 dBm0
J-STD-007	GSM (217 Hz)	-16 dBm0
iDEN	TDMA (22 and 11 Hz)	-18 dBm0

Table 7: Reference input level for normal speech input level

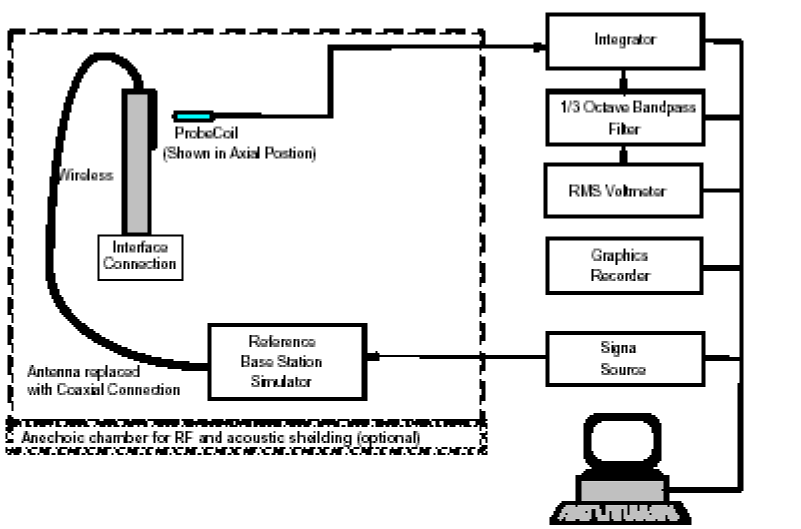


Figure 6: Magnetic field measurement test setup – in call method

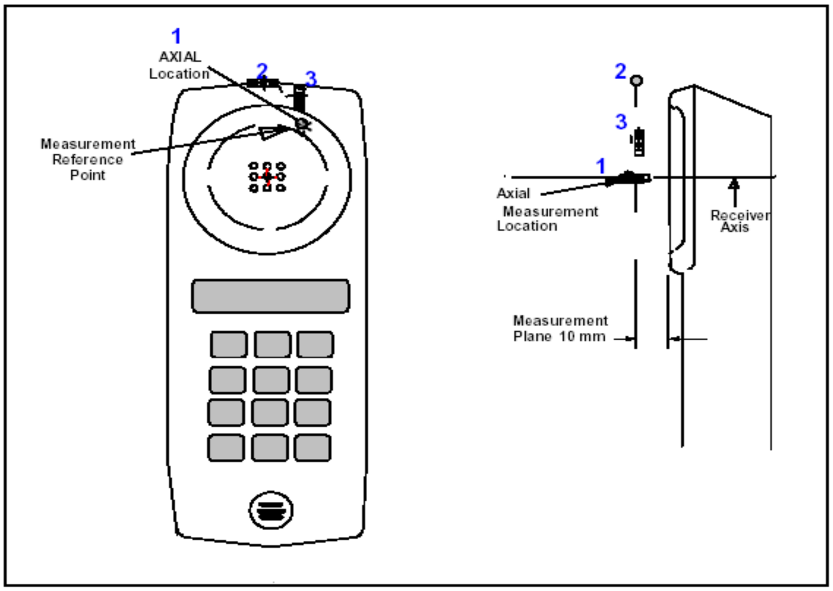


Figure 7: Axis & planes for WD audio frequency magnetic field measurements

6.0 Summary of results

Table 8 shows the results of the RF near-field emissions tests.

Wireless Device: BlackBerry Wireless Handheld – Model: R6230GE								
RF Emissions Test								
Mode	**f (MHz)**	**Cond. Power (dBm)**	**Peak E-Field (V/m)**	**Peak E-Field Delta after 360° Rotation* (V/m)**	**Net Peak E-field** (V/m)**	**Centered at mid Speaker or T-Coil**	**Battery Number**	**M-Rating**
GSM 1900	1850.2	29.8	82.0	0.46	82.46	Speaker	1	3
	1880.0	29.9	77.2	-	77.20	Speaker	1	3
	1909.8	30.0	70.6	-	70.60	Speaker	1	3
	1850.2	29.8	79.6	0.72	80.32	T-Coil	1	3
	1880.0	29.9	75.1	-	75.10	T-Coil	1	3
	1909.8	30.0	74.8	-	74.80	T-Coil	1	3
	1850.2	29.8	83.7	0.00	83.70	Speaker	2	3
Mode	**f (MHz)**	**Cond. Power (dBm)**	**Peak H-Field (A/m)**	**Peak H-Field Delta after 360° Rotation* (A/m)**	**Net Peak H-Field** (A/m)**	**Centered at mid Speaker or T-Coil**	**Battery Number**	**M-Rating**
GSM 1900	1850.2	29.8	0.200	0.018	0.218	Speaker	1	3
	1880.0	29.9	0.200	-	0.200	Speaker	1	3
	1909.8	30.0	0.184	-	0.184	Speaker	1	3
	1850.2	29.8	0.201	0.013	0.214	T-Coil	1	3
	1880.0	29.9	0.182	-	0.182	T-Coil	1	3
	1909.8	30.0	0.169	-	0.169	T-Coil	1	3
	1850.2	29.8	0.225	0.018	0.243	T-Coil	2	3
Overall M-Rating:								**M3**

Table 8 – Data Summary

*Peak Delta = (Maximum reading during rotation – Reading at 0^{o} rotation) x Probe Modulation Factor

**Net Peak Field = Peak Field + Peak Delta

6.1 Conclusion

The RIM BlackBerry 7230 Wireless Handheld Model Number R6230GE is categorized to be M3 based on RF performance in accordance with ANSI C63.19-2001, Rev. 3.6: American National Standard for Methods of Measurement of Compatibility between Wireless Communication Devices and Hearing Aids.

Therefore, the handheld is found to be in compliance with the requirements of FCC 20.19 (10-1-04 Edition) Hearing Aid-Compatible Mobile Handsets.

7.0 Measurement uncertainty

Table 9 outlines the measurement uncertainty for the SPEAG DASY4 measurement system.

HAC Uncertainty Budget
According to ANSI C63.19 [1]

Error Description	Uncertainty value	Prob. Dist.	Div.	(c_i) E	(c_i) H	Std. Unc. E	Std. Unc. H
Measurement System							
Probe Calibration	±5.1 %	N	1	1	1	±5.1 %	±5.1 %
Axial Isotropy	±4.7 %	R	$\sqrt{3}$	1	1	±2.7 %	±2.7 %
Sensor Displacement	±16.5 %	R	$\sqrt{3}$	1	0.145	±9.5 %	±1.4 %
Boundary Effects	±2.4 %	R	$\sqrt{3}$	1	1	±1.4 %	±1.4 %
Linearity	±4.7 %	R	$\sqrt{3}$	1	1	±2.7 %	±2.7 %
Scaling to Peak Envelope Power	±2.0 %	R	$\sqrt{3}$	1	1	±1.2 %	±1.2 %
System Detection Limit	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %
Readout Electronics	±0.3 %	N	1	1	1	±0.3 %	±0.3 %
Response Time	±0.8 %	R	$\sqrt{3}$	1	1	±0.5 %	±0.5 %
Integration Time	±2.6 %	R	$\sqrt{3}$	1	1	±1.5 %	±1.5 %
RF Ambient Conditions	±3.0 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %
RF Reflections	±12.0 %	R	$\sqrt{3}$	1	1	±6.9 %	±6.9 %
Probe Positioner	±1.2 %	R	$\sqrt{3}$	1	0.67	±0.7 %	±0.5 %
Probe Positioning	±4.7 %	R	$\sqrt{3}$	1	0.67	±2.7 %	±1.8 %
Extrap. and Interpolation	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %
Test Sample Related							
Device Positioning Vertical	±4.7 %	R	$\sqrt{3}$	1	0.67	±2.7 %	±1.8 %
Device Positioning Lateral	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %
Device Holder and Phantom	±2.4 %	R	$\sqrt{3}$	1	1	±1.4 %	±1.4 %
Power Drift	±5.0 %	R	$\sqrt{3}$	1	1	±2.9 %	±2.9 %
Phantom and Setup Related							
Phantom Thickness	±2.4 %	R	$\sqrt{3}$	1	0.67	±1.4 %	±0.9 %
Combined Std. Uncertainty						±14.7 %	±10.9 %
Expanded Std. Uncertainty on Power						±29.4 %	±21.8 %
Expanded Std. Uncertainty on Field						±14.7 %	±10.9 %

Table 9. Worst-Case uncertainty budget for HAC free field assessment according to ANSI C63.19.

[1] The budget is valid for the frequency range 800 MHz - 3 GHz and represents a worst-case analysis.

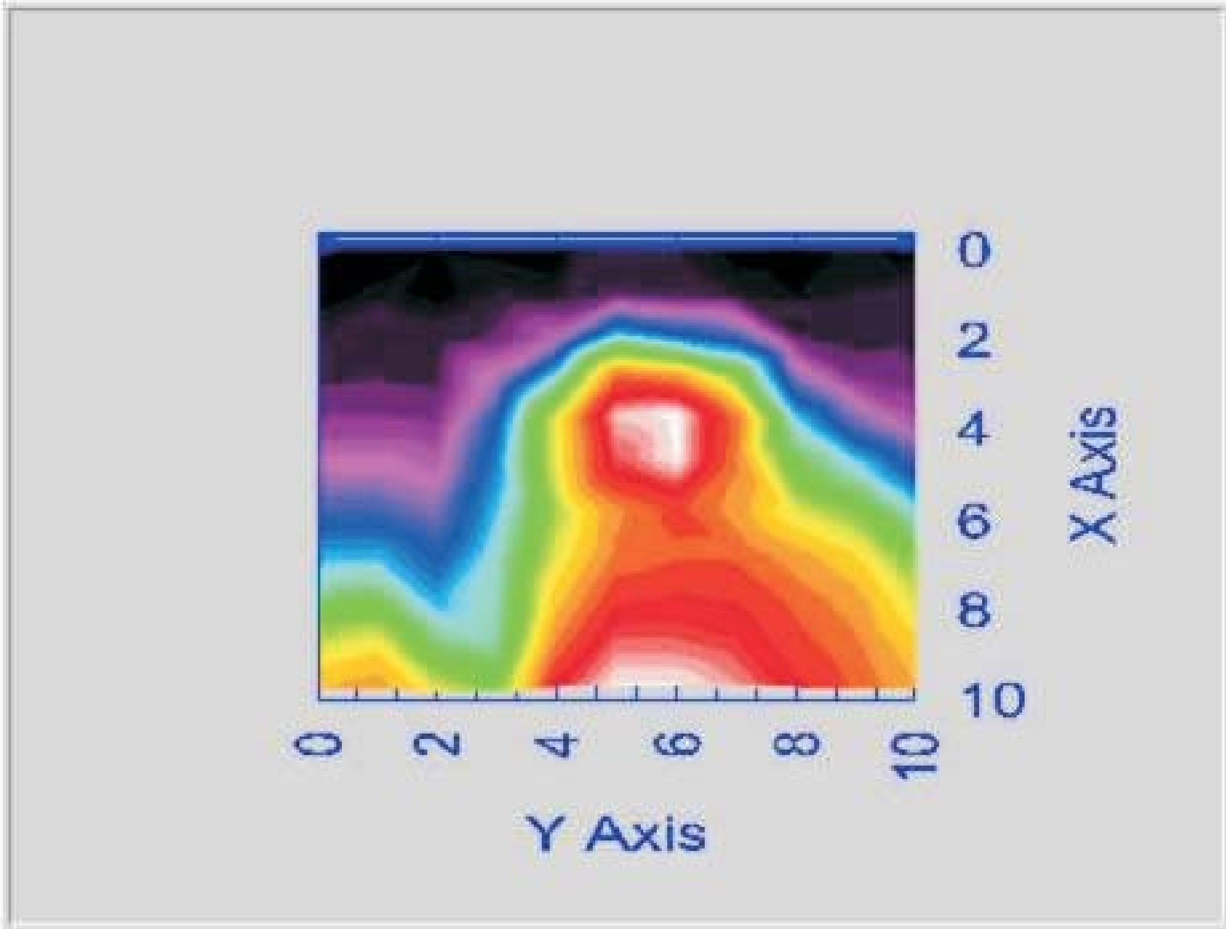
8.0 Annexes

Annex A: Measurement plots and data

A.1 T-Coil axial data and plot

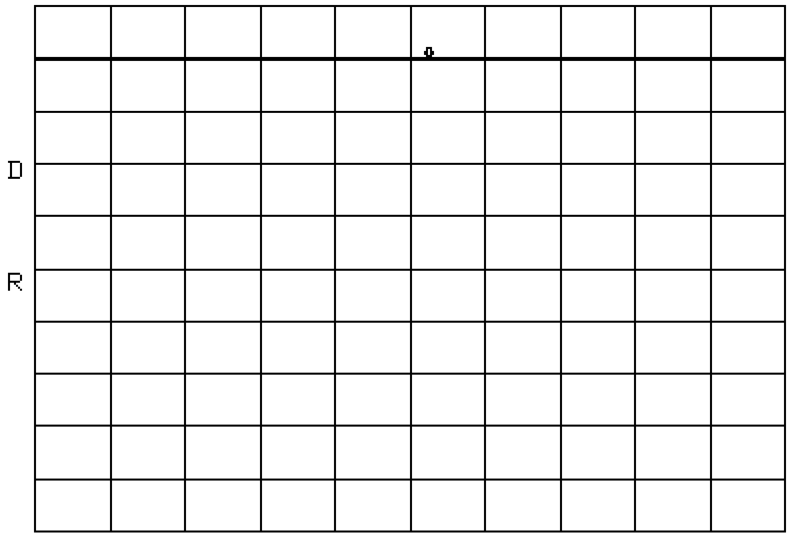
x/y (mm) T-Coil Scan to find centre

	0	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Audio Band	0	-32.034	-32.011	-31.821	-31.957	-32.006	-32.242	-32.309	-32	-31.822	-31.728	-31.887
Magnetic Field	0.5	-31.884	-31.849	-31.828	-31.812	-31.823	-31.297	-31.887	-31.591	-31.81	-31.775	-31.846
dB(A./m)	1	-31.76	-31.701	-31.737	-31.207	-28.924	-27.903	-25.209	-26.71	-31.301	-31.587	-31.609
	1.5	-31.46	-31.315	-31.362	-28.746	-23.017	-16.846	-16.738	-19.685	-28.26	-30.791	-31.189
	2	-30.84	-30.867	-30.93	-27.077	-19.31	-12.191	-11.588	-17.739	-26.342	-28.456	-29.998
	2.5	-29.739	-29.776	-30.124	-26.557	-18.916	-13.524	-12.122	-17.393	-22.884	-25.336	-27.764
	3	-28.074	-27.988	-28.861	-26.074	-21.32	-17.811	-16.934	-18.729	-20.98	-22.431	-25.042
	3.5	-26.107	-25.991	-27.606	-25.53	-21.302	-18.511	-17.994	-17.995	-19.177	-20.358	-22.872
	4	-23.859	-23.354	-26.102	-25.379	-20.237	-17.224	-16.813	-17.01	-18.11	-19.157	-21.256
	4.5	-21.567	-20.619	-23.886	-24.836	-18.725	-15.677	-15.712	-16.102	-17.461	-18.48	-20.215
	5	-19.568	-18.907	-21.041	-23.074	-16.617	-14.334	-14.264	-15.148	-16.566	-17.95	-19.417

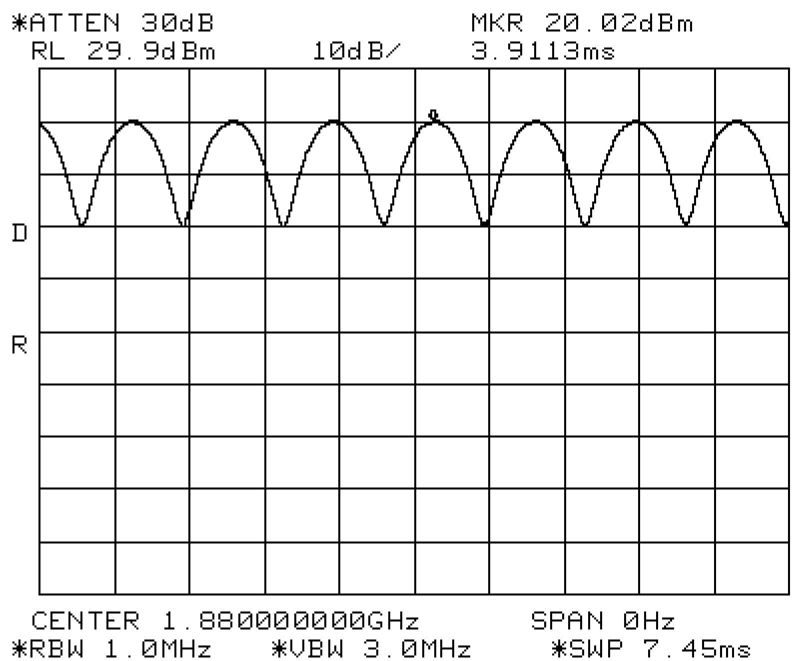

0
2
4
6
8
10
X Axis
0
2
4
6
8
10
Y Axis

A.2 Spectrum analyser plots : CW, 80 % AM and GSM signals

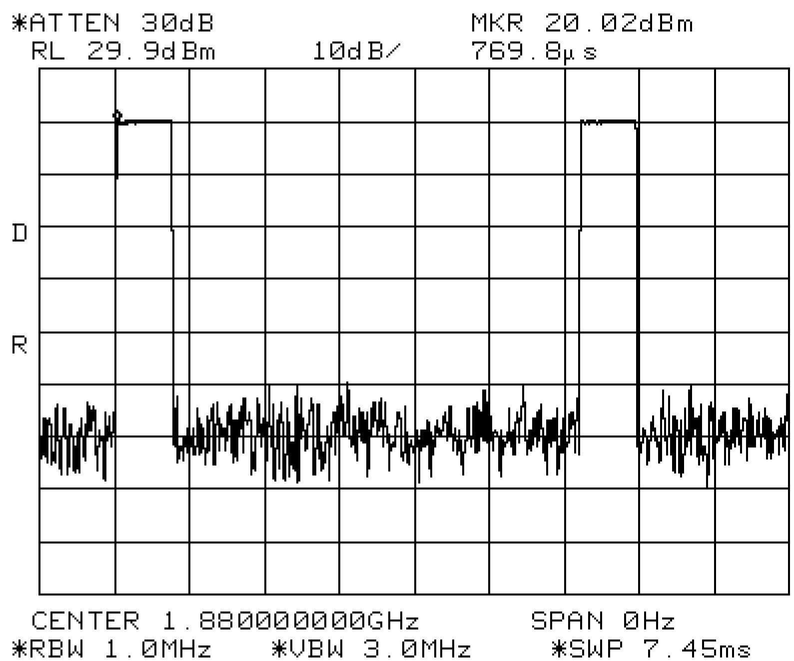
*ATTEN 30dB MKR 20.02dBm
RL 29.9dBm 10dB/ 3.9113ms



CENTER 1.880000000GHz SPAN 0Hz
*RBW 1.0MHz *VBW 3.0MHz *SWP 7.45ms



*ATTEN 30dB
RL 29.9dBm
10dB/
MKR 20.02dBm
3.9113ms
D
R
CENTER 1.880000000GHz
SPAN 0Hz
*RBW 1.0MHz
*VBW 3.0MHz
*SWP 7.45ms


*ATTEN 30dB
RL 29.9dBm
10dB/
MKR 20.02dBm
769.8μs
D
R
CENTER 1.880000000GHz
SPAN 0Hz
*RBW 1.0MHz
*VBW 3.0MHz
*SWP 7.45ms

A.3 Dipole validation and probe modulation factor plots

Please note that all contour plots show RMS values.

