


MOTOROLA
FCC ID: AZ489FT5824
DECLARATION OF COMPLIANCE HAC ASSESSMENT

Motorola Florida Corporate Research Laboratory
8000 West Sunrise Blvd
Fort Lauderdale, FL. 33322

Date of Report: September 12, 2005
Report Revision: Rev. C
Report ID: FCC HAC rpt_i710_Rev C_050912

Responsible Engineer: Mike Kanda
Date/s Tested: 8/31/05
Manufacturer/Location: Motorola - Plantation
Sector/Group/Div.: iDEN Subscriber
Date submitted for test: 8/31/05
DUT Description: i710; iDEN1: 1:3 TDMA; 16 QAM
 806-825; 896-902 MHz
Test TX mode(s): 1:3
Max. Power output: iDEN - 0.640W; Pulse Averaged; Factory-tuned
Nominal Power: iDEN - 0.600W; Pulse Averaged; Factory-tuned
Tx Frequency Bands: iDEN - 806-825, 896-902MHz
Signaling type: TDMA: iDEN
Model(s) Tested: H63XAN6RR4AN
Model(s) Certified: H63XAN6RR4AN
Serial Number(s): 364AEGQPM8
Rule Part(s): 20.19


Approved Applicable Accessories:

Battery(ies):
 SNN5705B (750mAh Li Ion)

Max E Field emission = 56.36 V/m @ 821MHz
Max H Field emission = 0.130 A/m @ 813.5
M Category = M4

Based on the information and the testing results provided herein, the undersigned certifies that when used as stated in the operating instructions supplied, said product complies with the national and international reference standards and guidelines listed in section 2.0 of this report. This report shall not be reproduced without written approval from an officially designated representative of the Motorola EME Laboratory.

The results and statements contained in this report pertain only to the device(s) evaluated.

/s/Al Wieczorek (signed)

Al Wieczorek; Motorola iDEN Subscriber Division

Approval Date: 9/12/05

Certification Date: 8/31/05

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REVISION HISTORY

Date	Revision	Comments
7/21/05	O	Initial release
8/10/05	A	Removal of A2LA Logo and Certification Number from report.
8/31/05	B	Data re-taken with re-measured Probe Modulation Factors (per C63.19).
9/12/2005	C	1. Corrected calculation errors in PMF table. 2. Corrected typographical error in section 6.1. 3. Added more the Measurement System Verification portion. 4. Added details of measurement system/calculations.

1.0 Introduction and Overview

This report details the utilization, test setup, test equipment, and test results of the Hearing Aid Compatibility (HAC) measurements performed at the Motorola Corporate Research Lab for the model number H63XAN6RR4AN of FCC ID: AZ489FT5824. Measurements were performed to ensure compliance to the PC63.19-2001 rd 3.6 standard. This report demonstrates compliance for near field emissions only and not for the T-coil performance compliance.

The test results presented herein clearly demonstrate compliance FCC 47 CFR section 20.19 and with the latest version of PC63.19-2001 rd 3.6 and only reflect the performance of the stated model herein.

2.0 Near Field Compliance Criteria (Per PC63.19-2001 rd 3.6)

Category	Target Parameters		
Near Field M-Rating	AWF	E-Field Emissions Peak -V/m	H-Field Emissions Peak - A/m
M3	iDEN = 0	63.1 – 112.2	0.19 – 0.34
M4	iDEN = 0	<63.1	<0.19

3.0 Description of Device Under Test (DUT)

FCC ID: AZ489FT5824 is a digital multi-service data capable device that employs time division multiplexing transmission technology with a duty cycle ranging from 16.67% to 33.33% using 16-QAM modulation for voice or circuit data transmission. This device may be used while held against the head in voice mode. FCC ID: AZ489FT5824 is capable of operating in the 806-825 MHz and 896-902MHz bands. The rated power is 0.6 watts pulse averaged.

The maximum output is 0.640 watts pulse average as defined by the upper limit of the production line final test station. The DUT was tuned to be within 5% of the maximum rated power.

4.0 Test Equipment List

Equipment Type	Model Number	Serial Number	Calibration Due Date
HP Power Meter	HP4418B	US39251267	7/25/06
Spectrum Analyzer	HP8566A	2140A01129	
PST Power Amplifier	AR2729-10	M2K2A00	CNR
Signal Generator	HP4432B	US538330732	1/14/06
Directional Coupler (NARDA)	3020A	O4017	9/23/05
H-Field probe	H3DV6	6036	1/7/06
E-Field probe	ER3DV6R	2246	6/13/06
SPEAG	DASY4	Version 4.5 B19.2	NA
Data Acquisition Electronics (DAE)	NA	357	1/7/06

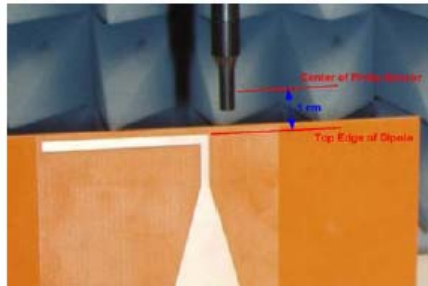
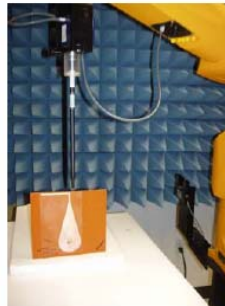
5.0 Descriptions of Measurement System

The laboratory utilizes a Dosimetric Assessment System (DASY4™) S.A.R. measurement system Version 4.5 B19.2 manufactured by Schmid & Partner Engineering AG (SPEAG™), of Zurich Switzerland. The test system consists of a Stäubli RX90L robot, DAE3V1, ER3DV6R E-Field probe, H3DV6 H-field probe, as well as the integrated HAC extension. Please reference the SPEAG user manual and application notes for detailed probe, robot, and HAC calibration and computational procedures. Section 3.0 presents relevant test equipment information. Appendices C present the applicable calibration certificates. Additional details concerning the test system measurement methods and calculations are provided in Appendix D.

The DASY4™ system is operated per the instructions in the DASY4™ Users Manual. The complete manual is available directly from SPEAG™. All measurement equipment used to assess EME HAC compliance was calibrated according to 17025 A2LA guidelines.

6.0 Measurement System Verification

The S.A.R. measurements were conducted with E and H field probes model/serial numbers ER3DV6R/SN2246 and H3DV6/SN6036. An un-modulated CW signal was used for system verification following the guidelines specified in the referenced standard. Note that the 1 cm probe to dipole separation is measured from the top surface of the dipole to the calibration reference point of the probe. The DASY4 output files of the system verification test results are included in Appendix A. The photos below depict the validation setup using a planar dipole per ANSI PC63.19 section 4.2.2.1.4. Section 6.1 summarizes the system performance check results.



6.1 System Verification Test Results

In accordance with C63.19-2005 clause 4.2.2.1 setup verification measurement results are listed and compared with expected values in the following table using an unmodulated signal (CW) from a commercially available signal generator to drive the reference dipole.

Frequency	Input power (W)	E-Field Results (V/m)	C63.19 Target (V/m)	% Deviation
813.5	0.100	221.3	224.6	-1.22
898.5	0.100	209.4	213.2	-1.64

Frequency	Input power (W)	H-Field Results (A/m)	C63.19 Target (A/m)	% Deviation
813.5	0.100	0.489	0.5139	-4.85
898.5	0.100	0.483	0.5032	-4.01

C63.19 clause 4.2.2.1.2 recommends additional test cases, one of which is to compare results from an 80% amplitude modulated (AM) signal with the CW results.

The results obtained are listed below:

Table 1 – System verification measurements using 80% AM modulated source

Freq	Meas.	Target	% Diff
813 E	209.4	206.6	1.4%
813 H	496.8	497.3	-0.1%
898 E	183.5	200	-8.3%
898 H	479	498.9	-4.0%

An additional recommend test case is the emulated or real test signal. Unfortunately no calibrated test set or signal generator emulating the iDEN protocol is commercially available that has the capability to accurately reproduce the quad 16-QAM signal. Alternatively the results for iDEN modulation were obtained using the device under test as a signal source to drive the antenna via an antenna adapter and an attenuator that assures a good match. That data is provided in Section 10 where it is compared to CW modulation during the measurement of the probe modulation response, per the alternate procedure given in C63.19-2005 Annex C.3.1.

7.0 DUT Setup and Test Procedure

Test Procedure

The automated test procedure guidelines presented in PC63.19-2001 section 4.3.1.2.2 were followed in order to demonstrate HAC compliance. The photos below depict the DUT test setup. The reference grid depicts the alignment with the center of the acoustic output used for coupling to hearing aid devices. The test results using embedded test mode software with an unlighted display are presented in section 9.0.



DUT test setup with 10mm spacing



Example illustration of WD with reference grid (Not to scale)

8.0 Environmental Test Conditions

The table below presents the range and average environmental conditions during the HAC tests reported herein:

	Target	Measured
Ambient Temperature	23 °C +/- 5 °C	Within Guidelines
Relative Humidity	0 - 80 %	Within Guidelines

The EME Lab RF environment uses a Spectrum Analyzer to monitor for extraneous large signal RF contaminants that could possibly affect the test results. If such unwanted signals are discovered the HAC scans are repeated. Per the pretest procedures in PC63.19-2001 rd 3.6 section 4.3.1.1 footnote 13, interference from reflective objects was found not to exceed -20dB.

9.0 Test Results Summary

The values listed in Table 1 and Table 2 below were calculated by multiplying the highest value in a non-excluded grid cell for each scan in Appendix B by the applicable Probe Modulation Factor determined in section 10 for the frequency band in which the handset transmitted during the scan. For example the value for the first scan in Appendix B was calculated as follows:

$$28.4 \text{ V/m (for grid 4 on page 17)} \times 1.86 \text{ (for 806-825 MHz band)} = 52.82 \text{ V/m.}$$

Table1

iDEN 800MHz band						
Freq.	Conducted Po (W)	E-Field (V/m)	E-Field excluded cells	H-Field (A/m)	H-Field excluded cells	M-Rating
806	0.640	52.82	1, 2, 3	0.129	1, 2, 3	M4
813.5	0.640	55.06	1, 2, 3	0.130	1, 2, 3	M4
821	0.640	56.36	2, 3, 6	0.123	1, 2, 3	M4
824	0.640	55.06	2, 3, 6	0.127	1, 2, 3	M4

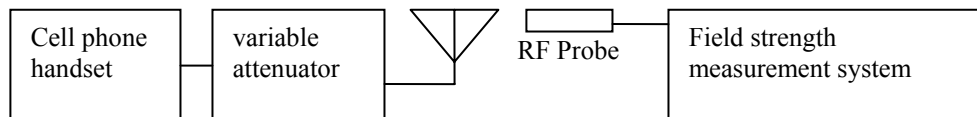
Table 2

iDEN 900MHz band						
Freq.	Conducted Po (W)	E-Field (V/m)	E-Field excluded cells	H-Field (A/m)	H-Field excluded cells	M-Rating
896	0.640	52.73	1, 2, 3	0.117	1, 2, 3	M4
899	0.640	55.35	1, 2, 3	0.126	1, 2, 3	M4
901	0.640	53.86	2, 3, 6	0.120	1, 2, 3	M4

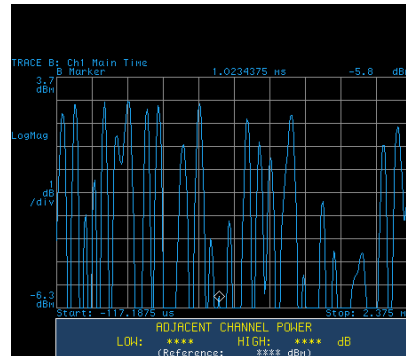
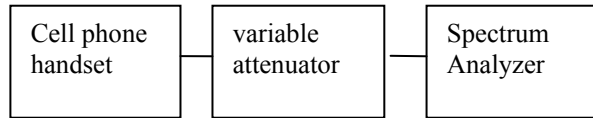
Probe rotations were taken at the highest measured location for every configuration. These have been marked on the worst-case contour plots in Appendix B.