Date/Time: 27/05/2005 10:38:31 AM

Test Laboratory: RTS

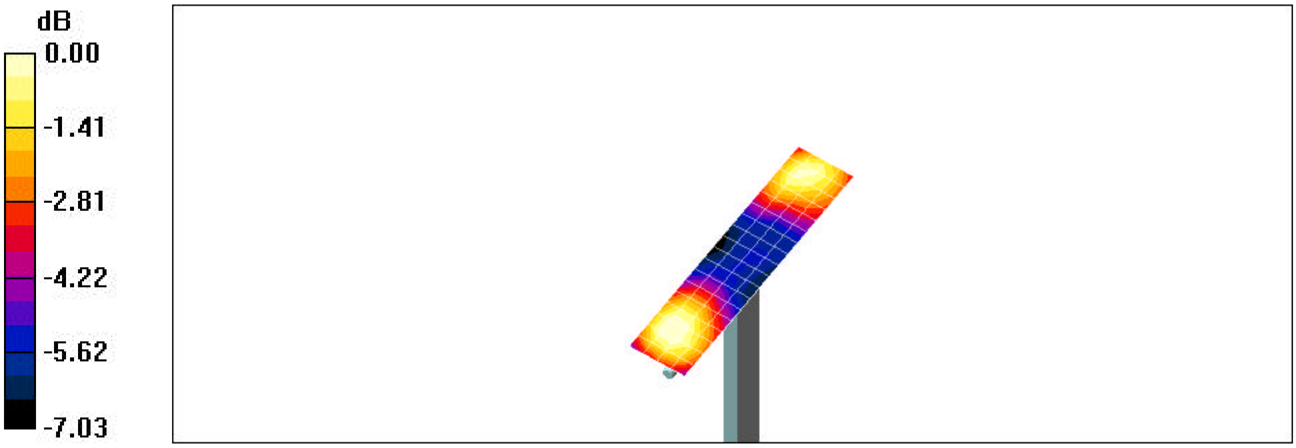
Dipole validation_CW 1880 MHz_E-Field

DUT: HAC Dipole 1880 MHz; Type: CD1880V3

Communication System: CW; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: s = 0 mho/m, e_r = 1; ? = 1000 kg/m^3
Phantom section: H Device Section

DASY4 Configuration:
- Probe: ER3DV6 - SN2285; ConvF(1, 1, 1); Calibrated: 10/12/2004
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn472; Calibrated: 03/01/2005
- Phantom: HAC Test Arch; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

E Scan 10mm above CD 1880 MHz/Hearing Aid Compatibility Test (5x19x1):
Measurement grid: dx=5mm, dy=5mm
Maximum value of Total (measured) = 138.2 V/m



0 dB = 138.2V/m

Date/Time: 27/05/2005 10:44:47 AM

Test Laboratory: RTS

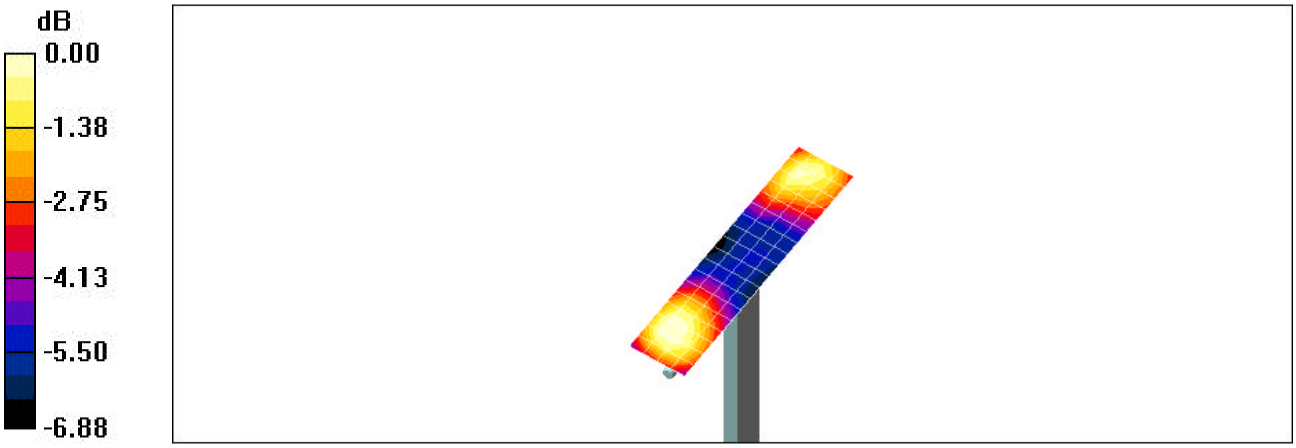
Dipole validation_ 80 % AM_1880 MHz_E-Field

DUT: HAC Dipole 1880 MHz; Type: CD1880V3

Communication System: CW; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: s = 0 mho/m, e_r = 1; ? = 1000 kg/m^3
Phantom section: H Device Section

DASY4 Configuration:
- Probe: ER3DV6 - SN2285; ConvF(1, 1, 1); Calibrated: 10/12/2004
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn472; Calibrated: 03/01/2005
- Phantom: HAC Test Arch; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

E Scan 10mm above CD 1880 MHz/Hearing Aid Compatibility Test (5x19x1):
Measurement grid: dx=5mm, dy=5mm
Maximum value of Total (measured) = 85.5 V/m



0 dB = 85.5V/m

Date/Time: 27/05/2005 10:52:39 AM

Test Laboratory: RTS

Dipole validation_ GSM 1880 MHz_E-Field

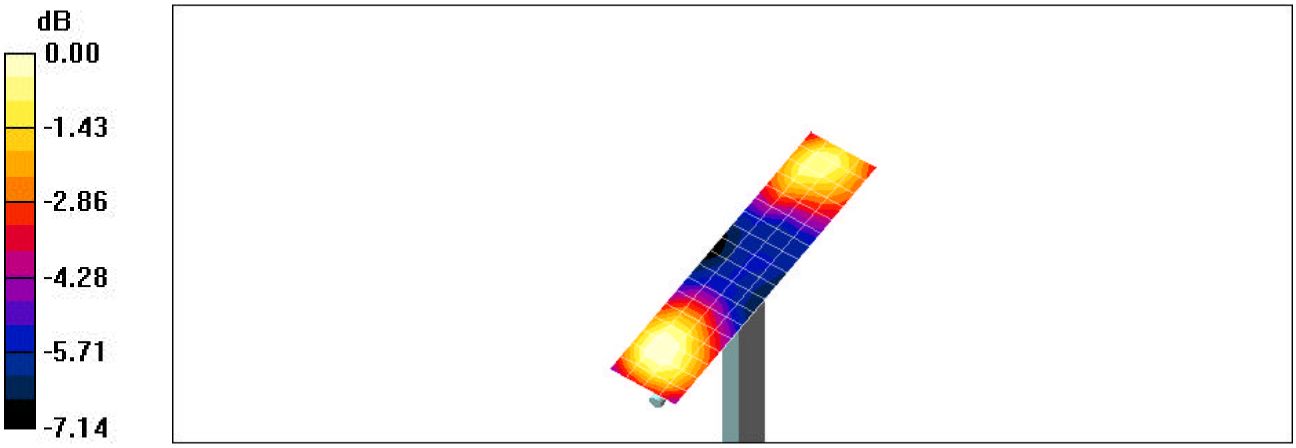
DUT: HAC Dipole 1880 MHz; Type: CD1880V3

Communication System: GSM 1900; Frequency: 1880 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: s = 0 mho/m, e_r = 1; ? = 1000 kg/m^3
Phantom section: H Device Section

DASY4 Configuration:
- Probe: ER3DV6 - SN2285; ConvF(1, 1, 1); Calibrated: 10/12/2004
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn472; Calibrated: 03/01/2005
- Phantom: HAC Test Arch; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

E Scan 10mm above CD 1880 MHz/Hearing Aid Compatibility Test (5x19x1):

Measurement grid: dx=5mm, dy=5mm
Maximum value of Total (measured) = 48.3 V/m



0 dB = 48.3V/m

Date/Time: 30/05/2005 9:27:05 AM

Test Laboratory: RTS

HAC_H_Dipole_CW_05-30-2005

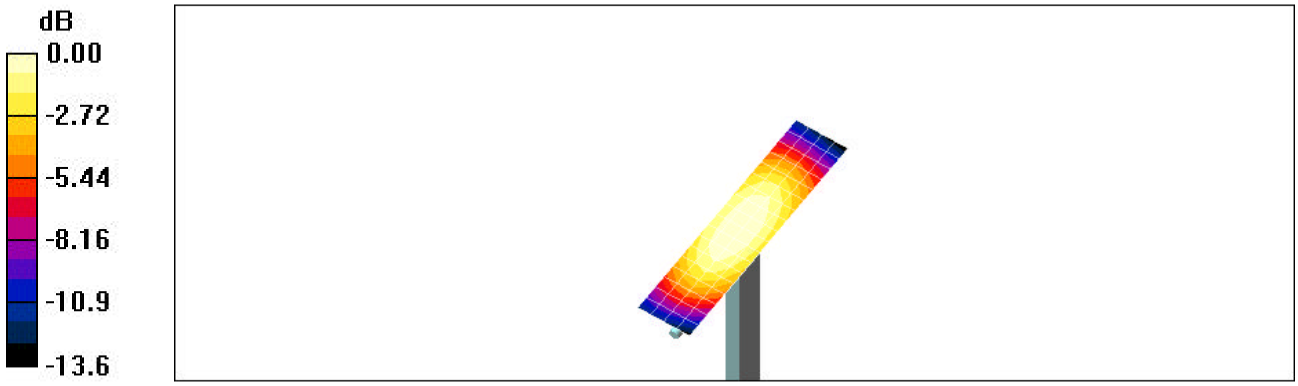
DUT: HAC Dipole 1880 MHz; Type: CD1880V3

Communication System: CW; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: s = 0 mho/m, e_r = 1; ? = 1 kg/m^3
Phantom section: H Dipole Section

DASY4 Configuration:
- Probe: H3DV6 - SN6105; ; Calibrated: 10/12/2004
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn472; Calibrated: 03/01/2005
- Phantom: HAC Test Arch; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

H Scan 10mm above CD 1880 MHz/Hearing Aid Compatibility Test (5x19x1):

Measurement grid: dx=5mm, dy=5mm
Maximum value of Total (measured) = 0.423 A/m



0 dB = 0.423A/m

Date/Time: 30/05/2005 9:36:41 AM

Test Laboratory: RTS

HAC_H_Dipole_AM80% _05-30-2005

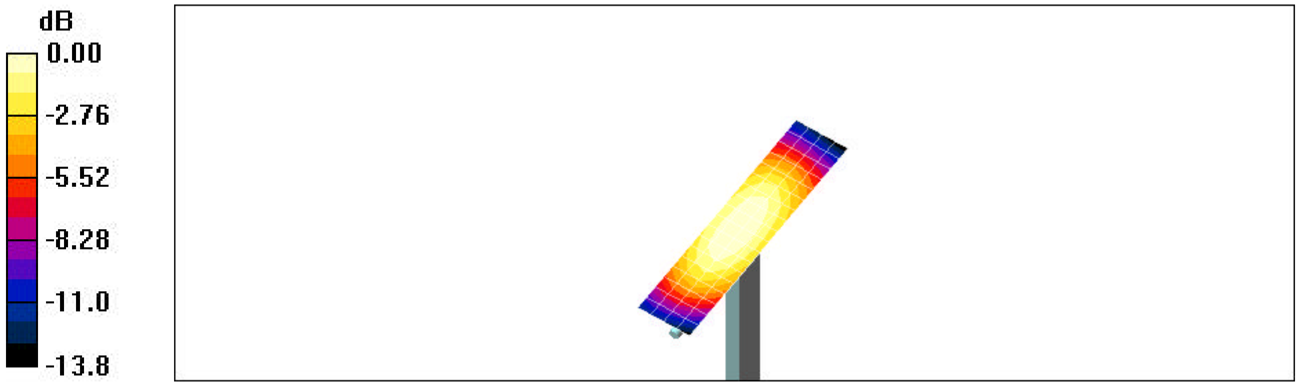
DUT: HAC Dipole 1880 MHz; Type: CD1880V3

Communication System: CW; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: s = 0 mho/m, e_r = 1; ? = 1 kg/m^3
Phantom section: H Dipole Section

DASY4 Configuration:
- Probe: H3DV6 - SN6105; ; Calibrated: 10/12/2004
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn472; Calibrated: 03/01/2005
- Phantom: HAC Test Arch; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

H Scan 10mm above CD 1880 MHz/Hearing Aid Compatibility Test (5x19x1):

Measurement grid: dx=5mm, dy=5mm
Maximum value of Total (measured) = 0.271 A/m



0 dB = 0.271A/m

Date/Time: 30/05/2005 9:44:42 AM

Test Laboratory: RTS

HAC_H_Dipole_GSM1880 _05-30-2005

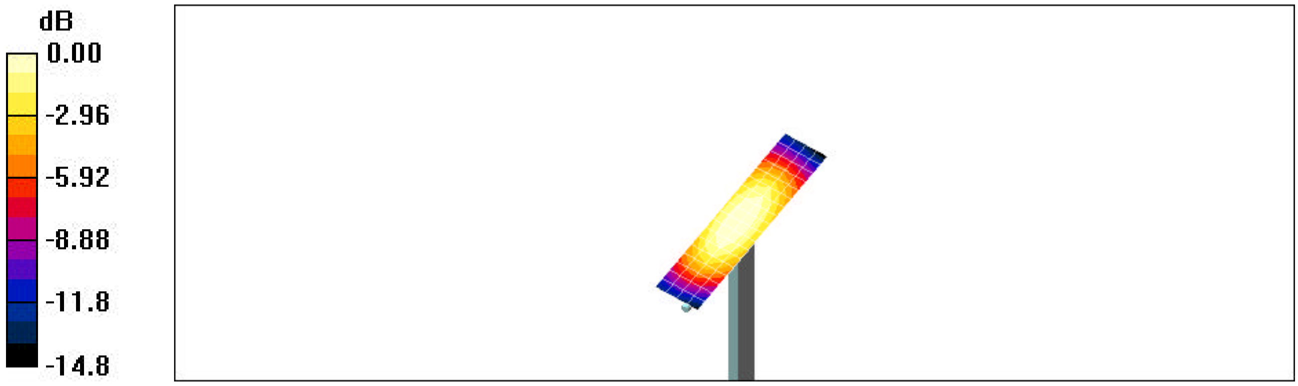
DUT: HAC Dipole 1880 MHz; Type: CD1880V3

Communication System: GSM 1900; Frequency: 1880 MHz;Duty Cycle: 1:8.3
Medium: Air Medium parameters used: s = 0 mho/m, e_r = 1; ? = 1 kg/m^3
Phantom section: H Dipole Section

DASY4 Configuration:
- Probe: H3DV6 - SN6105; ; Calibrated: 10/12/2004
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn472; Calibrated: 03/01/2005
- Phantom: HAC Test Arch; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

H Scan 10mm above CD 1880 MHz/Hearing Aid Compatibility Test (5x19x1):

Measurement grid: dx=5mm, dy=5mm
Maximum value of Total (measured) = 0.168 A/m



0 dB = 0.168A/m

A.4 Worst case RF emission field plots

- **indicates location of the probe rotation.**
- **The yellow shading shows exclusion blocks.**

Date/Time: 27/05/2005 12:44:51 PM

Test Laboratory: RTS

BB 7230 Model R6230GE_GSM 1900_Low Channel_Speaker Center_E-Field

DUT: BlackBerry Wireless Handheld; Type: Sample

Communication System: GSM 1900; Frequency: 1850.2 MHz;Duty Cycle: 1:8.18
Medium: Air Medium parameters used: s = 0 mho/m, e_r = 1; ? = 1000 kg/m^3
Phantom section: H Device Section

DASY4 Configuration:
- Probe: ER3DV6 - SN2285; ConvF(1, 1, 1); Calibrated: 10/12/2004
- Sensor-Surface: 0mm (Fix Surface)Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn472; Calibrated: 03/01/2005
- Phantom: HAC Test Arch; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

E Scan 10mm above Device Reference/Hearing Aid Compatibility Test (11x11x1):
Measurement grid: dx=5mm, dy=5mm
Maximum value of Total (measured) = 31.4 V/m

E Scan 10mm above Device Reference/Hearing Aid Compatibility Test (101x101x1):
Measurement grid: dx=5mm, dy=5mm
Maximum value of Total field (slot averaged) = 82.0 V/m
Hearing Aid Near-Field Category: M3 (AWF -5 dB)