10.0 Probe modulation factor measurement

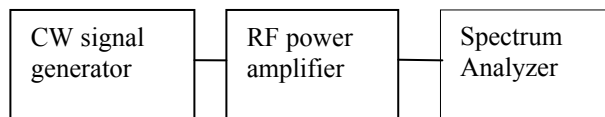
A - Per C63.19 rd 3.6 alternate measurement procedure steps 1, 2 and 3 the phone was set into a test mode at rated output power. The phone was connected to the reference dipole antenna through an attenuator to assure the E-field probe reading on the field strength measurement system was in the range corresponding to a C63.19 category rating of M2, as illustrated below. The crest factor of the DASY measurement system was set equal to the TDM multiplex factor (3) and the probe reading recorded as noted in Table 1.



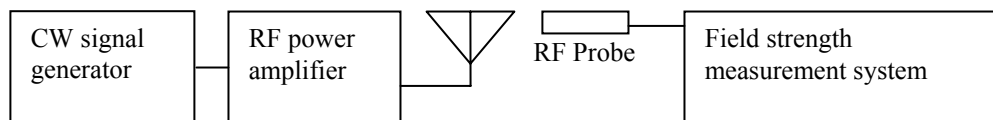
- B - The phone was then connected to a spectrum analyzer as illustrated below. Similar to C63.19 rd 3.6 Figure C-1 step 5, the analyzer was set for zero span (with a time span of 2.5ms. and amplitude scale of 1 dB/div to clearly show the peak amplitude and frequency of the digital modulation symbols that occur at a 4 kHz rate). As shown in the following spectrum analyzer display the peaks were set to 1 dB less than full scale.



- C - Per C63.19 rd 3.6 step 4 an unmodulated signal from a signal generator operating at the same frequency as the phone was amplified and applied to the spectrum analyzer in lieu of the phone and attenuator, as illustrated below. Per C63.19 rd 3.6 Figure C-1 step 6 the peak amplitude of the signal generator was set equal to the peak amplitude observed with the phone signal; i.e., 1 dB less than full scale indication on the spectrum analyzer.



- D - Per C63.19 rd step 6 the signal applied to the spectrum analyzer was then applied to the reference dipole as shown in Figure 5, The crest factor of the DASY measurement system was set to unity and the and the probe reading was recorded as noted in table 1.



- E - Per C63.19 rd 3.6, step 7 the square root of the ratio of the reading in D above divided by the reading in B above is calculated as the probe modulation factor and listed in Table 1.
- F - The above procedure is repeated for an H-field RF probe.

Table 1 – Probe Modulation Factor (PMF) data

Probe Model-SN	MHz	Source	Field strength (V/m or A/m)	PMF
ER3DV6R - 2246	813.5	Handset	207	1.86
ER3DV6R - 2246	813.5	E4432B/ AR Model SW1000	60	
ER3DV6R - 2246	898.5	Handset	142	1.87
ER3DV6R - 2246	898.5	E4432B/ AR Model SW1000	40.7	
H3DV6 - 6036	813.5	Handset	424	1.89
H3DV6 -6036	813.5	E4432B/ AR Model SW1000	119	
H3DV6 – 6036	898.5	Handset	287.7	1.85
H3DV6 – 6036	898.5	E4432B/ AR Model SW1000	84.4	

11.0 Uncertainty Budget

Motorola Uncertainty Budget for E-Field HAC Testing

Error	Value (R=1)	Distribution	Div	Std Unc	Unc^2	Source
RF Reflections	5.6%	R	1.73	3.2%	0.10%	From Reflection Test 050628.xls
Probe Calibration	5.1%	N	1.00	5.1%	0.26%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Isotropy	3.6%	R	1.73	2.1%	0.04%	From averaged results from IDEN HAC Tests i730, 850, 855, 450, 560 formatted.xls
Frequency Response						
Linearity	4.7%	R	1.73	2.7%	0.07%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Boundary Effects	2.4%	R	1.73	1.4%	0.02%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Sensor Displacement	16.5%	R	1.73	9.5%	0.91%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Probe Positioning accuracy	2.7%	R	1.73	1.6%	0.02%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Probe Positioner	1.2%	R	1.73	0.7%	0.00%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Extrapolation/Interpolation	1.0%	R	1.73	0.6%	0.00%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
System Detection Limit	1.0%	R	1.73	0.6%	0.00%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Readout Electronics	0.3%	N	1.00	0.3%	0.00%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Integration Time	2.6%	R	1.73	1.5%	0.02%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Response Time	0.8%	R	1.73	0.5%	0.00%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
RF Ambient Conditions	3.0%	R	1.73	1.7%	0.03%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Vertical Device Positioning	4.7%	R	1.73	2.7%	0.07%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Lateral Device Positioning	1.0%	R	1.73	0.6%	0.00%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Device Holder	1.4%	N	1.00	1.4%	0.02%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Power Drift	2.9%	R	1.73	1.7%	0.03%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
				Comb Std. Uncertainty	12.7%	
				Exp Uncertainty	25.5%	

Motorola Uncertainty Budget for H-Field HAC Testing

Error	Value (R=1)	Distribution	Div	Std Unc	Unc^2	Source
RF Reflections	5.6%	R	1.73	3.2%	0.10%	From Reflection Test 050628.xls
Probe Calibration	5.1%	N	1.00	5.1%	0.26%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Isotropy	3.6%	R	1.73	2.1%	0.04%	From averaged results from iDEN HAC Tests i730, 850, 855, 450, 560 formatted.xls
Frequency Response						
Linearity	4.7%	R	1.73	2.7%	0.07%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Boundary Effects	2.4%	R	1.73	1.4%	0.02%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Sensor Displacement	2.4%	R	1.73	1.4%	0.02%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Probe Positioning accuracy	3.1%	R	1.73	1.8%	0.03%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Probe Positioner	0.9%	R	1.73	0.5%	0.00%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Extrapolation/Interpolation	1.0%	R	1.73	0.6%	0.00%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
System Detection Limit	1.0%	R	1.73	0.6%	0.00%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Readout Electronics	0.3%	N	1.00	0.3%	0.00%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Integration Time	2.6%	R	1.73	1.5%	0.02%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Response Time	0.8%	R	1.73	0.5%	0.00%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
RF Ambient Conditions	3.0%	R	1.73	1.7%	0.03%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Vertical Device Positioning	3.1%	R	1.73	1.8%	0.03%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Lateral Device Positioning	0.6%	R	1.73	0.3%	0.00%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Device Holder	1.4%	N	1.00	1.4%	0.02%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
Power Drift	2.9%	R	1.73	1.7%	0.03%	SPEAG DASY Chapter 28 Hearing Aid Extention (Draft)
				Comb Std. Uncertain	8.4%	
				Exp Uncertainty	16.7%	

12.0 Conclusion

The highest Operational Maximum Calculated E and H field emissions results found for FCC ID: AZ489FT5824, model H63XAN6RR4AN are presented below. In accordance with FCC rule 47 CFR 2.1033(d) these test results clearly demonstrate compliance with FCC 47 CFR section 20.19 and with PC63.19-2001 rd 3.6.

Max E Field emission = 56.36 V/m @ 821MHz

Max H Field emission = 0.130 A/m @ 813.5

M Category = M4

APPENDIX A

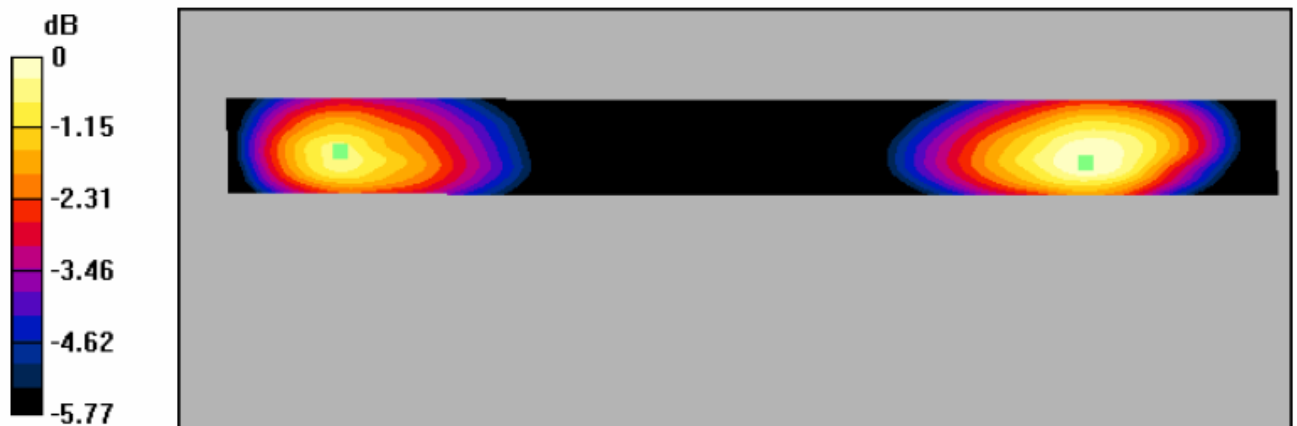
System Verification Results

Motorola Corporate Florida Research Lab
Planar Dipole
Date: 7/11/05

Comments:
813MHz E-field Validation
XFDTD Target = 224.8 V/m
Measured Results = 221.3 V/m
Delta from Target = -1.22%

HAC Procedure Notes: CW mode
Probe: ER3DV4R - SN2236, Calibrated: 1/7/2005, ConvF(1, 1, 1)
Duty Cycle: 1:1, Medium: Air, Medium parameters used: $\sigma = 0$; mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³
Electronics: DAE3 Sn357, Calibrated: 1/6/2005

Verification/Generic Scan 2 2 (101x101x1): Measurement grid: dx=2mm, dy=2mm, dz=20mm
Maximum value of E_tot (interpolated) = 221.3 V/m

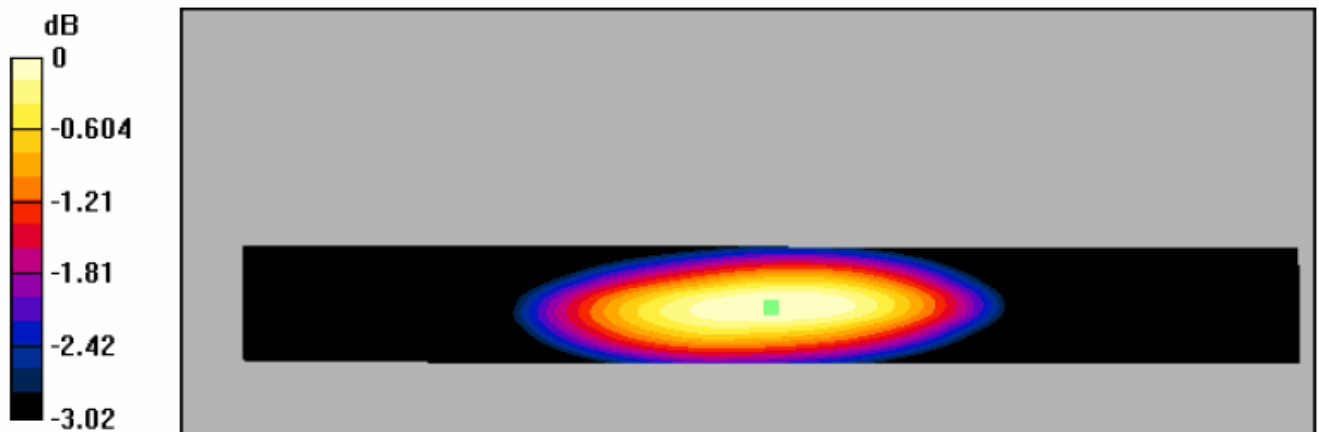


Motorola Corporate Florida Research Lab
Planar Dipole
Date: 7/11/05

Comments:
813MHz H-field Validation
XFDTD Target = 0.514 A/m
Measured Results = 0.489 A/m
Delta from Target = -4.85%

Procedure Notes: CW mode
Probe: H3DV6 - SN6036, Calibrated: 1/7/2005,
Duty Cycle: 1:1, Medium: Air, Medium parameters used: $\sigma = 0$; mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³
Electronics: DAE3 Sn357, Calibrated: 1/6/2005

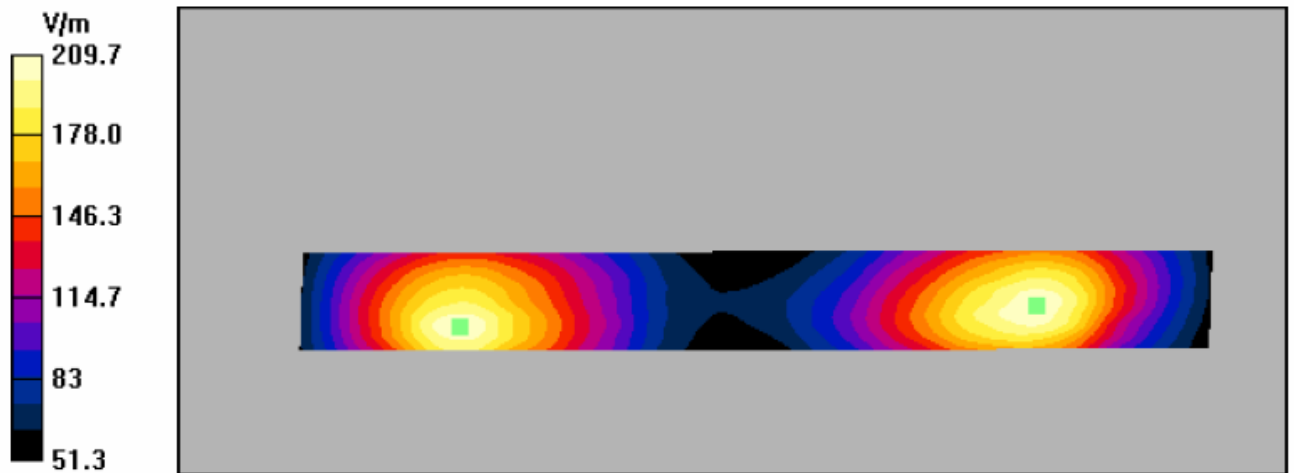
Verification/Generic Scan 2 2 (101x101x1): Measurement grid: dx=2mm, dy=2mm, dz=20mm
Maximum value of H_tot (interpolated) = 0.489 A/m



Motorola Corporate Florida Research Lab
Planar Dipole
Date: 7/11/05

Comments:
 900MHz E-field Validation
 XFDTD Target = 213.2 V/m
 Measured Results = 209.7 V/m
 Delta from Target = 4.85%

Procedure Notes: CW mode
 Probe: ER3DV4R - SN2236, Calibrated: 1/7/2005, ConvF(1, 1, 1)
 Duty Cycle: 1:1, Medium: Air, Medium parameters used: $\sigma = 0$; mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³
 Electronics: DAE3 Sn357, Calibrated: 1/6/2005
Verification/Generic Scan 2 2 (101x101x1): Measurement grid: dx=2mm, dy=2mm, dz=20mm
 Maximum value of E_tot (interpolated) = 209.4 V/m



Motorola Corporate Florida Research Lab
Planar Dipole
Date: 7/11/05

Comments:

900MHz H-field Validation
 XFDTD Target = 0.5032 A/m
 Measured Results = 0.483 A/m
 Delta from Target = -4.01%

Procedure Notes: CW mode

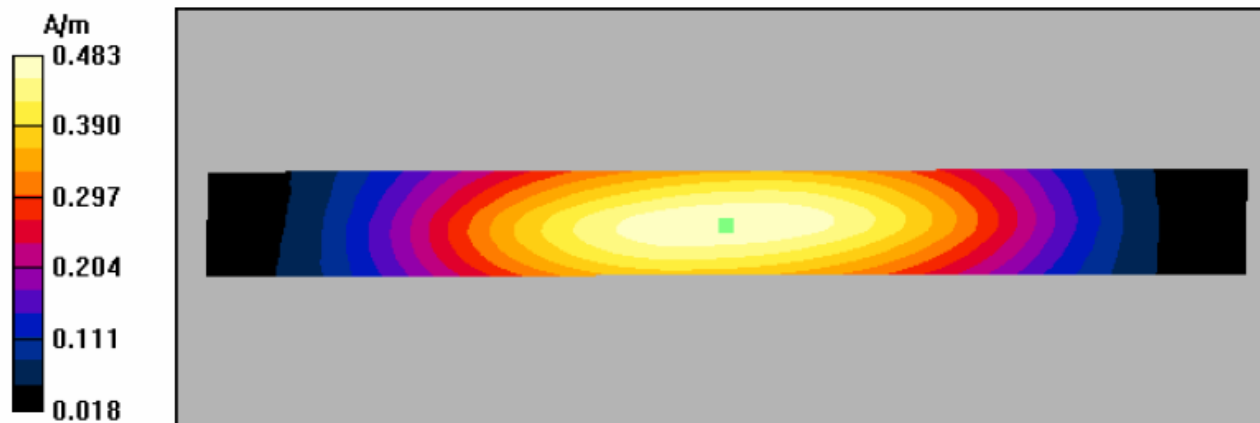
Probe: H3DV6 - SN6036, Calibrated: 1/7/2005,

Duty Cycle: 1:1, Medium: Air, Medium parameters used: $\sigma = 0$; mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³

Electronics: DAE3 Sn357, Calibrated: 1/6/2005

Verification/Generic Scan 2 2 (101x101x1): Measurement grid: dx=2mm, dy=2mm, dz=20mm

Maximum value of H_{tot} (interpolated) = 0.483 A/m



Appendix B

Measurement Results

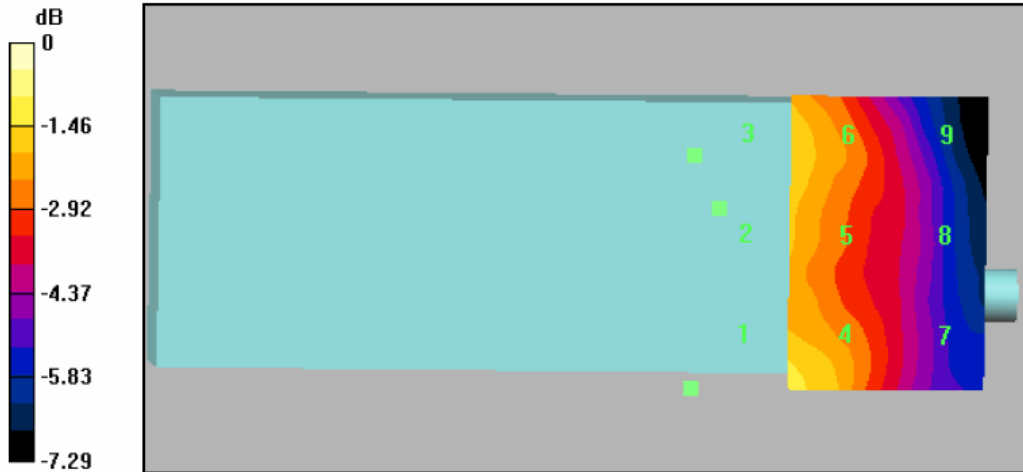
Motorola Corporate Florida Research Lab
iDEN i710 E-Field 800MHz band HAC assessment
Date: 7/14/05

SN 364AEGQPM8
 Frequency = 806MHz
 TX Pwr = 640mW

Procedure Notes: 3:1 transmission mode
 Probe: ER3DV6R - SN2246, Calibrated: 6/13/2005, ConvF(1, 1, 1)
 Duty Cycle: 1:3, Medium: Air, Medium parameters used: $\sigma = 0$; mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³
 Electronics: DAE3 Sn357, Calibrated: 1/6/2005
Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm, dz=5mm
 Drift = -0.144dB

E in V/m (Time averaged)

Grid 1	Grid 2	Grid 3
30.8	32.8	32.7
Grid 4	Grid 5	Grid 6
28.4	27	27.6
Grid 7	Grid 8	Grid 9
22.2	21.9	21.9