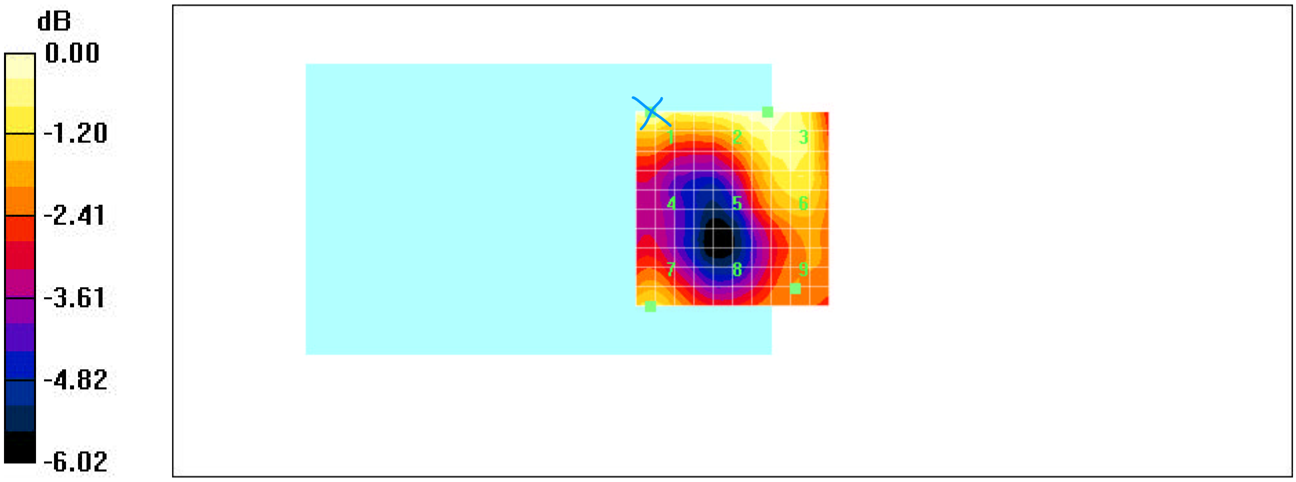
E in V/m (Time averaged)

Grid 1 **31.4**	Grid 2 **31.0**	Grid 3 **31.1**
Grid 4 **22.1**	Grid 5 **26.3**	Grid 6 **28.7**
Grid 7 **28.1**	Grid 8 **24.3**	Grid 9 **25.1**

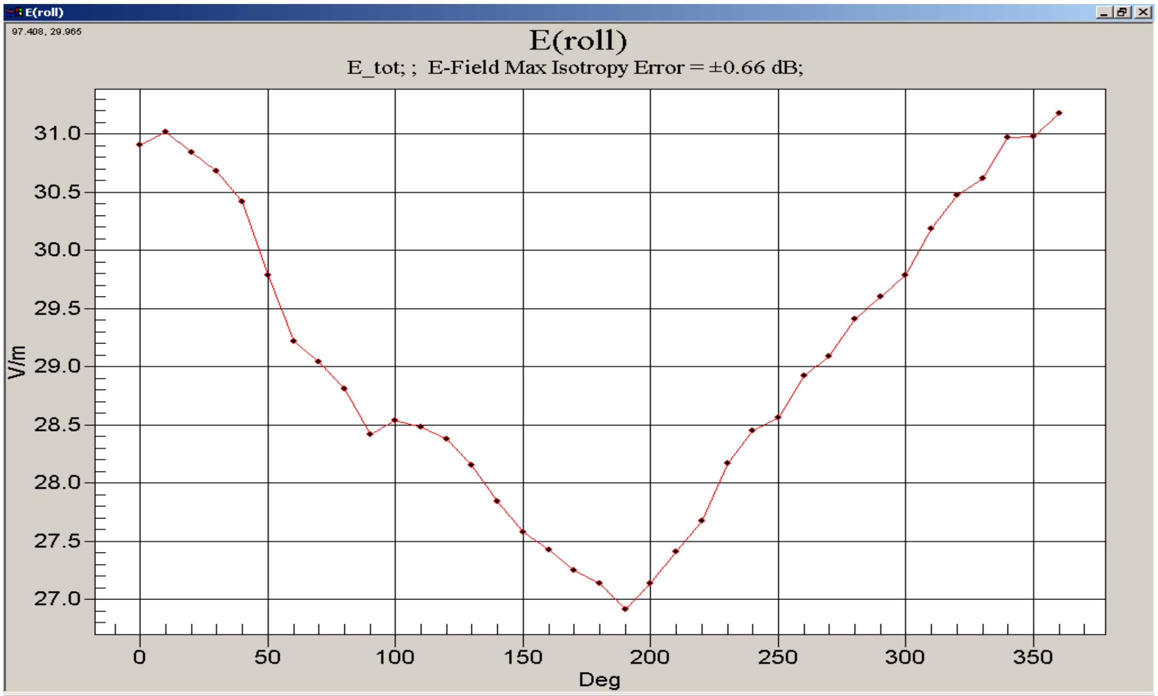
E in V/m (Slot averaged)

Grid 1 **89.9**	Grid 2 **88.7**	Grid 3 **88.8**
Grid 4 **63.3**	Grid 5 **75.1**	Grid 6 **82.0**
Grid 7 **80.4**	Grid 8 **69.5**	Grid 9 **71.8**

Category	AWF (dB)	Limits for E-Field Emissions (V/m)	Limits for H-Field Emissions (A/m)
M1	0	199.5 - 354.8	0.6 - 1.07
	-5	149.6 - 266.1	0.45 - 0.8
M2	0	112.2 - 199.5	0.34 - 0.6
	-5	84.1 - 149.6	0.25 - 0.45
M3	0	63.1 - 112.2	0.19 - 0.34
	-5	47.3 - 84.1	0.15 - 0.25
M4	0	<63.1	<0.19
	-5	<47.3	<0.15



0 dB = 31.4V/m



Delta Peak E-Field (V/m) = (Max. RMS Field – RMS Field at 0 degrees) * Modulation Factor
= (31.17 – 31.01) * 2.86
= 0.16 * 2.86
= 0.46

Date/Time: 27/05/2005 3:14:57 PM

Test Laboratory: RTS

BB 7230 Model R6230GE_GSM 1900_Low Channel_T-Coil Center_E-Field

DUT: BlackBerry Wireless Handheld; Type: Sample

Communication System: GSM 1900; Frequency: 1850.2 MHz;Duty Cycle: 1:8.18
Medium: Air Medium parameters used: s = 0 mho/m, e_r = 1; ? = 1000 kg/m^3
Phantom section: H Device Section

DASY4 Configuration:
- Probe: ER3DV6 - SN2285; ConvF(1, 1, 1); Calibrated: 10/12/2004
- Sensor-Surface: 0mm (Fix Surface)Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn472; Calibrated: 03/01/2005
- Phantom: HAC Test Arch; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

E Scan 10mm above Device Reference/Hearing Aid Compatibility Test (11x11x1):
Measurement grid: dx=5mm, dy=5mm
Maximum value of Total (measured) = 30.2 V/m

E Scan 10mm above Device Reference/Hearing Aid Compatibility Test (101x101x1):
Measurement grid: dx=5mm, dy=5mm
Maximum value of Total field (slot averaged) = 79.6 V/m
Hearing Aid Near-Field Category: M3 (AWF -5 dB)

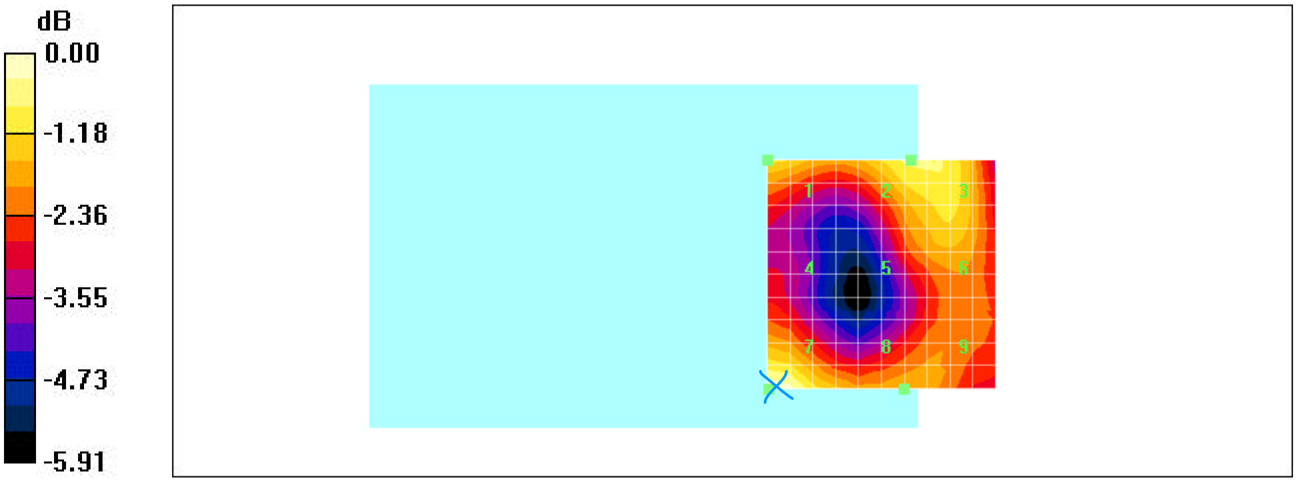
E in V/m (Time averaged)

Grid 1 **26.8**	Grid 2 **27.8**	Grid 3 **27.7**
Grid 4 **22.5**	Grid 5 **24.5**	Grid 6 **25.9**
Grid 7 **30.2**	Grid 8 **25.2**	Grid 9 **25.0**

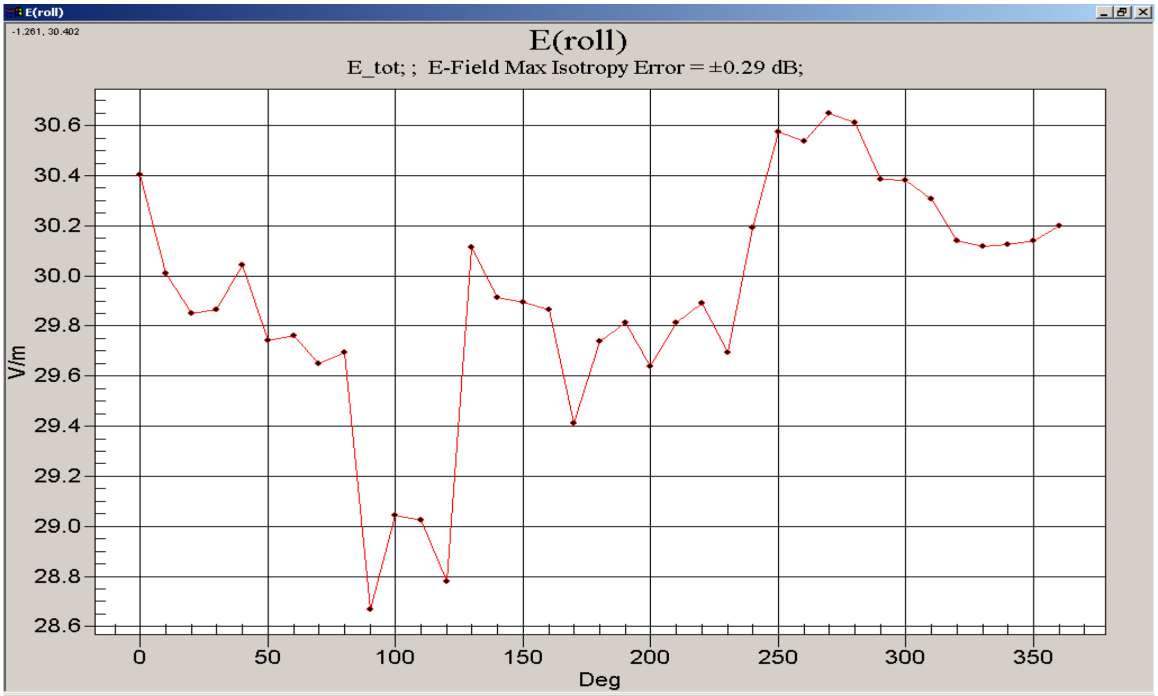
E in V/m (Slot averaged)

Grid 1 **76.6**	Grid 2 **79.6**	Grid 3 **79.3**
Grid 4 **64.5**	Grid 5 **70.0**	Grid 6 **74.0**
Grid 7 **86.3**	Grid 8 **72.2**	Grid 9 **71.6**

Category	AWF (dB)	Limits for E-Field Emissions (V/m)	Limits for H-Field Emissions (A/m)
M1	0	199.5 - 354.8	0.6 - 1.07
	-5	149.6 - 266.1	0.45 - 0.8
M2	0	112.2 - 199.5	0.34 - 0.6
	-5	84.1 - 149.6	0.25 - 0.45
M3	0	63.1 - 112.2	0.19 - 0.34
	-5	47.3 - 84.1	0.15 - 0.25
M4	0	<63.1	<0.19
	-5	<47.3	<0.15



0 dB = 30.2V/m



Delta Peak E-Field (V/m) = (Max. RMS Field – RMS Field at 0 degrees) * Modulation Factor
= (30.66 – 30.41) * 2.86
= 0.25 * 2.86
= 0.72

Date/Time: 27/05/2005 4:27:27 PM

Test Laboratory:RTS

BB 7230 Model R6230GE_GSM 1900_Low Channel_Speaker Center_E-Field_Battery 2

DUT: BlackBerry Wireless Handheld; Type: Sample

Communication System: GSM 1900; Frequency: 1850.2 MHz;Duty Cycle: 1:8.18
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Phantom section: H Device Section

DASY4 Configuration:
- Probe: ER3DV6 - SN2285; ConvF(1, 1, 1); Calibrated: 10/12/2004
- Sensor-Surface: 0mm (Fix Surface)Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn472; Calibrated: 03/01/2005
- Phantom: HAC Test Arch; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

E Scan 10mm above Device Reference/Hearing Aid Compatibility Test (11x11x1):
Measurement grid: dx=5mm, dy=5mm
Maximum value of Total (measured) = 31.4 V/m

E Scan 10mm above Device Reference/Hearing Aid Compatibility Test (101x101x1):
Measurement grid: dx=5mm, dy=5mm
Maximum value of Total field (slot averaged) = 83.7 V/m
Hearing Aid Near-Field Category: M3 (AWF -5 dB)

E in V/m (Time averaged)

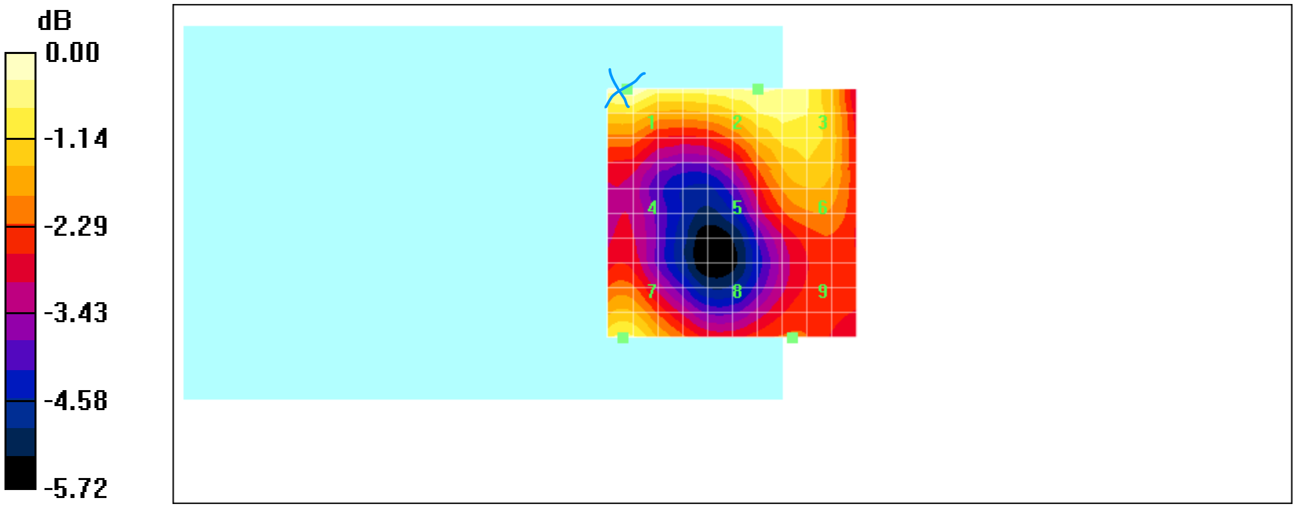
Grid 1 **31.5**	Grid 2 **30.5**	Grid 3 **30.3**
Grid 4 **22.9**	Grid 5 **25.6**	Grid 6 **27.2**
Grid 7 **29.3**	Grid 8 **24.2**	Grid 9 **24.4**

E in V/m (Slot averaged)