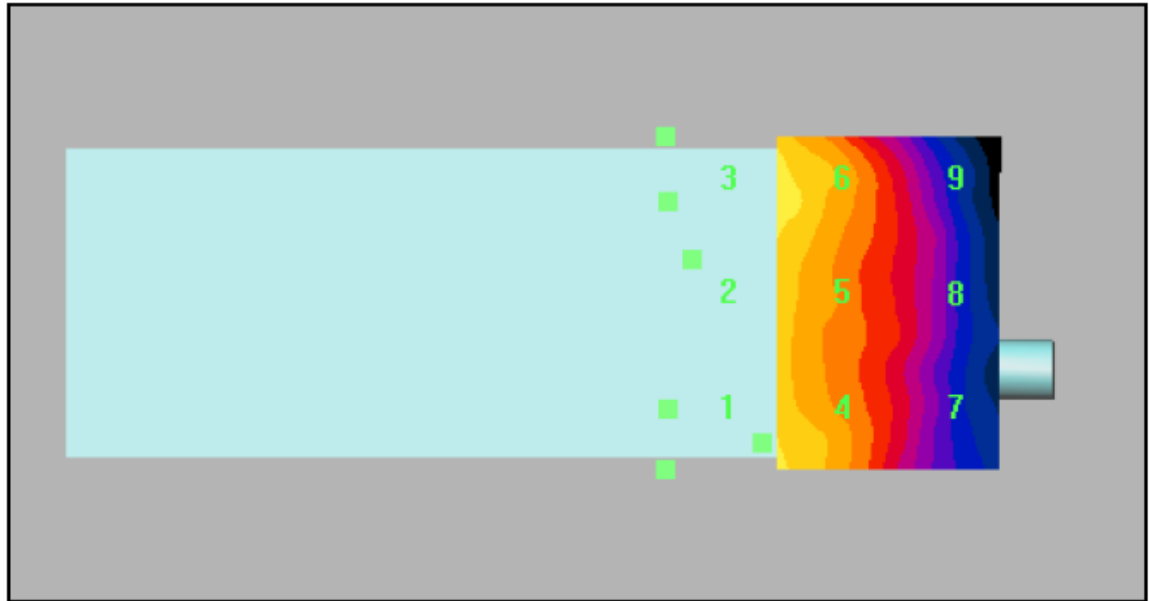
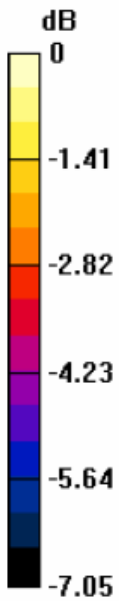
Motorola Corporate Florida Research Lab
iDEN i710 E-Field 800MHz band HAC assessment
Date: 7/14/05

SN 364AEGQPM8
 Frequency = 813MHz
 TX Pwr = 640mW

Procedure Notes: 3:1 transmission mode
 Probe: ER3DV6R - SN2246, Calibrated: 6/13/2005, ConvF(1, 1, 1)
 Duty Cycle: 1:3, Medium: Air, Medium parameters used: $\sigma = 0$; mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³
 Electronics: DAE3 Sn357, Calibrated: 1/6/2005
Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm, dz=5mm
 Drift = 0.0266dB

E in V/m (Time averaged)

Grid 1	Grid 2	Grid 3
30.8	33.5	33.8
Grid 4	Grid 5	Grid 6
29	28.7	29.6
Grid 7	Grid 8	Grid 9
23.3	23.7	23.6



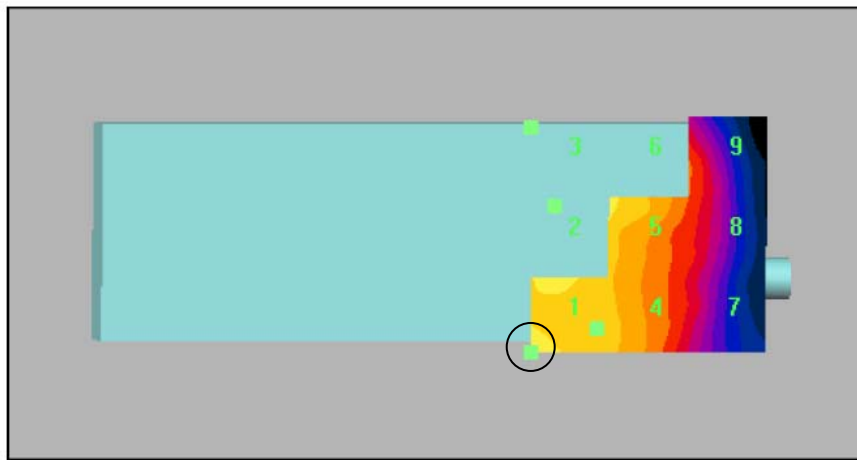
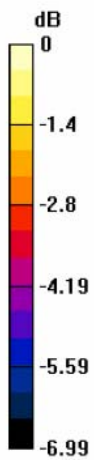
Motorola Corporate Florida Research Lab
iDEN i710 E-Field 800MHz band HAC assessment
Date: 7/14/05

SN 364AEGQPM8
 Frequency = 821MHz
 TX Pwr = 640mW

Procedure Notes: 3:1 transmission mode
 Probe: ER3DV6R - SN2246, Calibrated: 6/13/2005, ConvF(1, 1, 1)
 Duty Cycle: 1:3, Medium: Air, Medium parameters used: $\sigma = 0$; mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³
 Electronics: DAE3 Sn357, Calibrated: 1/6/2005
Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm, dz=5mm
 Drift = -0.115dB

E in V/m (Time averaged)

Grid 1	Grid 2	Grid 3
30.3	33.1	34.3
Grid 4	Grid 5	Grid 6
28.3	29.8	30.5
Grid 7	Grid 8	Grid 9
23.5	24.9	25.2



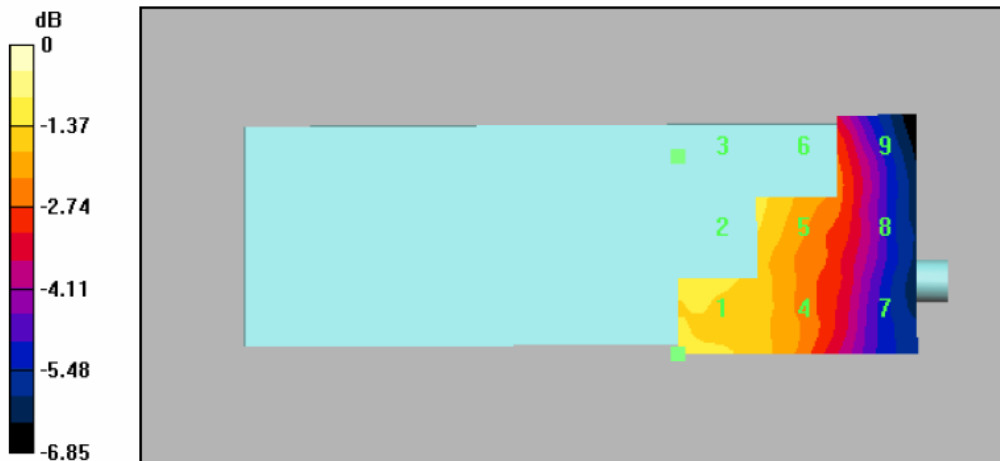
Motorola Corporate Florida Research Lab
iDEN i710 E-Field 800MHz band HAC assessment
Date: 7/14/05

SN 364AEGQPM8
 Frequency = 824MHz
 TX Pwr = 640mW

Procedure Notes: 3:1 transmission mode
 Probe: ER3DV6R - SN2246, Calibrated: 6/13/2005, ConvF(1, 1, 1)
 Duty Cycle: 1:3, Medium: Air, Medium parameters used: $\sigma = 0$; mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³
 Electronics: DAE3 Sn357, Calibrated: 1/6/2005
Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm, dz=5mm
 Drift = 0.0813 dB

E in V/m (Time averaged)

Grid 1	Grid 2	Grid 3
29.6	32.4	33.2
Grid 4	Grid 5	Grid 6
27.7	29	30.4
Grid 7	Grid 8	Grid 9
23.2	24.7	24.9



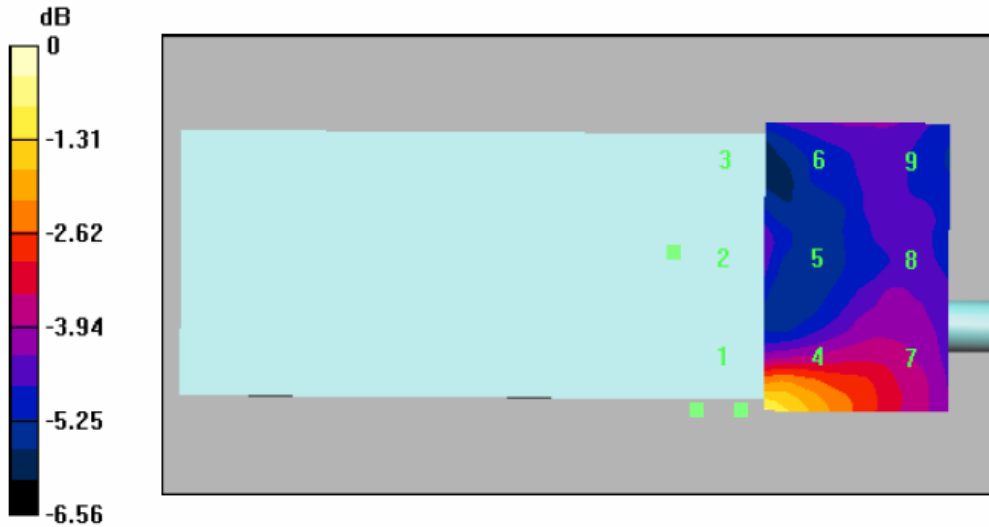
Date: 7/14/05

SN 364AEGQPM8
Frequency = 806MHz
TX Pwr = 640mW

Procedure Notes: 3:1 transmission mode
Probe: H3DV6 - SN6036, Calibrated: 1/7/2005,
Duty Cycle: 1:3, Medium: Air, Medium parameters used: $\sigma = 0$; mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³
Electronics: DAE3 Sn357, Calibrated: 1/6/2005
Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm, dz=5mm
Drift = -0.248 dB

H in A/m (Time averaged)

Grid 1	Grid 2	Grid 3
0.072	0.074	0.071
Grid 4	Grid 5	Grid 6
0.068	0.044	0.045
Grid 7	Grid 8	Grid 9
0.054	0.046	0.045



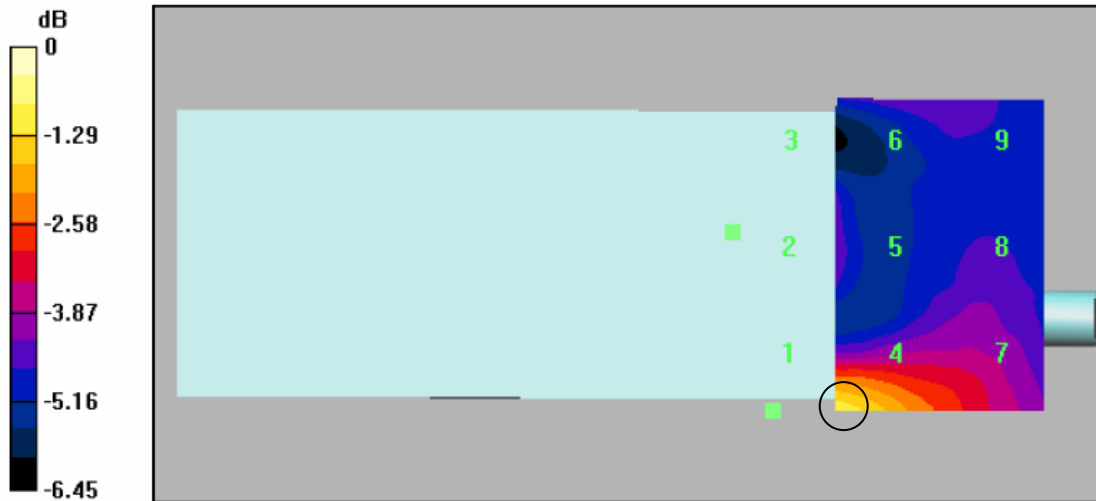
Motorola Corporate Florida Research Lab
iDEN i710 H-Field 800MHz band HAC assessment
Date: 7/14/05

SN 364AEGQPM8
 Frequency = 813MHz
 TX Pwr = 640mW

Procedure Notes: 3:1 transmission mode
 Probe: H3DV6 - SN6036, Calibrated: 1/7/2005,
 Duty Cycle: 1:3, Medium: Air, Medium parameters used: $\sigma = 0$; mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³
 Electronics: DAE3 Sn357, Calibrated: 1/6/2005
Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm, dz=5mm
 Drift = -0.182 dB

H in A/m (Time averaged)

Grid 1	Grid 2	Grid 3
0.074	0.076	0.074
Grid 4	Grid 5	Grid 6
0.069	0.046	0.046
Grid 7	Grid 8	Grid 9
0.056	0.047	0.046



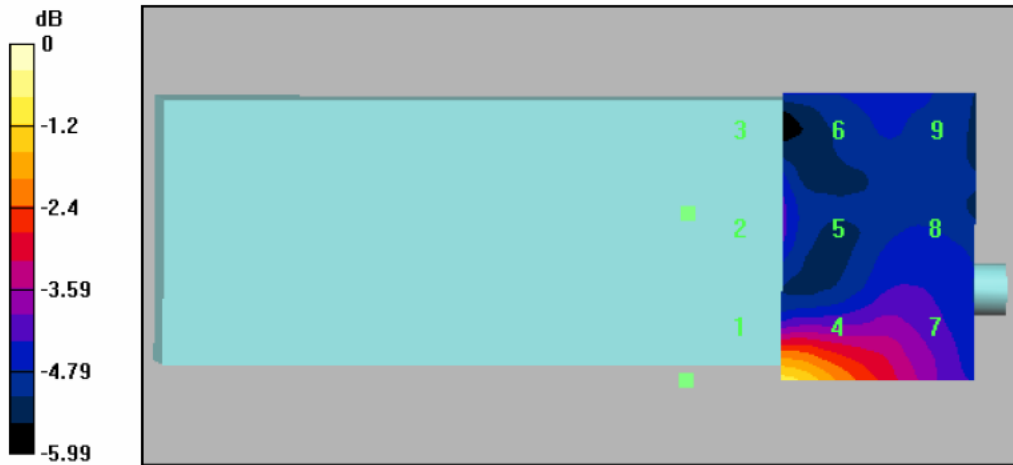
Motorola Corporate Florida Research Lab
iDEN i710 H-Field 800MHz band HAC assessment
Date: 7/14/05

SN 364AEGQPM8
Frequency = 821MHz
TX Pwr = 640mW

Procedure Notes: 3:1 transmission mode
Probe: H3DV6 - SN6036, Calibrated: 1/7/2005,
Duty Cycle: 1:3, Medium: Air, Medium parameters used: $\sigma = 0$; mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³
Electronics: DAE3 Sn357, Calibrated: 1/6/2005
Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm, dz=5mm
Drift = -0.0609 dB

H in A/m (Time averaged)

Grid 1	Grid 2	Grid 3
0.070	0.073	0.073
Grid 4	Grid 5	Grid 6
0.065	0.045	0.044
Grid 7	Grid 8	Grid 9
0.053	0.044	0.043



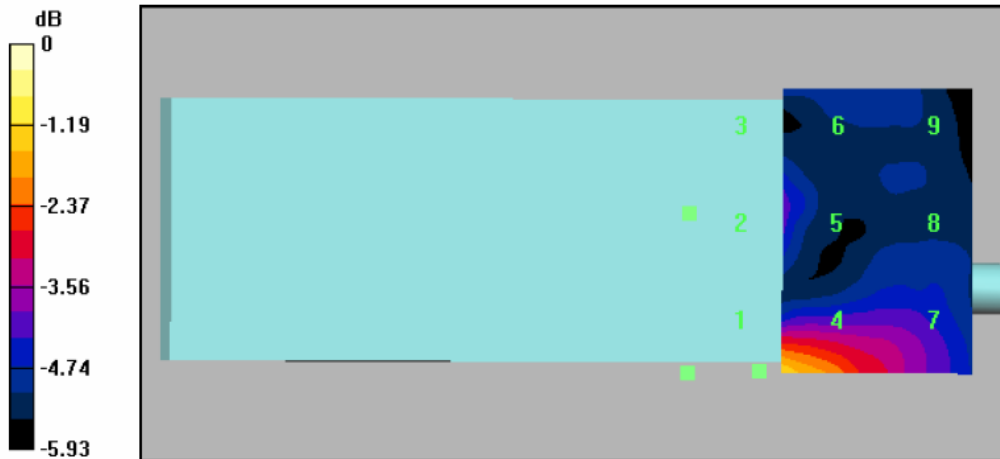
Motorola Corporate Florida Research Lab
iDEN i710 H-Field 800MHz band HAC assessment
Date: 7/14/05

SN 364AEGQPM8
 Frequency = 824MHz
 TX Pwr = 640mW

Procedure Notes: 3:1 transmission mode
 Probe: H3DV6 - SN6036, Calibrated: 1/7/2005,
 Duty Cycle: 1:3, Medium: Air, Medium parameters used: $\sigma = 0$; mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³
 Electronics: DAE3 Sn357, Calibrated: 1/6/2005
Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm, dz=5mm
 Drift = 0.105 dB

H in A/m (Time averaged)

Grid 1	Grid 2	Grid 3
0.072	0.077	0.072
Grid 4	Grid 5	Grid 6
0.067	0.048	0.046
Grid 7	Grid 8	Grid 9
0.055	0.045	0.044



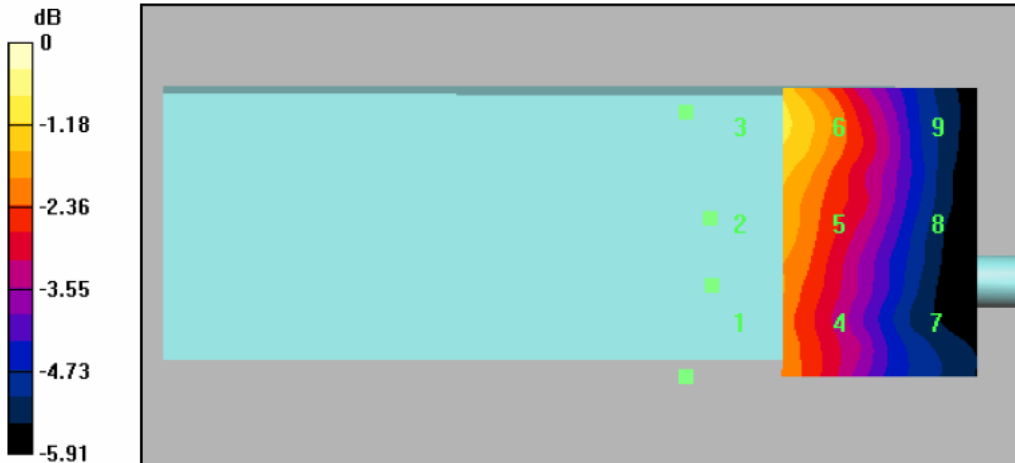
Motorola Corporate Florida Research Lab
iDEN i710 E-Field 900MHz band HAC assessment
Date: 7/14/05

SN 364AEGQPM8
 Frequency = 896MHz
 TX Pwr = 640mW

Procedure Notes: 3:1 transmission mode
 Probe: ER3DV6R - SN2246, Calibrated: 6/13/2005, ConvF(1, 1, 1)
 Duty Cycle: 1:3, Medium: Air, Medium parameters used: $\sigma = 0$; mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³
 Electronics: DAE3 Sn357, Calibrated: 1/6/2005
Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm, dz=5mm
 Drift = -0.0368 dB

E in V/m (Time averaged)

Grid 1	Grid 2	Grid 3
28.4	30.2	31.9
Grid 4	Grid 5	Grid 6
25.6	26.7	28.2
Grid 7	Grid 8	Grid 9
19.9	21.3	21.9



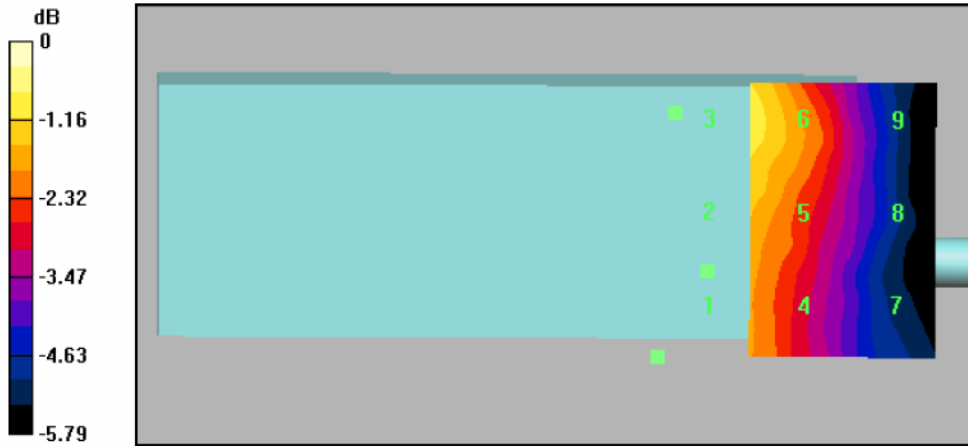
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iDEN i710 E-Field 900MHz band HAC assessment
Date: 7/14/05

SN 364AEGQPM8
 Frequency = 899MHz
 TX Pwr = 640mW

Procedure Notes: 3:1 transmission mode
 Probe: ER3DV6R - SN2246, Calibrated: 6/13/2005, ConvF(1, 1, 1)
 Duty Cycle: 1:3, Medium: Air, Medium parameters used: $\sigma = 0$; mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³
 Electronics: DAE3 Sn357, Calibrated: 1/6/2005
Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm, dz=5mm
 Drift = -0.290 dB

E in V/m (Time averaged)

Grid 1 29.7	Grid 2 31.6	Grid 3 33
Grid 4 26.9	Grid 5 28.5	Grid 6 29.6
Grid 7 21.3	Grid 8 22.6	Grid 9 23



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iDEN i710 E-Field 900MHz band HAC assessment
Date: 7/14/05

SN 364AEGQPM8
Frequency = 901MHz
TX Pwr = 640mW

Procedure Notes: 3:1 transmission mode

Probe: ER3DV6R - SN2246, Calibrated: 6/13/2005, ConvF(1, 1, 1)