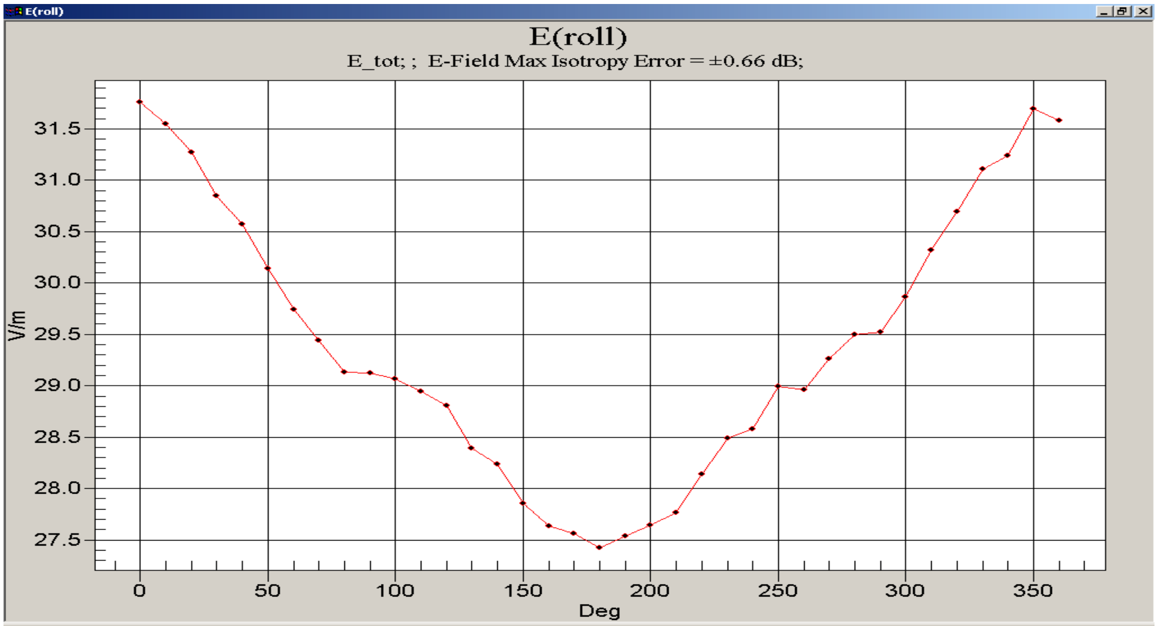
Grid 1 **90.0**	Grid 2 **87.3**	Grid 3 **86.6**
Grid 4 **65.4**	Grid 5 **73.1**	Grid 6 **77.9**
Grid 7 **83.7**	Grid 8 **69.2**	Grid 9 **69.8**

Category	AWF (dB)	Limits for E-Field Emissions (V/m)	Limits for H-Field Emissions (A/m)
M1	0	199.5 - 354.8	0.6 - 1.07
	-5	149.6 - 266.1	0.45 - 0.8
M2	0	112.2 - 199.5	0.34 - 0.6
	-5	84.1 - 149.6	0.25 - 0.45
M3	0	63.1 - 112.2	0.19 - 0.34
	-5	47.3 - 84.1	0.15 - 0.25

M4	0	<63.1	<0.19
	-5	<47.3	<0.15



0 dB = 31.5V/m



Delta Peak E-Field (V/m) = (Max. RMS Field – RMS Field at 0 degrees) * Modulation Factor
= (31.78 – 31.78) * 2.86
= 0 * 2.86
= 0

Date/Time: 30/05/2005 10:14:03 AM

Test Laboratory: RTS

BB 7230 Model R6230GE_GSM 1900_Low Channel_Speaker Center_H-Field

DUT: BlackBerry Wireless Handheld; Type: Sample

Communication System: GSM 1900; Frequency: 1850.2 MHz;Duty Cycle: 1:6.35
Medium: Air Medium parameters used: s = 0 mho/m, e_r = 1; ? = 1 kg/m^3
Phantom section: H Device Section

DASY4 Configuration:
- Probe: H3DV6 - SN6105; ; Calibrated: 10/12/2004
- Sensor-Surface: 0mm (Fix Surface)Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn472; Calibrated: 03/01/2005
- Phantom: HAC Test Arch; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

H Scan 10mm above Device Reference/Hearing Aid Compatibility Test (11x11x1):
Measurement grid: dx=5mm, dy=5mm
Maximum value of Total (measured) = 0.079 A/m

H Scan 10mm above Device Reference/Hearing Aid Compatibility Test (101x101x1):
Measurement grid: dx=5mm, dy=5mm
Maximum value of Total field (slot averaged) = 0.200 A/m
Hearing Aid Near-Field Category: M3 (AWF -5 dB)

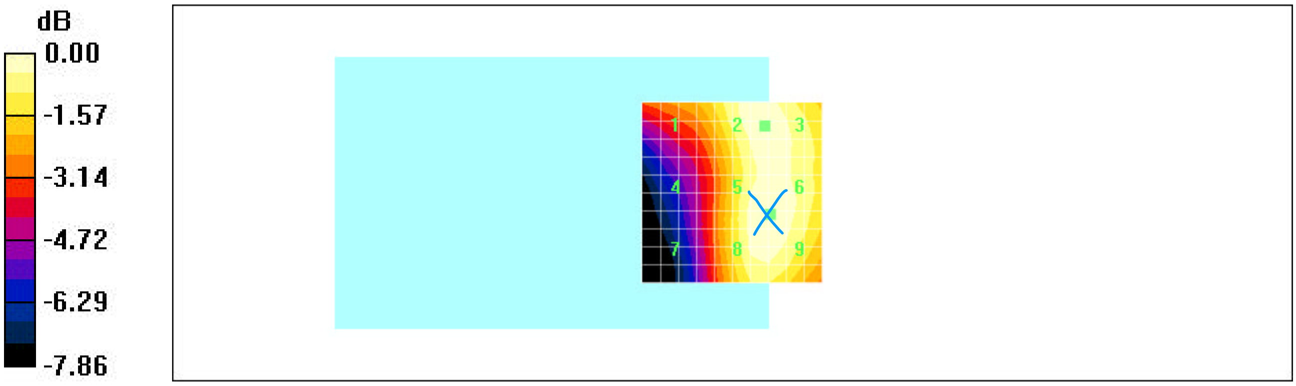
H in A/m (Time averaged)

Grid 1 **0.064**	Grid 2 **0.078**	Grid 3 **0.078**
Grid 4 **0.052**	Grid 5 **0.079**	Grid 6 **0.080**
Grid 7 **0.049**	Grid 8 **0.079**	Grid 9 **0.079**

H in A/m (Slot averaged)

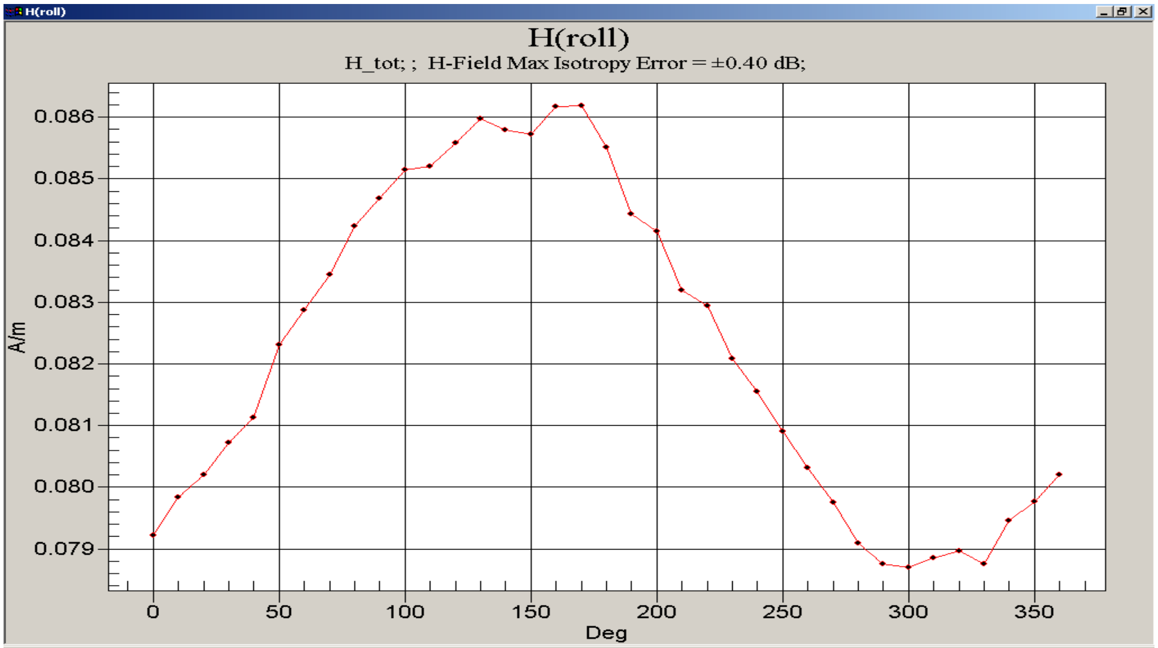
Grid 1 **0.161**	Grid 2 **0.197**	Grid 3 **0.197**
Grid 4 **0.130**	Grid 5 **0.200**	Grid 6 **0.200**
Grid 7 **0.122**	Grid 8 **0.199**	Grid 9 **0.200**

Category	AWF (dB)	Limits for E-Field Emissions (V/m)	Limits for H-Field Emissions (A/m)
M1	0	199.5 - 354.8	0.6 - 1.07
	-5	149.6 - 266.1	0.45 - 0.8
M2	0	112.2 - 199.5	0.34 - 0.6
	-5	84.1 - 149.6	0.25 - 0.45
M3	0	63.1 - 112.2	0.19 - 0.34
	-5	47.3 - 84.1	0.15 - 0.25
M4	0	<63.1	<0.19
	-5	<47.3	<0.15



0 dB = 0.080A/m

0 dB = 0.080A/m



Delta Peak H-Field (A/m) = (Max. RMS Field – RMS Field at 0 degrees) * Modulation Factor
= (0.086 – 0.079) * 2.52
= 0.007 * 2.52
= 0.018

Date/Time: 30/05/2005 11:05:44 AM

Test Laboratory: RTS

BB 7230 Model R6230GE_GSM 1900_Low Channel_T-Coil Center_H-Field

DUT: BlackBerry Wireless Handheld; Type: Sample

Communication System: GSM 1900; Frequency: 1850.2 MHz;Duty Cycle: 1:6.35
Medium: Air Medium parameters used: s = 0 mho/m, e_r = 1; ? = 1 kg/m^3
Phantom section: H Device Section

DASY4 Configuration:
- Probe: H3DV6 - SN6105; ; Calibrated: 10/12/2004
- Sensor-Surface: 0mm (Fix Surface)Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn472; Calibrated: 03/01/2005
- Phantom: HAC Test Arch; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

H Scan 10mm above Device Reference/Hearing Aid Compatibility Test (11x11x1):

Measurement grid: dx=5mm, dy=5mm
Maximum value of Total (measured) = 0.079 A/m

H Scan 10mm above Device Reference/Hearing Aid Compatibility Test (101x101x1):

Measurement grid: dx=5mm, dy=5mm
Maximum value of Total field (slot averaged) = 0.201 A/m
Hearing Aid Near-Field Category: M3 (AWF -5 dB)

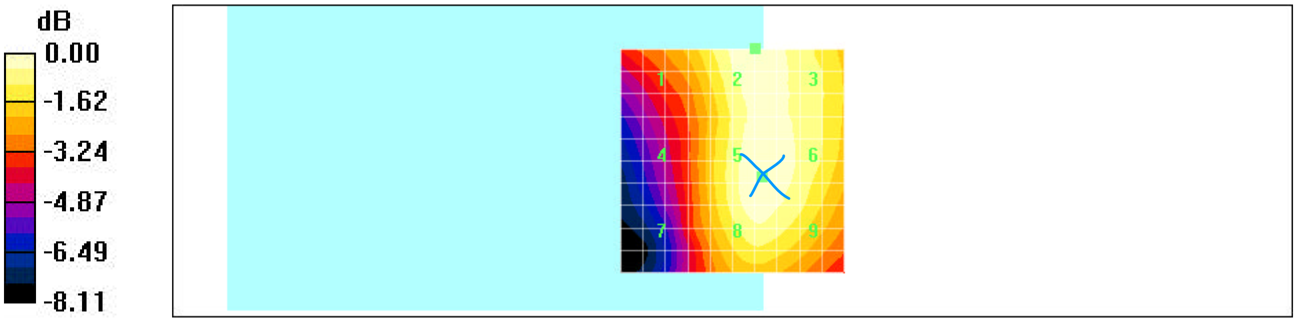
H in A/m (Time averaged)

Grid 1 **0.065**	Grid 2 **0.079**	Grid 3 **0.078**
Grid 4 **0.056**	Grid 5 **0.080**	Grid 6 **0.079**
Grid 7 **0.055**	Grid 8 **0.079**	Grid 9 **0.077**

H in A/m (Slot averaged)

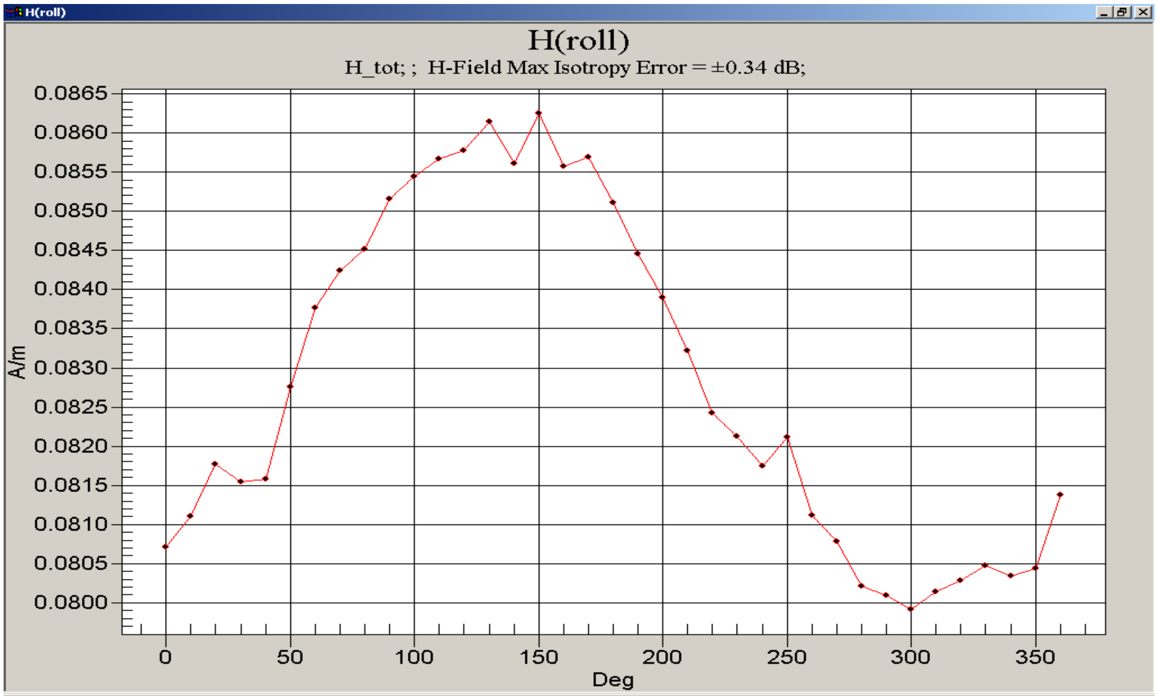
Grid 1 **0.163**	Grid 2 **0.199**	Grid 3 **0.196**
Grid 4 **0.142**	Grid 5 **0.201**	Grid 6 **0.199**
Grid 7 **0.139**	Grid 8 **0.198**	Grid 9 **0.195**

Category	AWF (dB)	Limits for E-Field Emissions (V/m)	Limits for H-Field Emissions (A/m)
M1	0	199.5 - 354.8	0.6 - 1.07
	-5	149.6 - 266.1	0.45 - 0.8
M2	0	112.2 - 199.5	0.34 - 0.6
	-5	84.1 - 149.6	0.25 - 0.45
M3	0	63.1 - 112.2	0.19 - 0.34
	-5	47.3 - 84.1	0.15 - 0.25
M4	0	<63.1	<0.19
	-5	<47.3	<0.15



0 dB = 0.080A/m

0 dB = 0.080A/m



Delta Peak H-Field (A/m) = (Max. RMS Field – RMS Field at 0 degrees) * Modulation Factor
= (0.086 – 0.081) * 2.52
= 0.005 * 2.52
= 0.013

Date/Time: 30/05/2005 11:47:57 AM

Test Laboratory: RTS

BB 7230 Model R6230GE_GSM 1900_Low Channel_T-Coil Center_H-Field_Batt. 2

DUT: BlackBerry Wireless Handheld; Type: Sample

Communication System: GSM 1900; Frequency: 1850.2 MHz;Duty Cycle: 1:6.35
Medium: Air Medium parameters used: s = 0 mho/m, e_r = 1; ? = 1 kg/m^3
Phantom section: H Device Section

DASY4 Configuration:
- Probe: H3DV6 - SN6105; ; Calibrated: 10/12/2004
- Sensor-Surface: 0mm (Fix Surface)Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn472; Calibrated: 03/01/2005
- Phantom: HAC Test Arch; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

H Scan 10mm above Device Reference/Hearing Aid Compatibility Test (11x11x1):

Measurement grid: dx=5mm, dy=5mm
Maximum value of Total (measured) = 0.089 A/m

H Scan 10mm above Device Reference/Hearing Aid Compatibility Test (101x101x1):

Measurement grid: dx=5mm, dy=5mm
Maximum value of Total field (slot averaged) = 0.225 A/m
Hearing Aid Near-Field Category: M3 (AWF -5 dB)

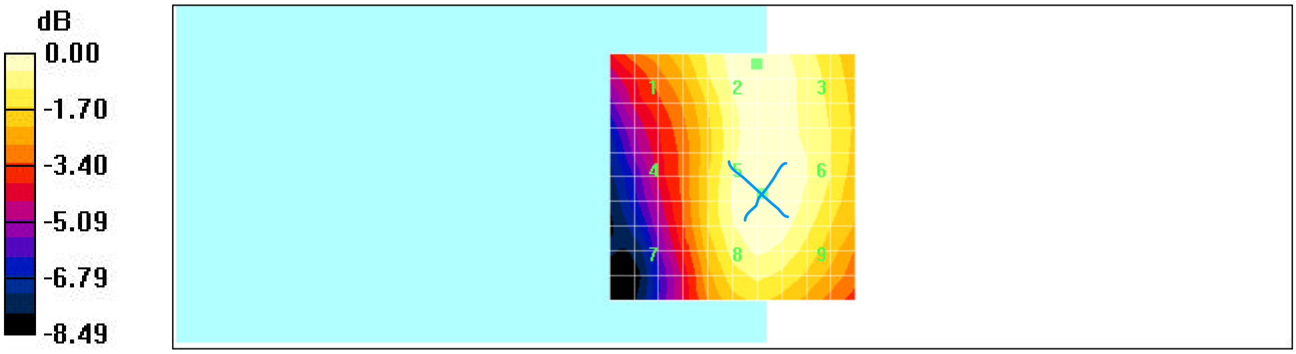
H in A/m (Time averaged)