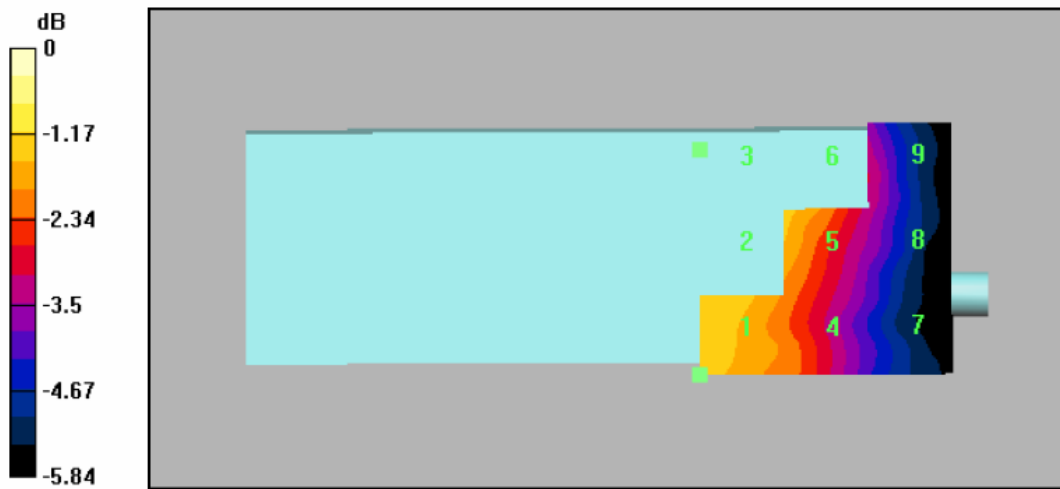
Duty Cycle: 1:3, Medium: Air, Medium parameters used: $\sigma = 0$; mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³

Electronics: DAE3 Sn357, Calibrated: 1/6/2005

Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm, dz=5mm
Drift = 0.257 dB

E in V/m (Time averaged)

Grid 1	Grid 2	Grid 3
28	30.5	32.1
Grid 4	Grid 5	Grid 6
25.5	27.8	28.8
Grid 7	Grid 8	Grid 9
20.3	22	22.5



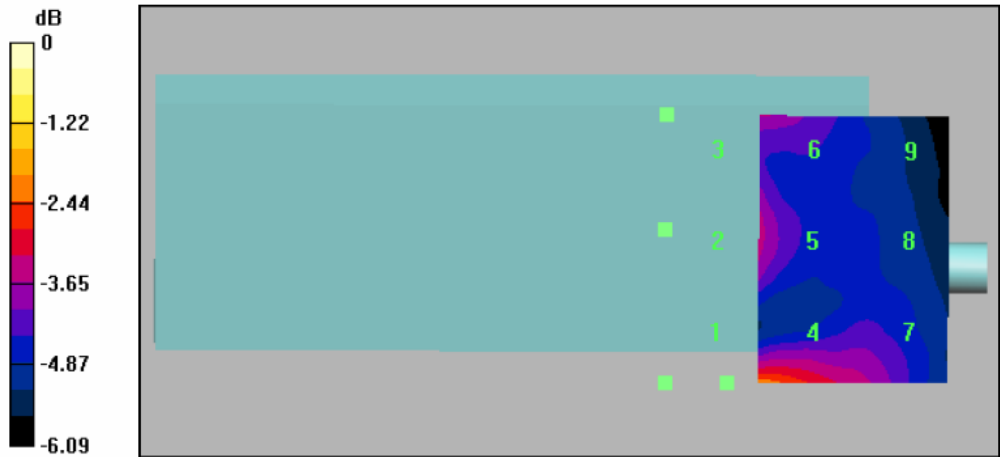
Motorola Corporate Florida Research Lab
iDEN i710 H-Field 900MHz band HAC assessment
Date: 7/14/05

SN 364AEGQPM8
Frequency = 896MHz
TX Pwr = 640mW

Procedure Notes: 3:1 transmission mode
Probe: H3DV6 - SN6036, Calibrated: 1/7/2005,
Duty Cycle: 1:3, Medium: Air, Medium parameters used: $\sigma = 0$; mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m3
Electronics: DAE3 Sn357, Calibrated: 1/6/2005
Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm, dz=5mm
Drift = -0.138 dB

H in A/m (Time averaged)

Grid 1	Grid 2	Grid 3
0.071	0.081	0.077
Grid 4	Grid 5	Grid 6
0.063	0.055	0.054
Grid 7	Grid 8	Grid 9
0.055	0.047	0.047



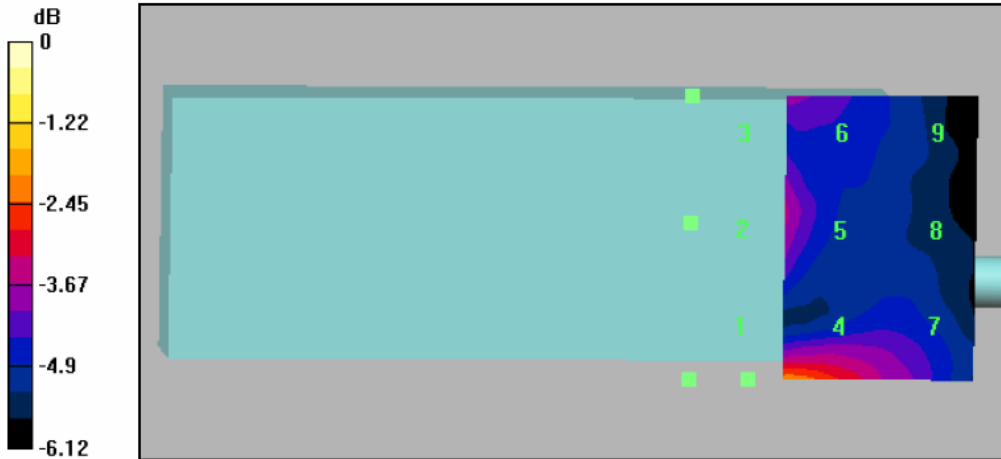
Motorola Corporate Florida Research Lab
iDEN i710 H-Field 900MHz band HAC assessment
Date: 7/14/05

SN 364AEGQPM8
 Frequency = 899MHz
 TX Pwr = 640mW

Procedure Notes: 3:1 transmission mode
 Probe: H3DV6 - SN6036, Calibrated: 1/7/2005,
 Duty Cycle: 1:3, Medium: Air, Medium parameters used: $\sigma = 0$; mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³
 Electronics: DAE3 Sn357, Calibrated: 1/6/2005
Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm, dz=5mm
 Drift = -0.384 dB

H in A/m (Time averaged)

Grid 1	Grid 2	Grid 3
0.073	0.086	0.081
Grid 4	Grid 5	Grid 6
0.068	0.057	0.056
Grid 7	Grid 8	Grid 9
0.057	0.049	0.049



Motorola Corporate Florida Research Lab
iDEN i710 H-Field 900MHz band HAC assessment
Date: 7/14/05

SN 364AEGQPM8
 Frequency = 901MHz
 TX Pwr = 640mW

Procedure Notes: 3:1 transmission mode
 Probe: H3DV6 - SN6036, Calibrated: 1/7/2005,
 Duty Cycle: 1:3, Medium: Air, Medium parameters used: $\sigma = 0$; mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³
 Electronics: DAE3 Sn357, Calibrated: 1/6/2005
Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm, dz=5mm
 Drift = -0.280 dB

H in A/m (Time averaged)

Grid 1	Grid 2	Grid 3
0.070	0.082	0.078
Grid 4	Grid 5	Grid 6
0.065	0.055	0.055
Grid 7	Grid 8	Grid 9
0.055	0.048	0.049



Appendix C

Probe Calibration Certificate

Calibration Laboratory of
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 Zeughausstrasse 43, 8004 Zurich, Switzerland



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 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 108**

Client **Motorola MFRL**

Certificate No: **ER3-2246_Jun05**

CALIBRATION CERTIFICATE

Object **ER3DV6R - SN:2246**

Calibration procedure(s) **QA CAL-02.v4**
Calibration procedure for E-field probes optimized for close near field evaluations in air

Calibration date: **June 13, 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).
 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	3-May-05 (METAS, No. 251-00466)	May-06
Power sensor E4412A	MY41495277	3-May-05 (METAS, No. 251-00466)	May-06
Power sensor E4412A	MY41498087	3-May-05 (METAS, No. 251-00466)	May-06
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-05 (METAS, No. 251-00467)	May-06
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	19-Jan-05 (SPEAG, No. DAE4-617_Jan05)	Jan-06
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
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

Calibrated by:	Name Nico Vetterli	Function Laboratory Technician	Signature 
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Approved by:	Name Katja Pokovic	Function Technical Manager	Signature 
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Issued: June 13, 2005

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

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Accreditation No.: **SCS 108**

Glossary:

NORM _{x,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., $\vartheta = 0$ 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:

- *NORM_{x,y,z}*: Assessed for E-field polarization $\vartheta = 0$ for XY sensors and $\vartheta = 90$ for Z sensor ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide).
- *NORM(f)_{x,y,z}* = *NORM_{x,y,z}* * *frequency_response* (see Frequency Response Chart).
- *DCP_{x,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 *NORM_x* (no uncertainty required).

ER3DV6R SN:2246

June 13, 2005

DASY - Parameters of Probe: ER3DV6R SN:2246Sensitivity in Free Space [$\mu\text{V}/(\text{V}/\text{m})^2$]Diode Compression^ANormX **$3.75 \pm 10.1 \%$ (k=2)**DCP X **94 mV**NormY **$3.87 \pm 10.1 \%$ (k=2)**DCP Y **94 mV**NormZ **$5.75 \pm 10.1 \%$ (k=2)**DCP Z **94 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

221 °

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%.