Grid 1 **0.073**	Grid 2 **0.087**	Grid 3 **0.087**
Grid 4 **0.064**	Grid 5 **0.089**	Grid 6 **0.089**
Grid 7 **0.063**	Grid 8 **0.089**	Grid 9 **0.088**

H in A/m (Slot averaged)

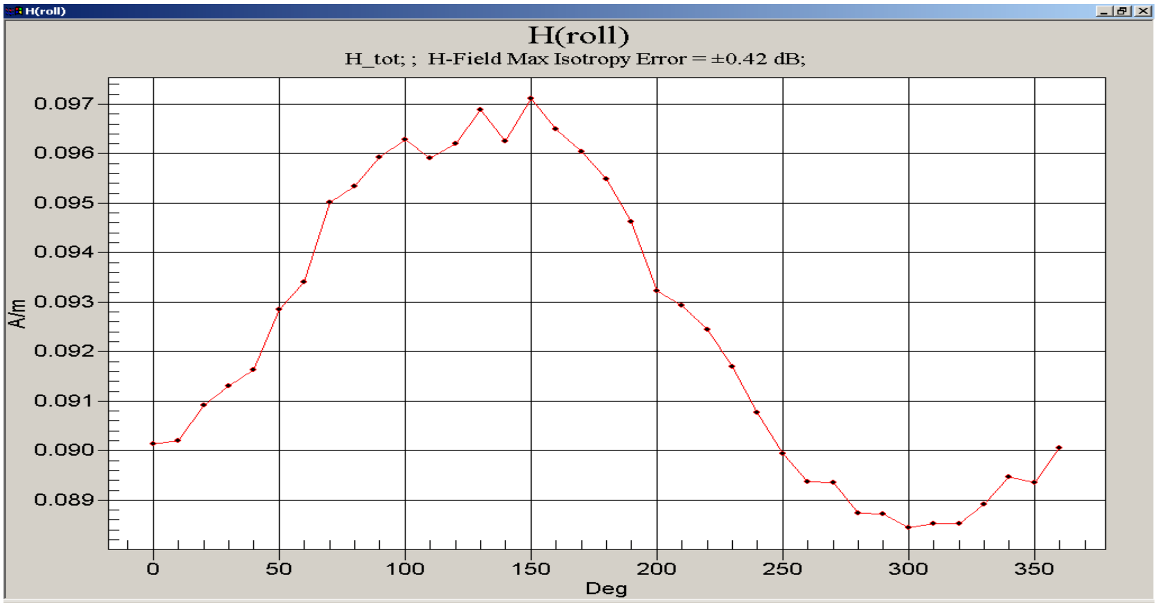
Grid 1 **0.185**	Grid 2 **0.220**	Grid 3 **0.218**
Grid 4 **0.162**	Grid 5 **0.225**	Grid 6 **0.224**
Grid 7 **0.159**	Grid 8 **0.223**	Grid 9 **0.221**

Category	AWF (dB)	Limits for E-Field Emissions (V/m)	Limits for H-Field Emissions (A/m)
M1	0	199.5 - 354.8	0.6 - 1.07
	-5	149.6 - 266.1	0.45 - 0.8
M2	0	112.2 - 199.5	0.34 - 0.6
	-5	84.1 - 149.6	0.25 - 0.45
M3	0	63.1 - 112.2	0.19 - 0.34
	-5	47.3 - 84.1	0.15 - 0.25
M4	0	<63.1	<0.19
	-5	<47.3	<0.15



0 dB = 0.089A/m

0 dB = 0.089A/m



Delta Peak H-Field (A/m) = (Max. RMS Field – RMS Field at 0 degrees) * Modulation Factor
= (0.097 – 0.090) * 2.52
= 0.007 * 2.52
= 0.018

Annex B: Probe and dipole calibration certificates

The description below is for the SPEAG E-field probe used for HAC RF emission measurements (Source: http://www.dasy4.com)

ER3DV6 Isotropic E-Field Probe for General Near-Field Measurements

Construction

- One dipole parallel, two dipoles normal to probe axis
- Built-in shielding against static charges
- PEEK enclosure material (resistant to organic solvents, e.g., glycolether)

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

- 2 V/m to > 1000 V/m; Linearity: ± 0.2 dB

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

Application

- General near-field measurements up to 6 GHz
- Field component measurements
- Fast automatic scanning in phantoms

The description below is for the SPEAG H-field probe used for HAC RF emission measurements (Source: http://www.dasy4.com)

H3DV6 3-Dimensional H-Field Probe for Small Band Applications

Construction

- Three concentric loop sensors with 3.8 mm loop diameters
- Resistively loaded detector diodes for linear response
- Built-in shielding against static charges
- PEEK enclosure material (resistant to organic solvents, e.g., glycolether)

Frequency

- 200 MHz to 3 GHz (absolute accuracy ± 6.0%, k=2); Output linearized

Directivity

- ± 0.25 dB (spherical isotropy error)

Dynamic Range

- 10 mA/m to 2 A/m at 1 GHz

E-Field Interference

- < 10% at 3 GHz (for plane wave)

Dimensions

- Overall length: 330 mm (Tip: 40 mm)
- Tip diameter: 6 mm (Body: 12 mm)
- Distance from probe tip to dipole centers: 3 mm

Application

- General magnetic near-field measurements up to 3 GHz
- Field component measurements
- Surface current measurements
- Measurements in air or liquids
- Low interaction with the measured field

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S Swiss Calibration Service

Accredited by the Swiss Federal Office of Metrology and Accreditation
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Client **RIM**

Certificate No: ER3-2285_Dec04

CALIBRATION CERTIFICATE

Object	**ER3DV6 - SN:2285**
Calibration procedure(s)	**QA CAL-02.v4** **Calibration procedure for E-field probes optimized for close near field evaluations in air**
Calibration date:	**December 10, 2004**
Condition of the calibrated item	**In Tolerance**

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 (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	5-May-04 (METAS, No. 251-00388)	May-05
Power sensor E4412A	MY41495277	5-May-04 (METAS, No. 251-00388)	May-05
Reference 3 dB Attenuator	SN: S5054 (3c)	10-Aug-04 (METAS, No. 251-00403)	Aug-05
Reference 20 dB Attenuator	SN: S5086 (20b)	3-May-04 (METAS, No. 251-00389)	May-05
Reference 30 dB Attenuator	SN: S5129 (30b)	10-Aug-04 (METAS, No. 251-00404)	Aug-05
Reference Probe ER3DV6	SN: 2328	6-Oct-04 (SPEAG, No. ER3-2328_Oct04)	Oct-05
DAE4	SN: 617	29-Sep-04 (SPEAG, No. DAE4-617_Sep04)	Sep-05

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092180	18-Sep-02 (SPEAG, in house check Oct-03)	In house check: Oct 05
RF generator HP 8648C	US3642U01700	4-Aug-99 (SPEAG, in house check Dec-03)	In house check: Dec-05
Network Analyzer HP 8753E	US37390585	18-Oct-01 (SPEAG, in house check Nov-04)	In house check: Nov 05

	Name	Function	Signature
Calibrated by:	**Nico Vetterli**	**Laboratory Technician**	N. Vetterli
Approved by:	**Katja Pokovic**	**Technical Manager**	Katja Pokovic

Issued: December 13, 2004

Glossary:

NORMx,y,z	sensitivity in free space
DCP	diode compression point
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 1309-1996, " IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", 1996.

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 (no uncertainty required). DCP does not depend on frequency.
- *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:2285

Manufactured:	September 20, 2002
Last calibrated:	January 12, 2004
Recalibrated:	December 10, 2004

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

DASY - Parameters of Probe: ER3DV6 SN:2285

Sensitivity in Free Space [$\mu V/(V/m)^2$]		Diode Compression[A]	
NormX	**1.24** ± 10.1 % (k=2)	DCP X	**95** mV
NormY	**1.41** ± 10.1 % (k=2)	DCP Y	**95** mV
NormZ	**1.55** ± 10.1 % (k=2)	DCP Z	**98** mV

Frequency Correction

X	**0.0**
Y	**0.0**
Z	**0.0**

Sensor Offset (Probe Tip to Sensor Center)

X	**2.5** mm
Y	**2.5** mm
Z	**2.5** mm

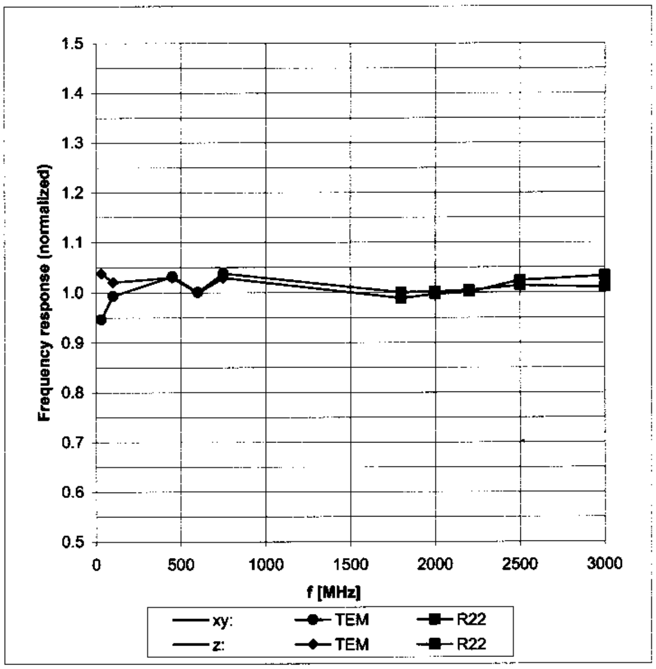
Connector Angle **51** °

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%.

[A] numerical linearization parameter: uncertainty not required

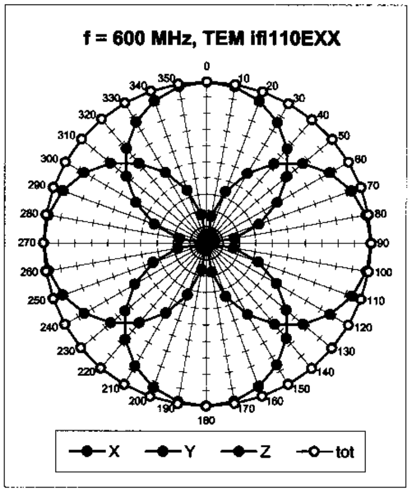
Frequency Response of E-Field

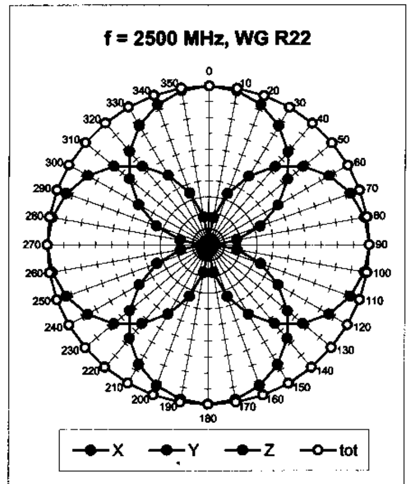
(TEM-Cell:ifi110 EXX, Waveguide R22)



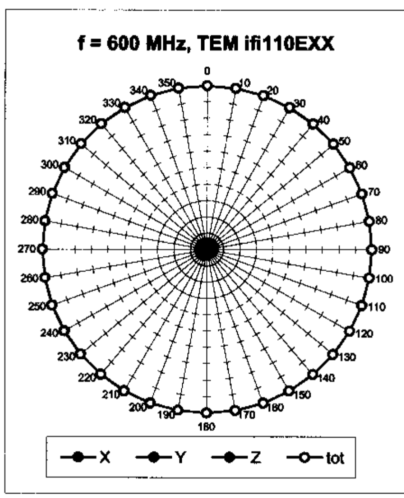
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

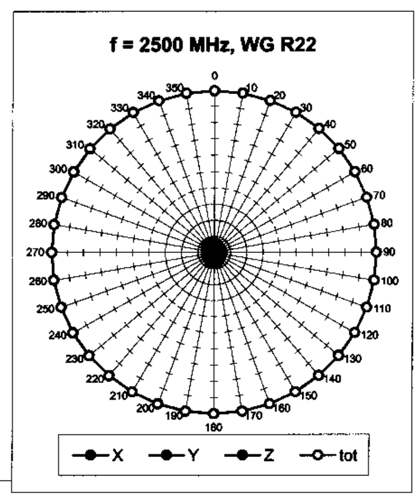
Receiving Pattern (ϕ), $\vartheta = 0°$



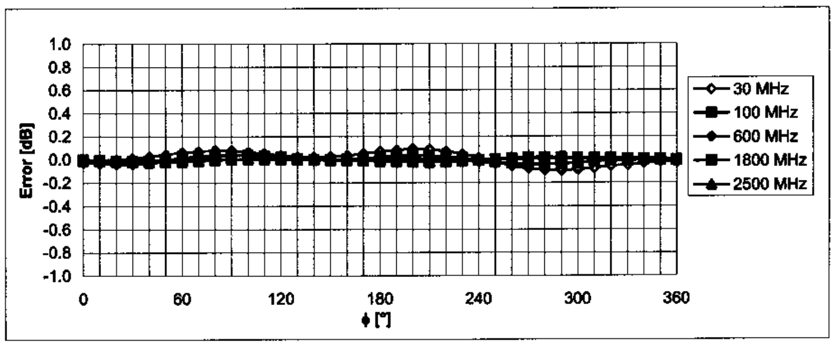


Receiving Pattern (ϕ), $\vartheta = 90°$



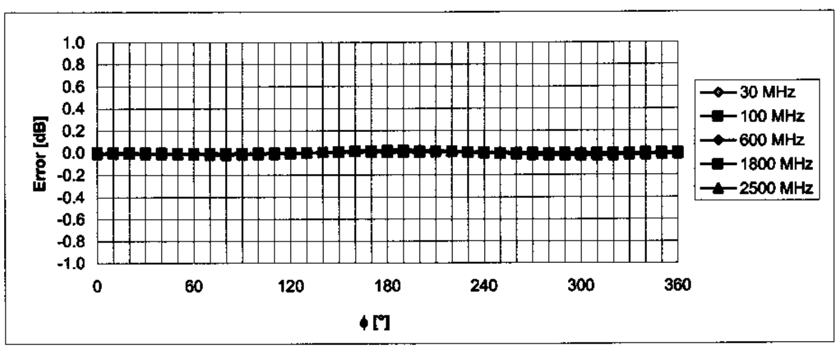


Receiving Pattern (ϕ), ϑ = 0°



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

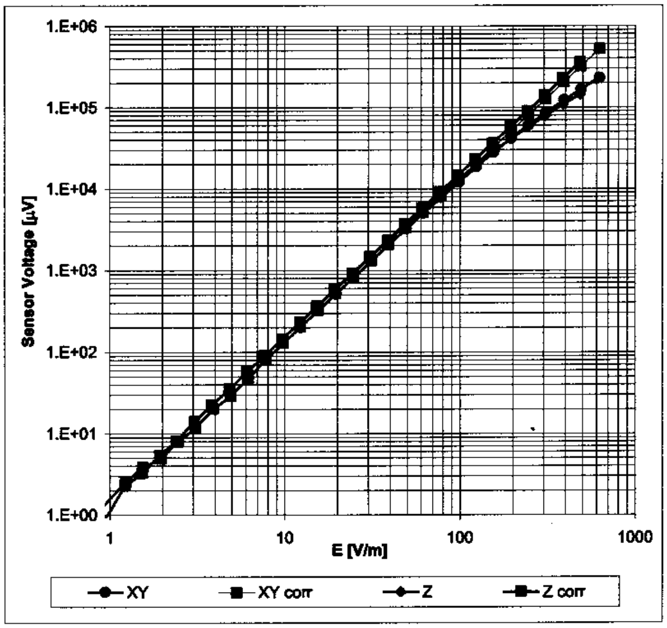
Receiving Pattern (ϕ), ϑ = 90°

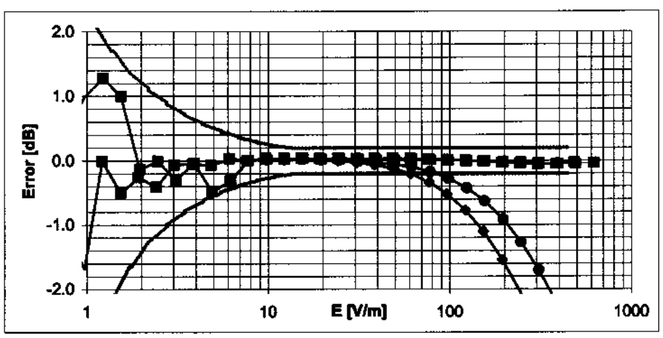


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(E-field)

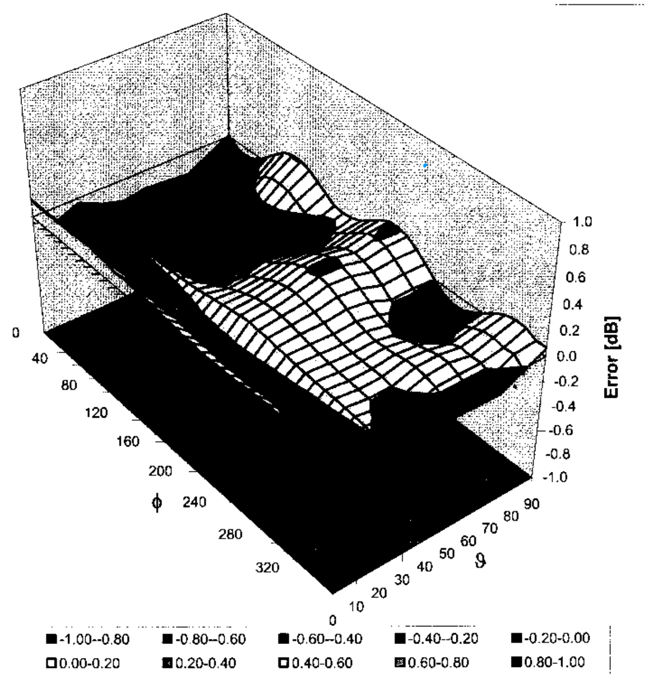
(Waveguide R22, f = 1800 MHz)





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)

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The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **RIM**

Certificate No: **H3-6105_Dec04**

CALIBRATION CERTIFICATE

Object	**H3DV6 - SN:6105**
Calibration procedure(s)	**QA CAL-03.v4** **Calibration procedure for H-field probes optimized for close near field evaluations in air**
Calibration date:	**December 10, 2004**
Condition of the calibrated item	**In Tolerance**

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 (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	5-May-04 (METAS, No. 251-00388)	May-05
Power sensor E4412A	MY41495277	5-May-04 (METAS, No. 251-00388)	May-05
Reference 3 dB Attenuator	SN: S5054 (3c)	10-Aug-04 (METAS, No. 251-00403)	Aug-05
Reference 20 dB Attenuator	SN: S5086 (20b)	3-May-04 (METAS, No. 251-00389)	May-05
Reference 30 dB Attenuator	SN: S5129 (30b)	10-Aug-04 (METAS, No. 251-00404)	Aug-05
Reference Probe H3DV6	SN: 6182	6-Oct-04 (SPEAG, No. H3-6182_Oct04)	Oct-05
DAE4	SN: 617	29-Sep-04 (SPEAG, No. DAE4-617_Sep04)	Sep-05

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092180	18-Sep-02 (SPEAG, in house check Oct-03)	In house check: Oct 05
RF generator HP 8648C	US3642U01700	4-Aug-99 (SPEAG, in house check Dec-03)	In house check: Dec-05
Network Analyzer HP 8753E	US37390585	18-Oct-01 (SPEAG, in house check Nov-04)	In house check: Nov 05

	Name	Function	Signature
Calibrated by:	Nico Vetterli	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: December 13, 2004

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

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Glossary:

NORMx,y,z	sensitivity in free space
DCP	diode compression point
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 1309-1996, " IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", 1996.

Methods Applied and Interpretation of Parameters:

- *X,Y,Z_a0a1a2:* Assessed for E-field polarization ϑ = 90 for XY sensors and ϑ = 0 for Z sensor (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide).
- *X,Y,Z(f)_a0a1a2= X,Y,Z_a0a1a2* frequency_response* (see Frequency Response Chart).
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency.
- *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 *X_a0a1a2* (no uncertainty required).

Probe H3DV6

SN:6105

Manufactured:	January 4, 2002
Last calibrated:	January 12, 2004
Recalibrated:	December 10, 2004

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

DASY - Parameters of Probe: H3DV6 SN:6105

Sensitivity in Free Space [A/m / $\sqrt{(\mu V)}$]

	a0	a1	a2
X	**2.852E-03**	**1.139E-4**	**-2.960E-5** ± 5.1 % (k=2)
Y	**2.600E-03**	**1.234E-4**	**-2.015E-5** ± 5.1 % (k=2)
Z	**2.910E-03**	**2.506E-5**	**-2.259E-5** ± 5.1 % (k=2)

Diode Compression[1]

DCP X	**88** mV
DCP Y	**88** mV
DCP Z	**89** mV

Sensor Offset (Probe Tip to Sensor Center)

X	**3.0** mm
Y	**3.0** mm
Z	**3.0** mm

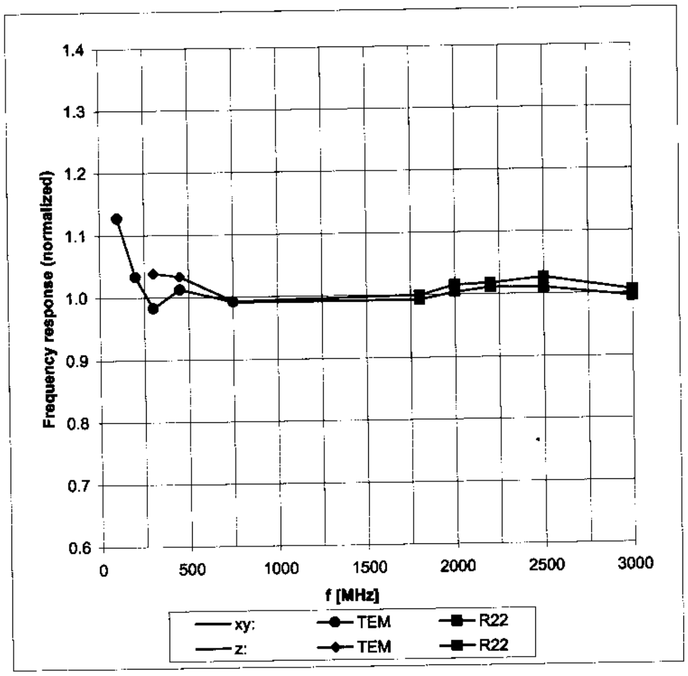
Connector Angle **103** °

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%.

[1] numerical linearization parameter: uncertainty not required

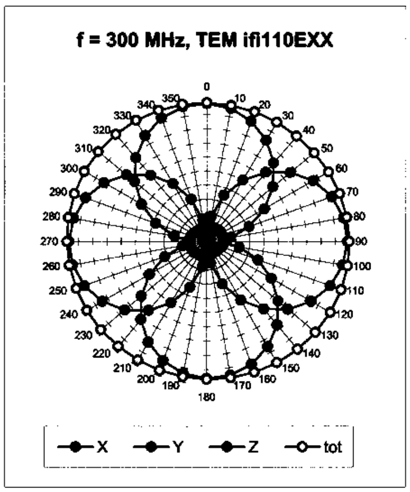
Frequency Response of H-Field

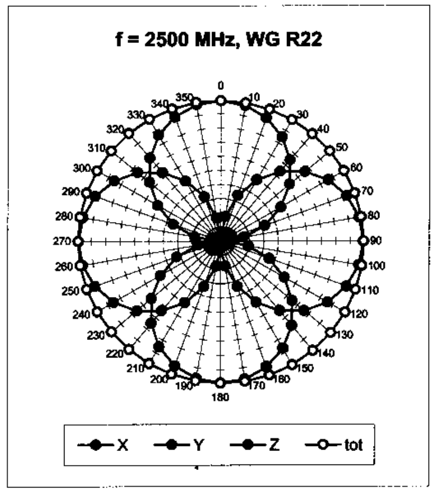
(TEM-Cell:Ifi110, Waveguide R22)



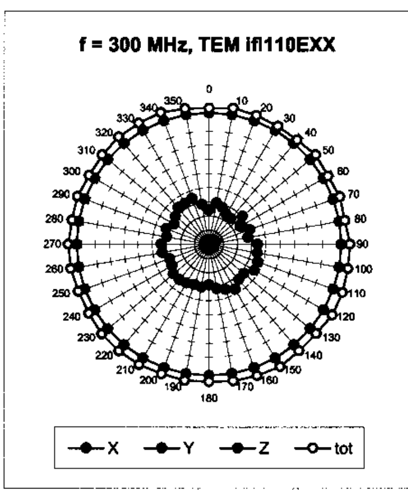
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

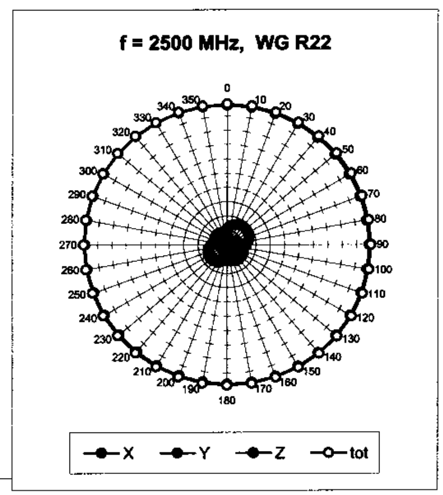
Receiving Pattern (ϕ), ϑ = 90°



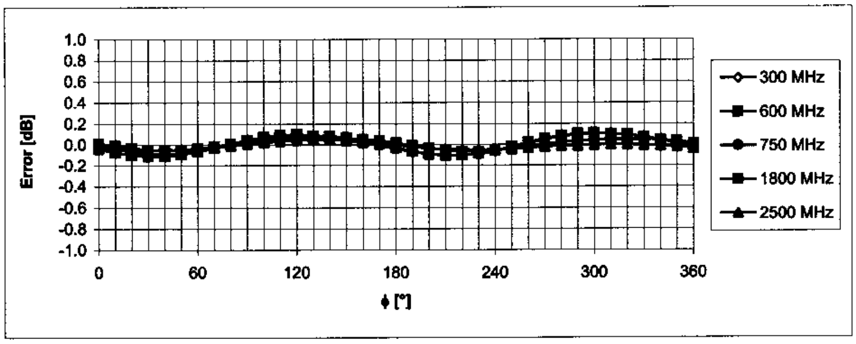


Receiving Pattern (ϕ), ϑ = 0°



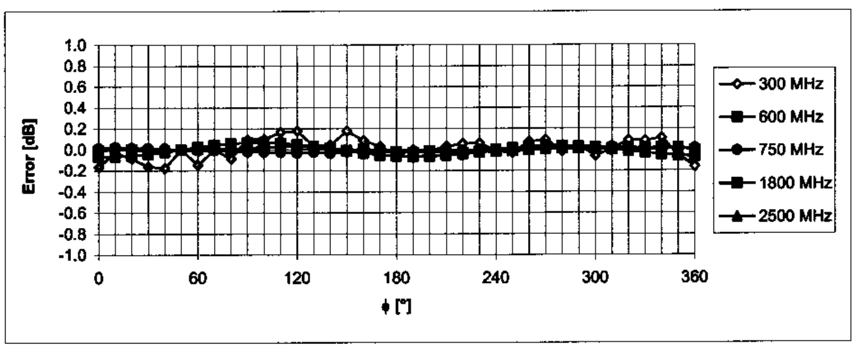


Receiving Pattern (ϕ), $\vartheta = 90°$



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

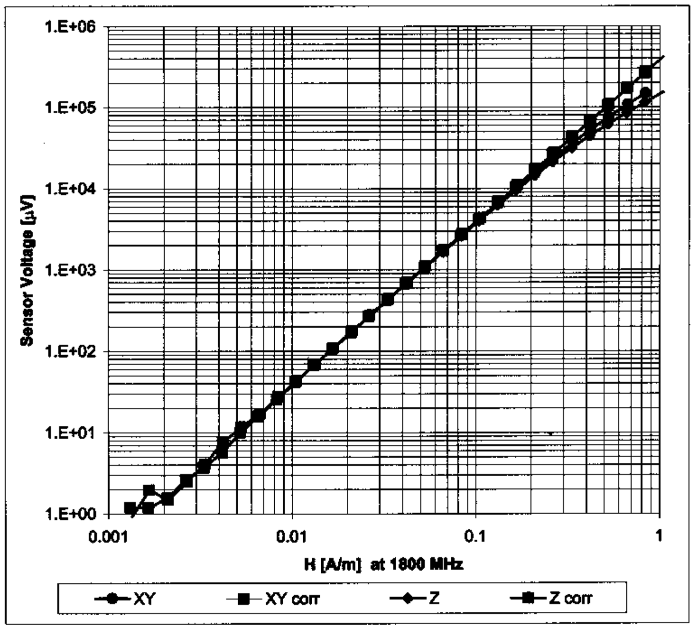
Receiving Pattern (ϕ), $\vartheta = 0°$

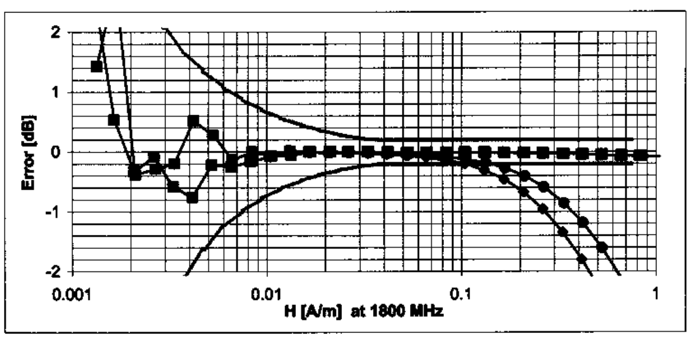


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(H-field)

(Waveguide R22, f = 1800 MHz)





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

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Client RIM **Certificate No: CD835V3-1011_Feb05**

CALIBRATION CERTIFICATE

Object	**CD835V3 - SN: 1011**
Calibration procedure(s)	**QA CAL-20.v2** **Calibration procedure for dipoles in air**
Calibration date:	**February, 24, 2005**
Condition of the calibrated item	**In Tolerance**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
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 (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter EPM E442	GB37480704	12-Oct-04 (METAS, No. 251-00412)	Oct-05
Power sensor HP 8481A	US37292783	12-Oct-04 (METAS, No. 251-00412)	Oct-05
Reference 20 dB Attenuator	SN: 5086 (20g)	10-Aug-04 (METAS, No 251-00402)	Aug-05
Reference 10 dB Attenuator	SN: 5047.2 (10r)	10-Aug-04 (METAS, No 251-00402)	Aug-05
Reference Probe ER3DV6	SN 2328	06-Oct-04 (SPEAG, No. ER3-2328_Oct04)	Oct-05
DAE4	SN 601	07-Jan-05 (SPEAG, No. DAE4-601_Jan05)	Jan-06

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092312	10-Aug-03 (SPEAG, in house check Jan-04)	In house check: Oct-05
Power sensor HP 8481A	MY41093315	10-Aug-03 (SPEAG, in house check Jan-04)	In house check: Oct-05
RF generator Agilent E8251A	US41140111	4-Aug-03 (Agilent)	In house check: Aug-05
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (SPEAG, in house check Nov-04)	In house check: Nov-05
Probe H3DV6	SN: 6065	10-Oct-04 (SPEAG, No. H3-6065-Oct04)	Calibration, Oct-05

	Name	Function	Signature
Calibrated by:	**Mike Meili**	**Laboratory Technician**	M. Meili
Approved by:	**Fin Bomholt**	**Technical Director**	F. Bomholt

Issued: February 27, 2005

This calibration certificate is issued as an intermediate solution until the specific calibration procedure is submitted and accepted in the frame of the accreditation of the Calibration Laboratory of Schmid & Partner Engineering AG (based on ISO/IEC 17025 International Standard)

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

References

[1] ANSI-PC63.19-2003 (Draft)
American National Standard for 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 standard [1], the measurement planes (probe sensor center) are selected to be at a distance of 10 mm above the the top 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 DASY4 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 10 mm (in z) above the 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, 10mm above the dipole surface.
- *H-field distribution:* H-field is measured with an isotropic H-field probe with 100mW forward power to the antenna feed point, in the x-y-plane. The scan area and sensor distance is equivalent to the E-field scan. The maximum of the field is available at the center (subgrid 5) above the feed point. The H-field value stated as calibration value represents the maximum of the interpolated H-field, 10mm above the dipole surface at the feed point.

1 Measurement Conditions

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

DASY Version	DASY4	V4.5 B13
DASY PP Version	SEMCAD	V1.8 B144
Phantom	HAC Test Arch	SD HAC P01 BA, #1002
Distance Dipole Top - Probe Center	10 mm	
Scan resolution	dx, dy = 5 mm	area = 20 x 180 mm
Frequency	**835 MHz** ± 1 MHz	
Forward power at dipole connector	20.0 dBm = 100mW	
Input power drift	< 0.05 dB	

2 Maximum Field values

H-field 10 mm above dipole surface	condition	**interpolated maximum**
Maximum measured	100 mW forward power	**0.442 A/m**

Uncertainty for H-field measurement: 8.2% (k=2)

E-field 10 mm above dipole surface	condition	**interpolated maximum**
Maximum measured above high end	100 mW forward power	165.0 V/m
Maximum measured above low end	100 mW forward power	155.8 V/m
Averaged maximum above arm	100 mW forward power	**160.4 V/m**

Uncertainty for E-field measurement: 12.8% (k=2)

3 Appendix

3.1 Antenna Parameters

Frequency	**Return Loss**	**Impedance**
800 MHz	16.9 dB	(40.9-j9.4) Ohm
835 MHz	**27.7 dB**	**(52.6 + j3.3) Ohm**
900 MHz	16.9 dB	(49.1 - j14.3) Ohm
950 MHz	19.9 dB	(46.5 + j9.1) Ohm
960 MHz	16.4 dB	(56.0 + j15.0) Ohm

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.

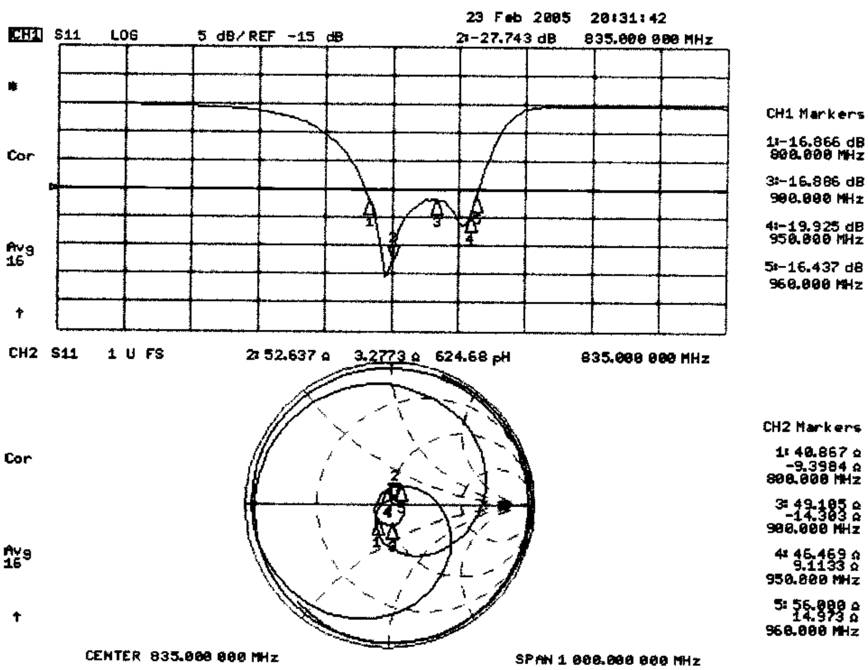
The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.

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.