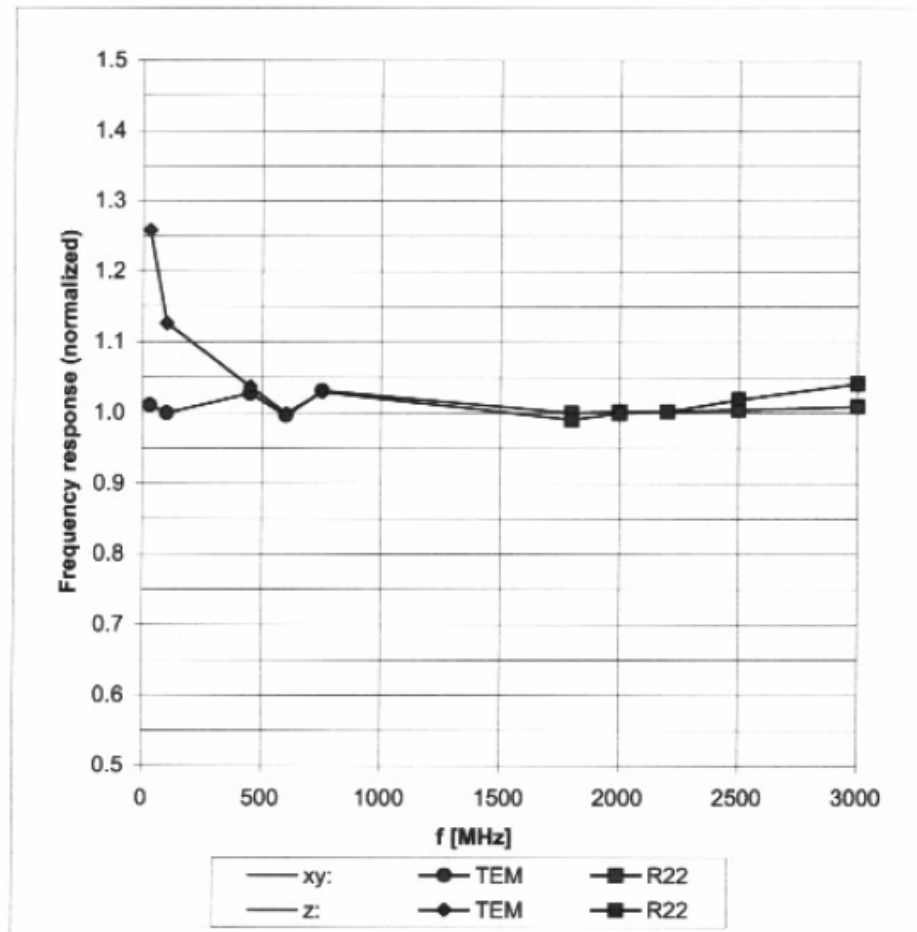
^A numerical linearization parameter: uncertainty not required

ER3DV6R SN:2246

June 13, 2005

Frequency Response of E-Field

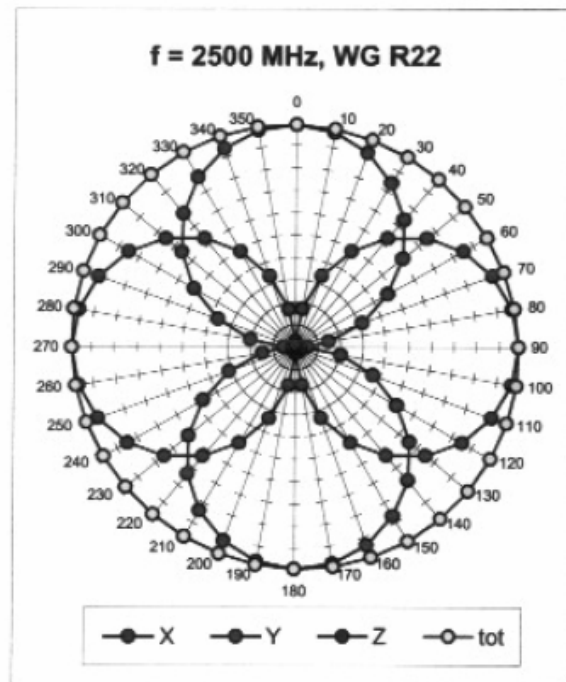
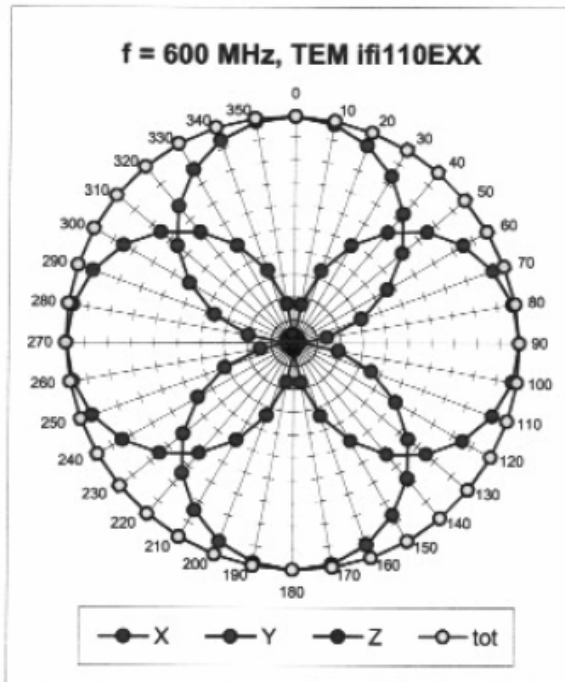
(TEM-Cell:ifi110 EXX, Waveguide R22)

Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

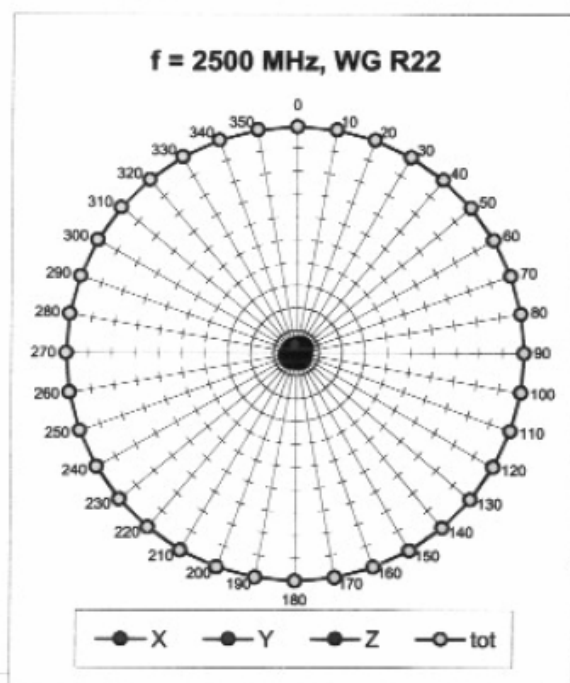
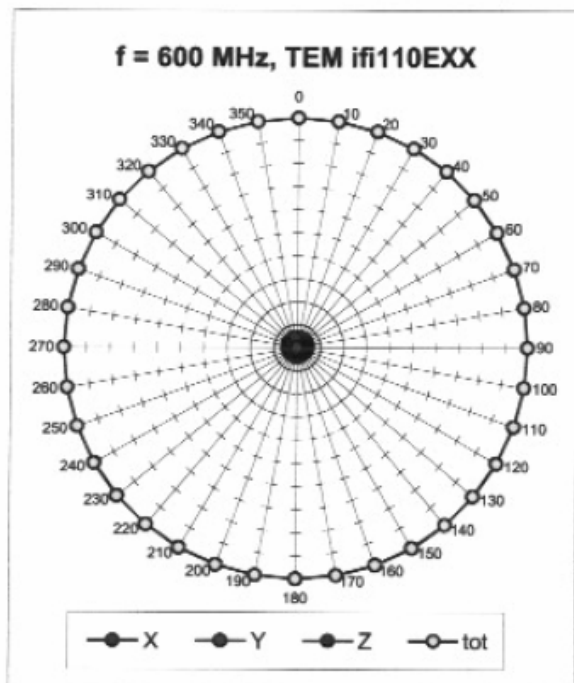
ER3DV6R SN:2246

June 13, 2005

Receiving Pattern (ϕ), $\vartheta = 0^\circ$

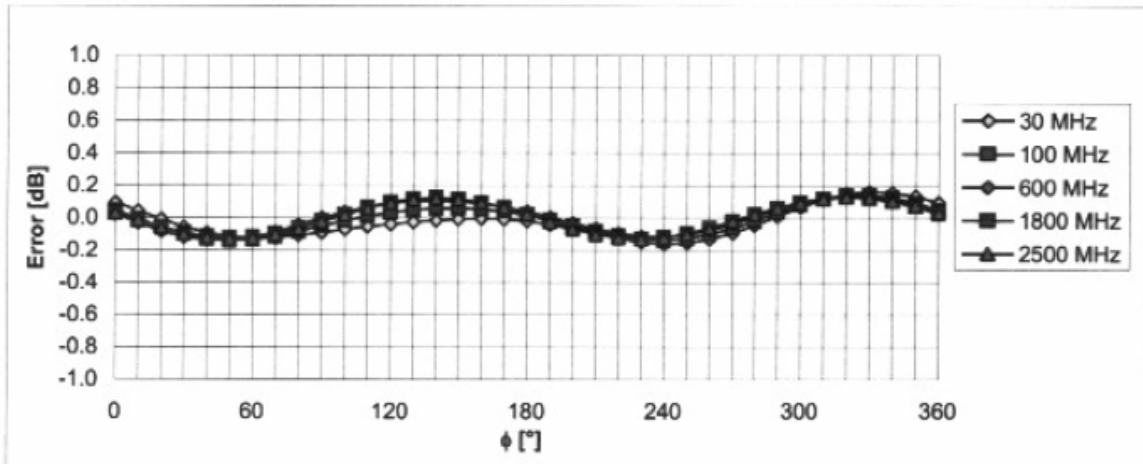
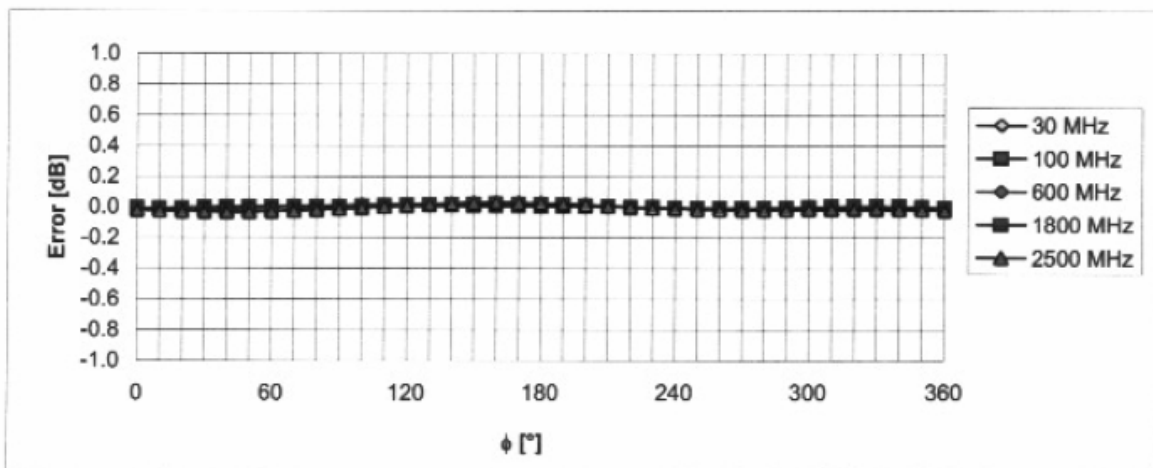