3.3 Measurement Sheets

3.3.1 Return Loss and Smith Chart



3.3.2 DASY4 H-field result

See page 5

3.3.3 DASY4 E-Field result

See page 6

Date/Time: 24.02.2005 11:14:35

Test Laboratory: SPEAG, Zurich, Switzerland
File Name: H_CD835_1011_050224.da4

DUT: HAC-Dipole 835 MHz; Type: D835V3; Serial: 1011
Program Name: HAC H Dipole

Communication System: CW; Frequency: 835 MHz;Duty Cycle: 1:1
Medium parameters used: $\sigma = 0$; mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Phantom section: H Dipole Section

DASY4 Configuration:
- Probe: H3DV6 - SN6065; ; Calibrated: 10.12.2004
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn901; Calibrated: 29.06.2004
- Phantom: HAC Phantom; Type: SD HAC P01 BA; Serial: 1002
- Measurement SW: DASY4, V4.5 Build 13; Postprocessing SW: SEMCAD, V1.8 Build 144

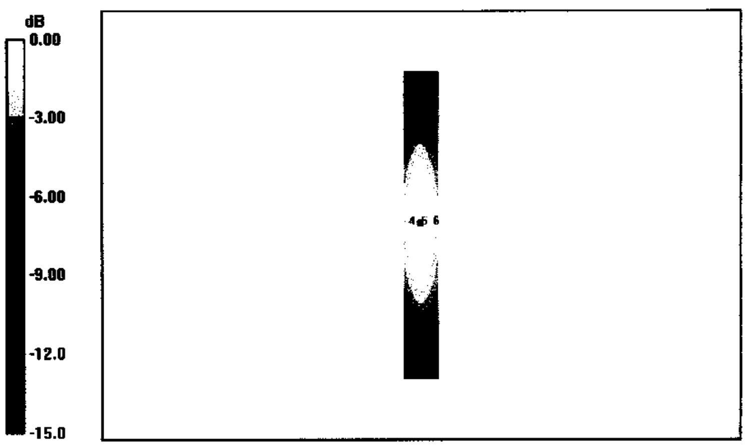
H Scan 10mm above CD 835 MHz/Hearing Aid Compatibility Test (41x361x1): Measurement grid: dx=5mm, dy=5mm, dz=5.5555mm
Maximum value of Total field (slot averaged) = 0.442 A/m
Hearing Aid Near-Field Category: M2 (AWF 0 dB)

H in A/m (Time averaged)

Grid 1 **0.366**	Grid 2 **0.388**	Grid 3 **0.362**
Grid 4 **0.417**	[illegible]	Grid 6 **0.415**
Grid 7 **0.361**	Grid 8 **0.383**	Grid 9 **0.362**

H in A/m (Slot averaged)

Grid 1 **0.366**	Grid 2 **0.388**	Grid 3 **0.362**
Grid 4 **0.417**	[illegible]	Grid 6 **0.415**
Grid 7 **0.361**	Grid 8 **0.383**	Grid 9 **0.362**



0 dB = 0.442A/m

Date/Time: 24.02.2005 08:58:55

Test Laboratory: SPEAG, Zurich, Switzerland
File Name: E_CD835_1011_050224.da4

DUT: HAC-Dipole 835 MHz; Type: D835V3; Serial: 1011
Program Name: HAC E Dipole

Communication System: CW; Frequency: 835 MHz;Duty Cycle: 1:1
Medium parameters used: $\sigma = 0$; mho/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Phantom section: E Dipole Section

DASY4 Configuration:
- Probe: ER3DV6 - SN2328; ConvF(1, 1, 1); Calibrated: 06.10.2004
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn901; Calibrated: 29.06.2004
- Phantom: HAC Phantom; Type: SD HAC P01 BA; Serial: 1002
- Measurement SW: DASY4, V4.5 Build 13; Postprocessing SW: SEMCAD, V1.8 Build 144

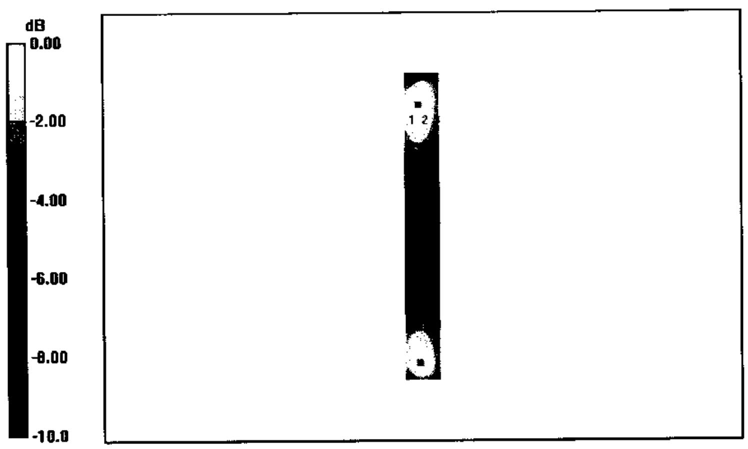
E Scan 10mm above CD 835 MHz/Hearing Aid Compatibility Test (41x361x1): Measurement grid: dx=5mm, dy=5mm, dz=5.5555mm
Maximum value of Total field (slot averaged) = 165.0 V/m
Hearing Aid Near-Field Category: M2 (AWF 0 dB)

E in V/m (Time averaged)

Grid 1 **163.5**	Grid 2 **165.0**	Grid 3 **153.0**
Grid 4 **90.3**	Grid 5 **91.3**	Grid 6 **85.1**
Grid 7 **153.1**	Grid 8 **155.8**	Grid 9 **147.3**

E in V/m (Slot averaged)

Grid 1 **163.5**	Grid 2 **165.0**	Grid 3 **153.0**
Grid 4 **90.3**	Grid 5 **91.3**	Grid 6 **85.1**
Grid 7 **153.1**	Grid 8 **155.8**	Grid 9 **147.3**



0 dB = 165.0V/m

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

Client RIM **Certificate No: CD1880V3-1008_Feb05**

CALIBRATION CERTIFICATE

Object	**CD1880V3 - SN: 1008**
Calibration procedure(s)	**QA CAL-20.v2** **Calibration procedure for dipoles in air**
Calibration date:	**February, 23, 2005**
Condition of the calibrated item	**In Tolerance**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
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 (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter EPM E442	GB37480704	12-Oct-04 (METAS, No. 251-00412)	Oct-05
Power sensor HP 8481A	US37292783	12-Oct-04 (METAS, No. 251-00412)	Oct-05
Reference 20 dB Attenuator	SN: 5086 (20g)	10-Aug-04 (METAS, No 251-00402)	Aug-05
Reference 10 dB Attenuator	SN: 5047.2 (10r)	10-Aug-04 (METAS, No 251-00402)	Aug-05
Reference Probe ER3DV6	SN 2328	06-Oct-04 (SPEAG, No. ER3-2328_Oct04)	Oct-05
DAE4	SN 601	07-Jan-05 (SPEAG, No. DAE4-601_Jan05)	Jan-06

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092312	10-Aug-03 (SPEAG, in house check Jan-04)	In house check: Oct-05
Power sensor HP 8481A	MY41093315	10-Aug-03 (SPEAG, in house check Jan-04)	In house check: Oct-05
RF generator Agilent E8251A	US41140111	4-Aug-03 (Agilent)	In house check: Aug-05
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (SPEAG, in house check Nov-04)	In house check: Nov-05
Probe H3DV6	SN: 6065	10-Oct-04 (SPEAG, No. H3-6065-Oct04)	Calibration, Oct-05

	Name	Function	Signature
Calibrated by:	Mike Meili	Laboratory Technician	M. Meili
Approved by:	Fin Bomholt	Technical Director	F. Bomholt

Issued: February 27, 2005

This calibration certificate is issued as an intermediate solution until the specific calibration procedure is submitted and accepted in the frame of the accreditation of the Calibration Laboratory of Schmid & Partner Engineering AG (based on ISO/IEC 17025 International Standard)

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

References

[1] ANSI-PC63.19-2003 (Draft)
American National Standard for 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 standard [1], the measurement planes (probe sensor center) are selected to be at a distance of 10 mm above the the top 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 DASY4 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 10 mm (in z) above the 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, 10mm above the dipole surface.
- *H-field distribution:* H-field is measured with an isotropic H-field probe with 100mW forward power to the antenna feed point, in the x-y-plane. The scan area and sensor distance is equivalent to the E-field scan. The maximum of the field is available at the center (subgrid 5) above the feed point. The H-field value stated as calibration value represents the maximum of the interpolated H-field, 10mm above the dipole surface at the feed point.

1 Measurement Conditions

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

DASY Version	DASY4	V4.5 B13
DASY PP Version	SEMCAD	V1.8 B144
Phantom	HAC Test Arch	SD HAC P01 BA, #1002
Distance Dipole Top - Probe Center	10 mm	
Scan resolution	dx, dy = 5 mm	area = 20 x 90 mm
Frequency	**1880 MHz** ± 1 MHz	
Forward power at dipole connector	20.0 dBm = 100mW	
Input power drift	< 0.05 dB	

2 Maximum Field values

H-field 10 mm above dipole surface	condition	**interpolated maximum**
Maximum measured	100 mW forward power	**0.444 A/m**

Uncertainty for H-field measurement: 8.2% (k=2)

E-field 10 mm above dipole surface	condition	**interpolated maximum**
Maximum measured above high end	100 mW forward power	136.1 V/m
Maximum measured above low end	100 mW forward power	134.7 V/m
Averaged maximum above arm	100 mW forward power	**135.4 V/m**

Uncertainty for E-field measurement: 12.8% (k=2)

3 Appendix

3.1 Antenna Parameters

Frequency	**Return Loss**	**Impedance**
1710 MHz	28.5 dB	(52.3 + j4.4) Ohm
1880 MHz	**19.1 dB**	**(59.0 + j7.4) Ohm**
1900 MHz	19.8 dB	(59.8 + j2.2) Ohm
1950 MHz	26.2 dB	(55.1 - j3.5) Ohm
2000 MHz	23.0 dB	(46.8 + j8.0) Ohm

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.

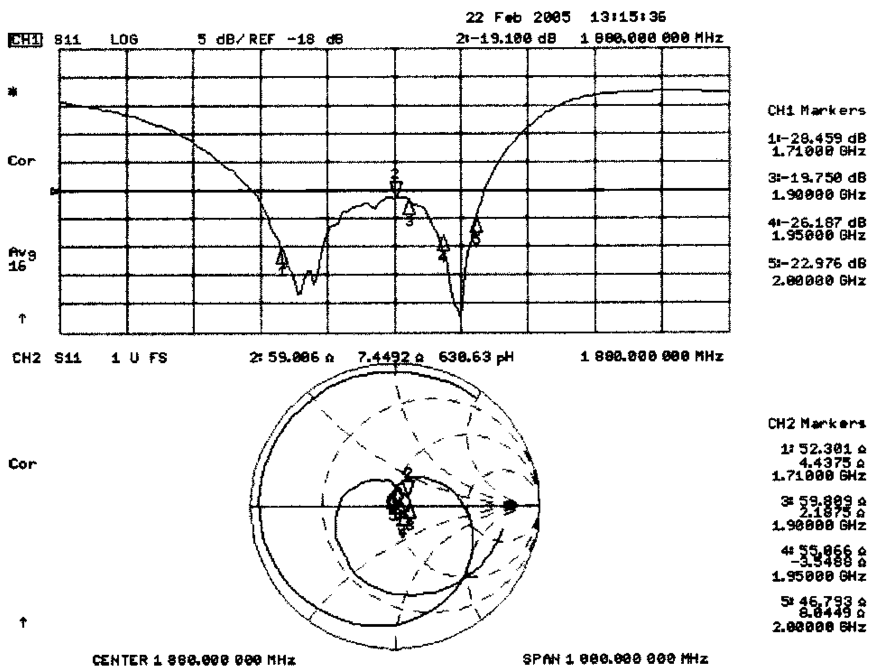
The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.

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.

3.3 Measurement Sheets

3.3.1 Return Loss and Smith Chart



3.3.2 DASY4 H-field result

See page 5

3.3.3 DASY4 E-Field result

See page 6

Date/Time: 23.02.2005 12:27:27

Test Laboratory: SPEAG, Zurich, Switzerland
File Name: H_CD1880_1008_050223.da4

DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: 1008
Program Name: HAC H Dipole

Communication System: CW; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium parameters used: $\sigma = 0$; mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Phantom section: H Dipole Section

DASY4 Configuration:
- Probe: H3DV6 - SN6065; ; Calibrated: 10.12.2004
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn901; Calibrated: 29.06.2004
- Phantom: HAC Phantom; Type: SD HAC P01 BA; Serial: 1002
- Measurement SW: DASY4, V4.5 Build 13; Postprocessing SW: SEMCAD, V1.8 Build 144

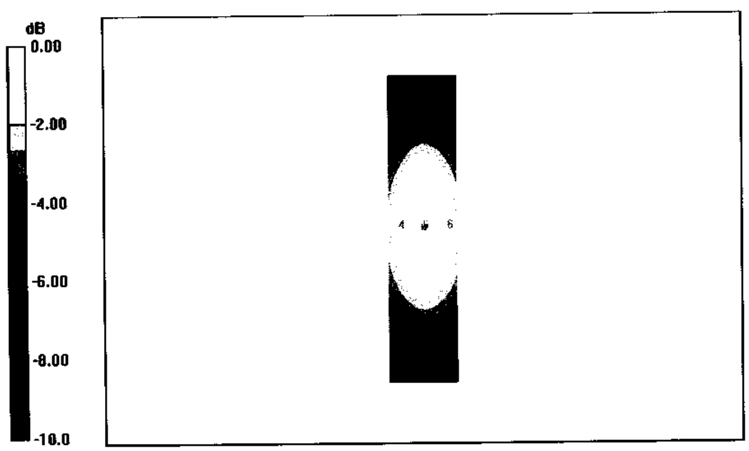
H Scan 10mm above CD 1880 MHz/Hearing Aid Compatibility Test (41x181x1): Measurement grid: dx=5mm, dy=5mm, dz=5.5555mm
Maximum value of Total field (slot averaged) = 0.444 A/m
Hearing Aid Near-Field Category: M2 (AWF 0 dB)

H in A/m (Time averaged)

Grid 1 **0.378**	Grid 2 **0.407**	Grid 3 **0.390**
Grid 4 **0.416**	**Grid 5** **0.444**	Grid 6 **0.427**
Grid 7 **0.374**	Grid 8 **0.400**	Grid 9 **0.386**

H in A/m (Slot averaged)

Grid 1 **0.378**	Grid 2 **0.407**	Grid 3 **0.390**
Grid 4 **0.416**	**Grid 5** **0.444**	Grid 6 **0.427**
Grid 7 **0.374**	Grid 8 **0.400**	Grid 9 **0.386**



0 dB = 0.444A/m

Date/Time: 23.02.2005 18:29:42

Test Laboratory: SPEAG, Zurich, Switzerland
File Name: E_CD1880_1008_050223.da4

DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: 1008
Program Name: HAC E Dipole

Communication System: CW; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium parameters used: $\sigma = 0$; mho/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Phantom section: E Dipole Section

DASY4 Configuration:
- Probe: ER3DV6 - SN2328; ConvF(1, 1, 1); Calibrated: 06.10.2004
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn901; Calibrated: 29.06.2004
- Phantom: HAC Phantom; Type: SD HAC P01 BA; Serial: 1002
- Measurement SW: DASY4, V4.5 Build 13; Postprocessing SW: SEMCAD, V1.8 Build 144

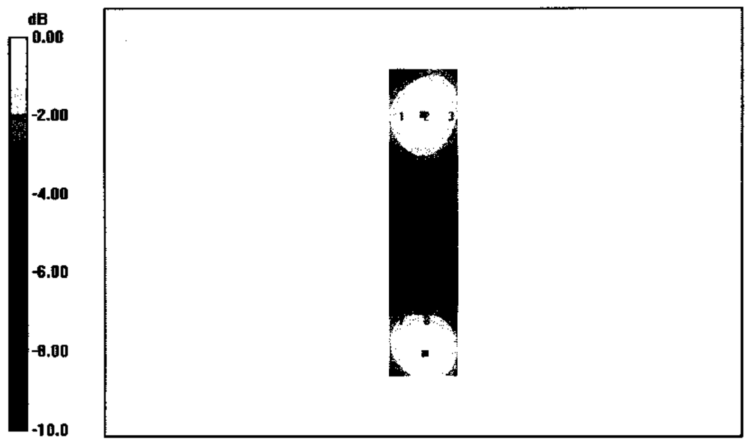
E Scan 10mm above CD 1880 MHz/Hearing Aid Compatibility Test (41x181x1): Measurement grid: dx=5mm, dy=5mm, dz=5.5555mm
Maximum value of Total field (slot averaged) = 136.1 V/m
Hearing Aid Near-Field Category: M2 (AWF 0 dB)

E in V/m (Time averaged)

Grid 1 **129.7**	Grid 2 **134.7**	Grid 3 **132.4**
Grid 4 **90.0**	Grid 5 **92.6**	Grid 6 **89.2**
Grid 7 **129.1**	Grid 8 **136.1**	Grid 9 **133.9**

E in V/m (Slot averaged)

Grid 1 **129.7**	Grid 2 **134.7**	Grid 3 **132.4**
Grid 4 **90.0**	Grid 5 **92.6**	Grid 6 **89.2**
Grid 7 **129.1**	Grid 8 **136.1**	Grid 9 **133.9**



0 dB = 136.1V/m

Annex C: Test set up photos

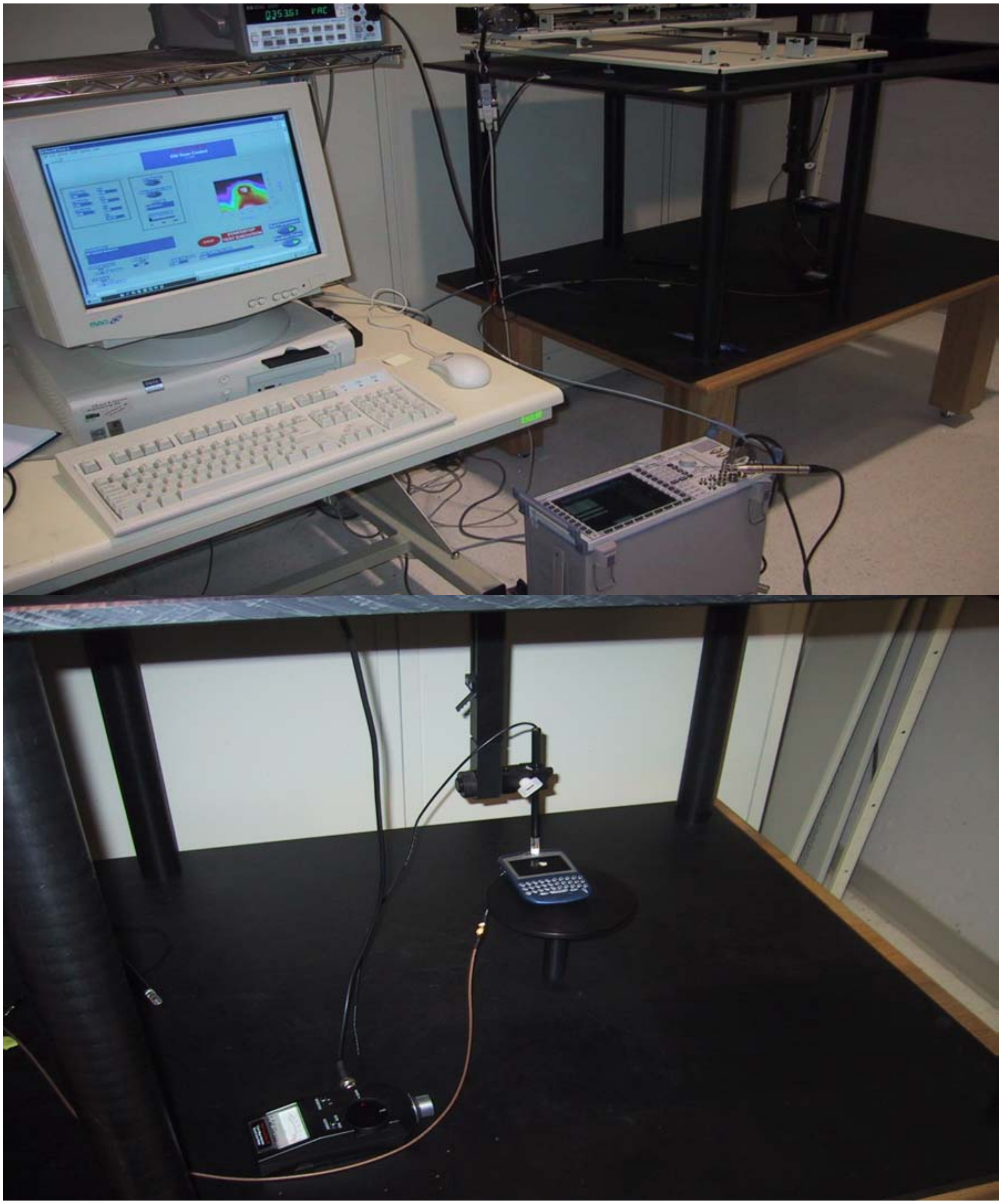


Figure 1 – T-Coil Audio Band Magnetic Field Measurement System

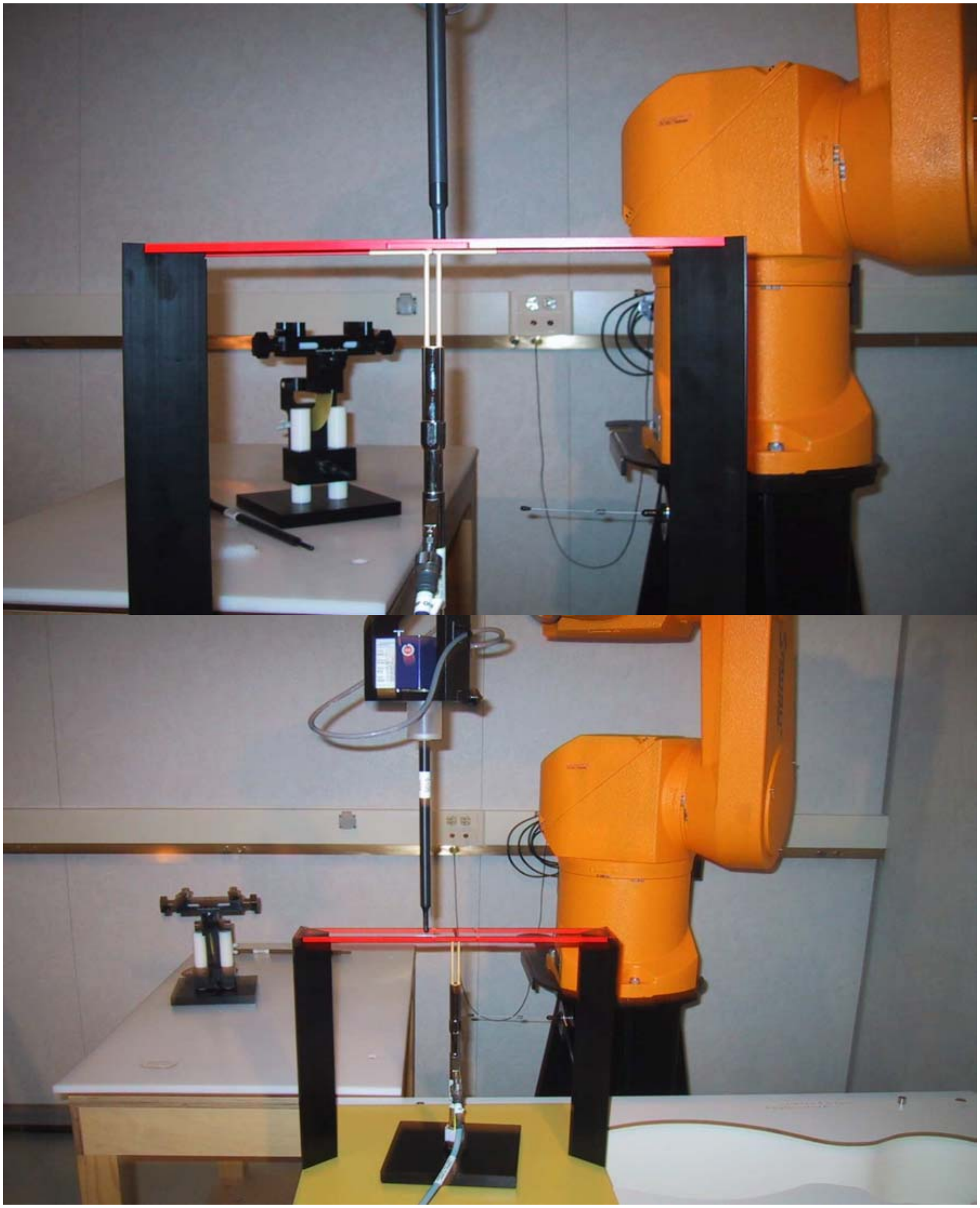


Figure 2 – Dipole validation and modulation measurement setup 1

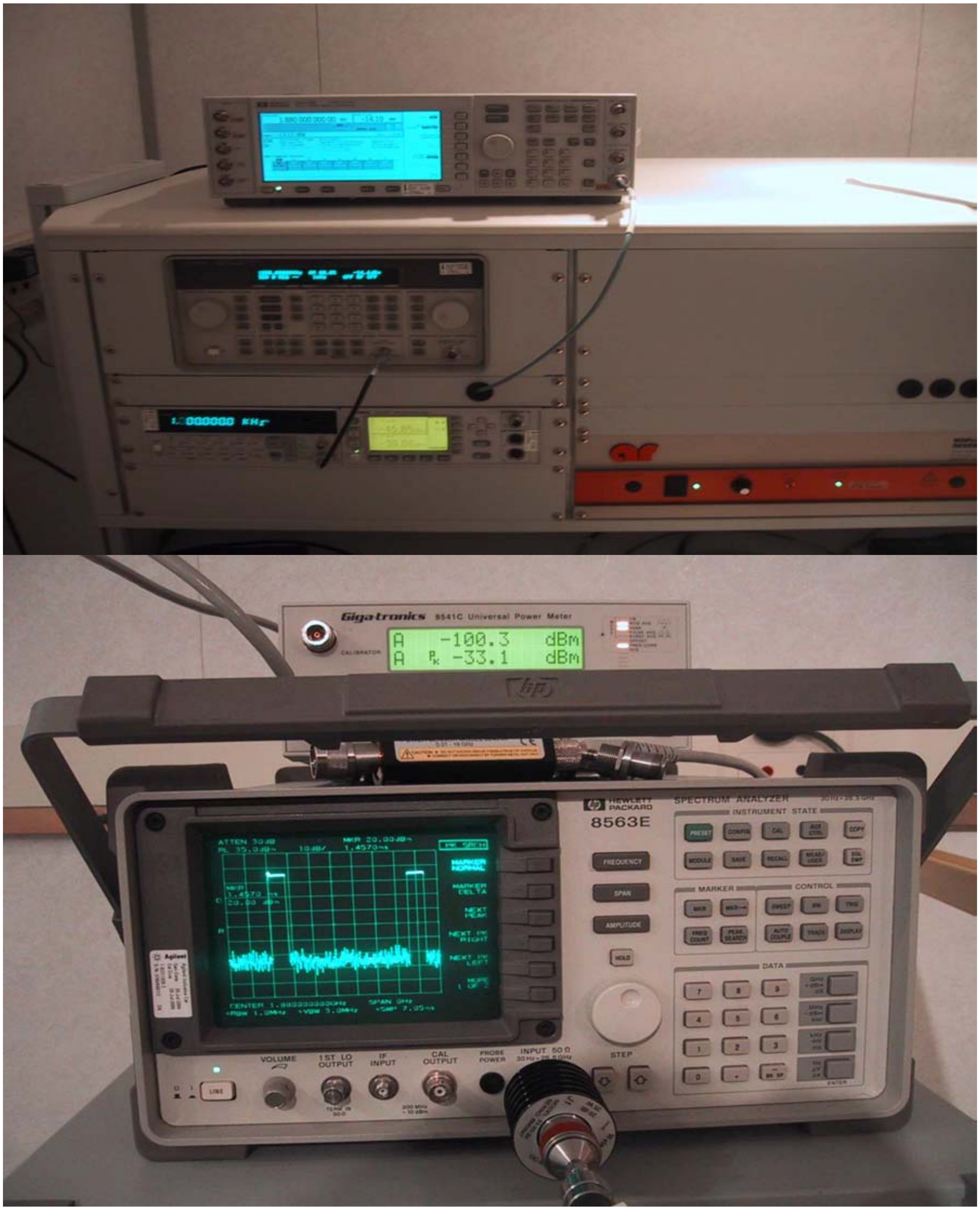


Figure 3 – Dipole validation and modulation measurement setup 2

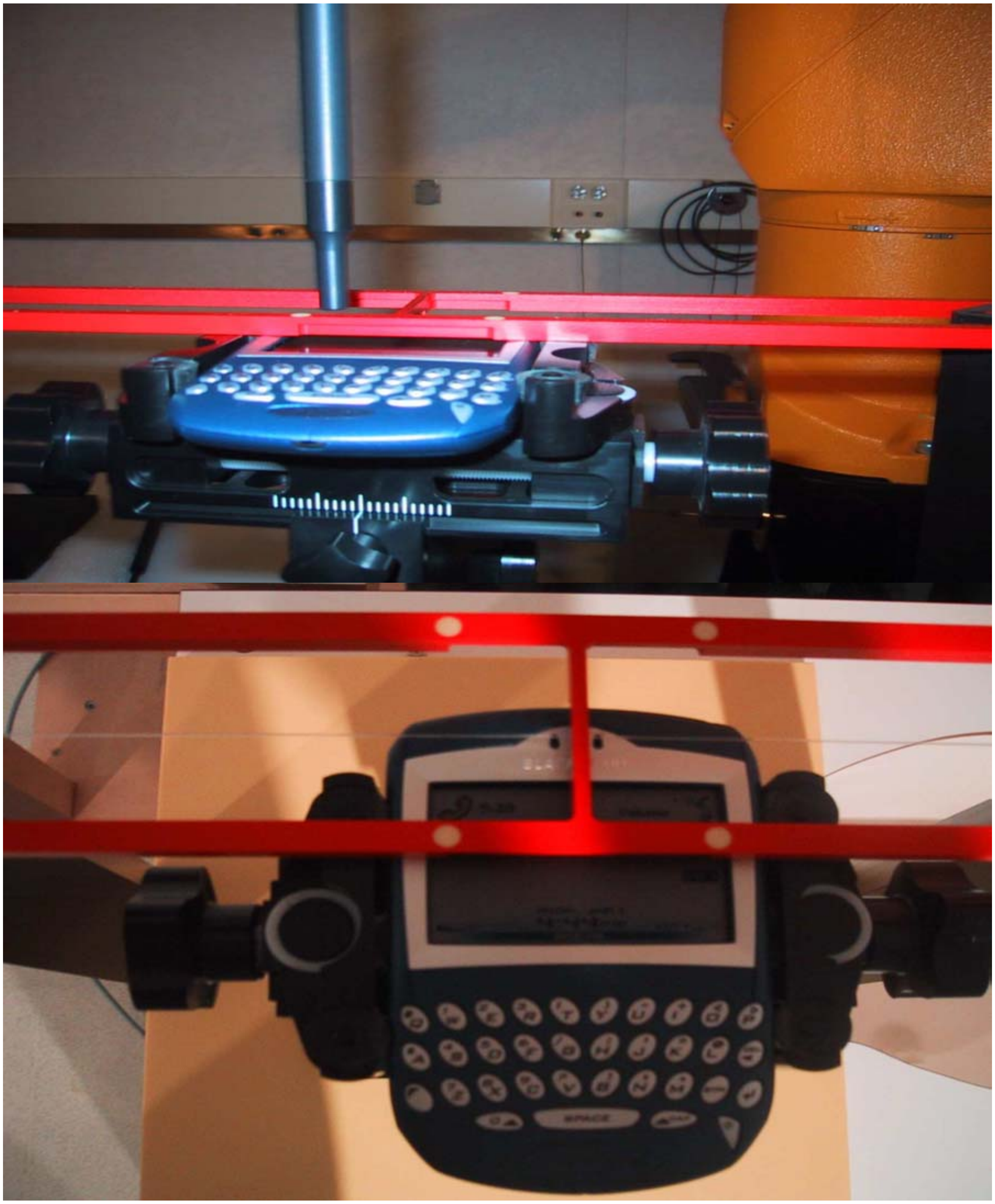


Figure 4 – HAC RF emission E-field test setup

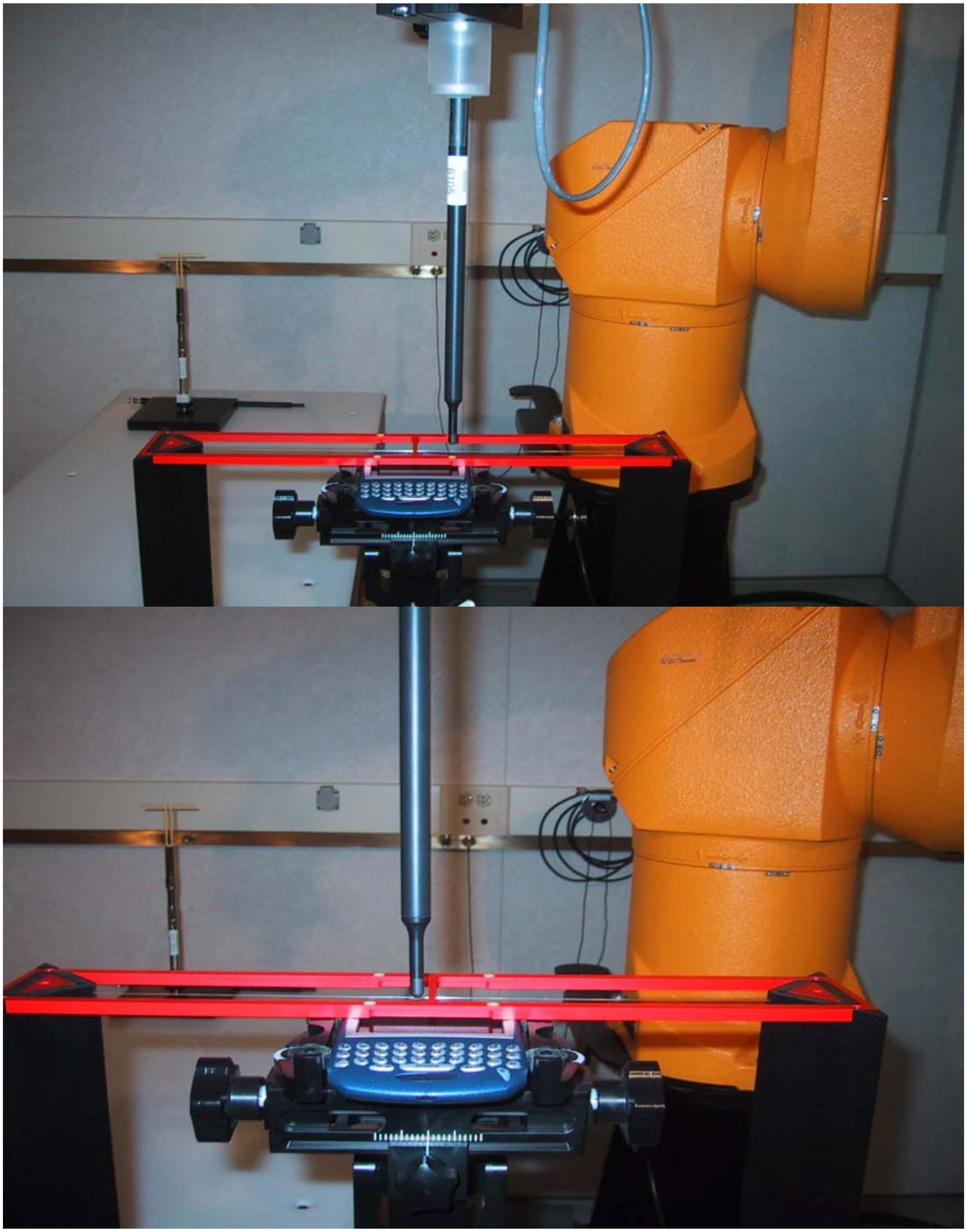


Figure 5 – HAC RF emission H-field test setup