Receiving Pattern (ϕ), $\vartheta = 90^\circ$



ER3DV6R SN:2246

June 13, 2005

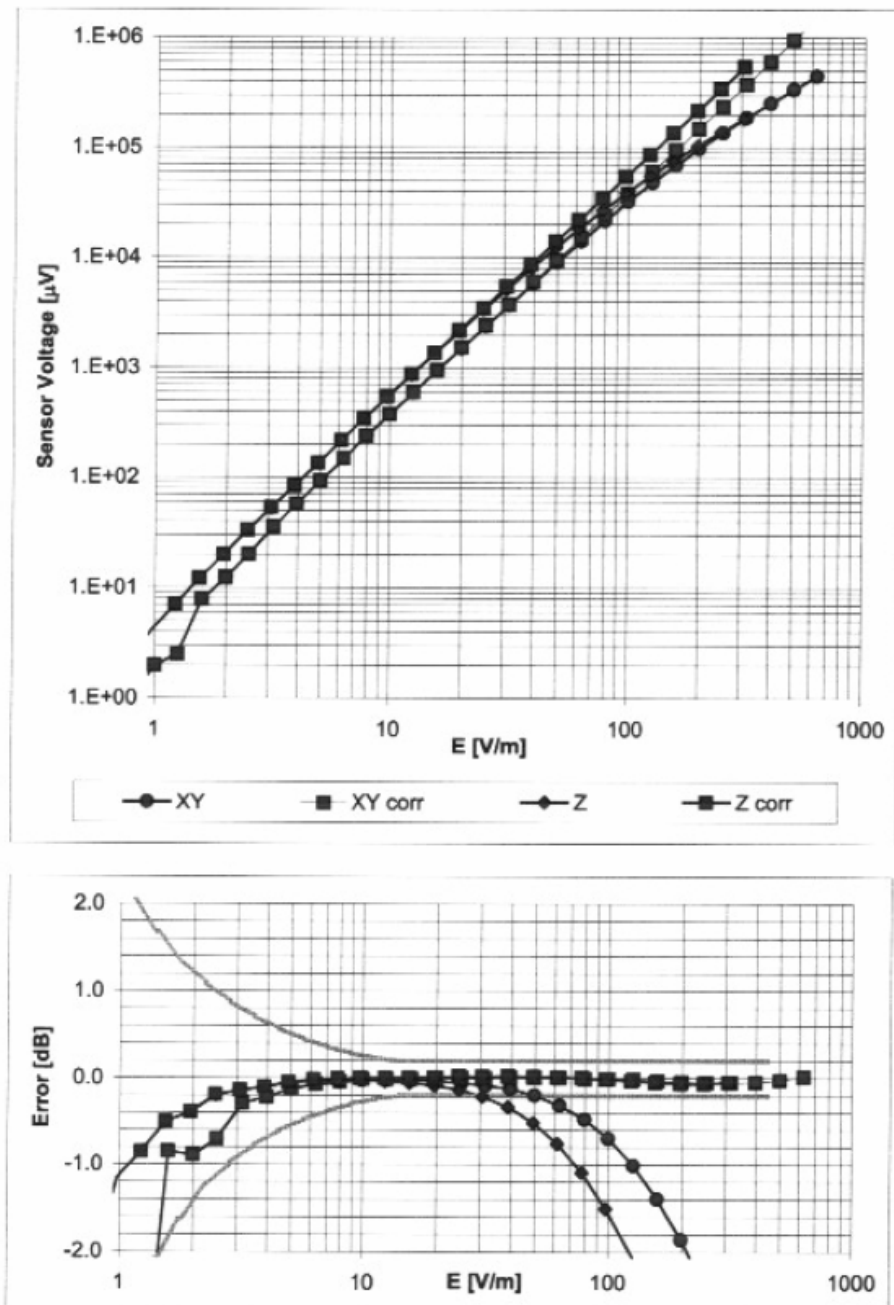
Receiving Pattern (ϕ), $\vartheta = 0^\circ$ Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)**Receiving Pattern (ϕ), $\vartheta = 90^\circ$** Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

ER3DV6R SN:2246

June 13, 2005

Dynamic Range f(E-field)

(Waveguide R22, $f = 1800$ MHz)



Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

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Accreditation No.: SCS 108

Client **Motorola CGISS**

Certificate No: **H3-6036_Jan05**

CALIBRATION CERTIFICATE

Object **H3DV6 - SN:6036**

Calibration procedure(s) **QA CAL-03.v4**
Calibration procedure for H-field probes optimized for close near field
evaluations in air

Calibration date: **January 7, 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).
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 $(22 \pm 3)^{\circ}\text{C}$ 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: January 13, 2005

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Accreditation No.: **SCS 108**

Glossary:

NORM _{x,y,z}	sensitivity in free space
DCP	diode compression point
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Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ 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:

- 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 $\vartheta = 90$ for XY sensors and $\vartheta = 0$ for Z sensor ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide).
- $X, Y, Z(f)_{a0a1a2} = X, Y, Z_{a0a1a2} \cdot \text{frequency_response}$ (see Frequency Response Chart).
- $DCP_{x,y,z}$: 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).

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DASY - Parameters of Probe: H3DV6 SN:6036Sensitivity in Free Space [A/m / $\sqrt{(\mu\text{V})}$]

	a0	a1	a2
X	2.652E-03	1.271E-5	-3.893E-5 $\pm$ 5.1 % (k=2)
Y	2.689E-03	1.106E-5	-5.700E-5 $\pm$ 5.1 % (k=2)
Z	3.056E-03	-2.728E-5	-5.504E-5 $\pm$ 5.1 % (k=2)

Diode Compression¹

DCP X	85 mV
DCP Y	85 mV
DCP Z	85 mV

Sensor Offset (Probe Tip to Sensor Center)

X	3.0 mm
Y	3.0 mm
Z	3.0 mm

Connector Angle 133 °

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%.

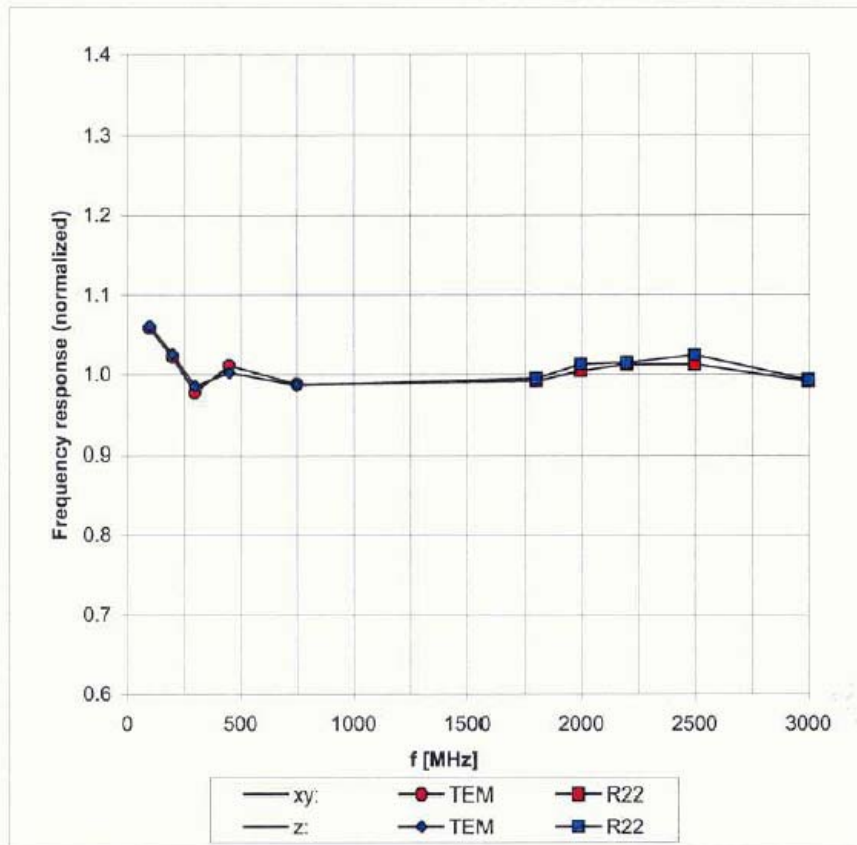
¹ numerical linearization parameter: uncertainty not required

H3DV6 SN:6036

January 7, 2005

Frequency Response of H-Field

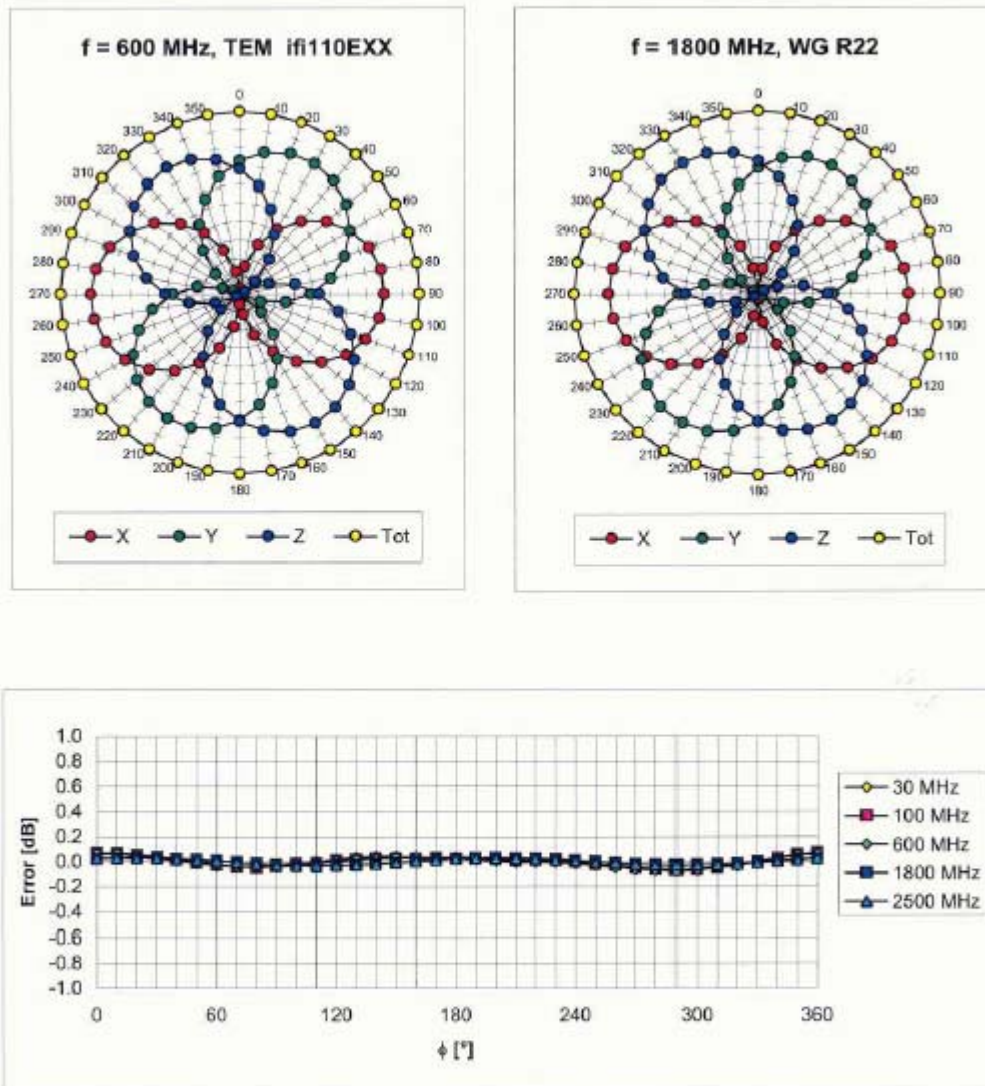
(TEM-Cell:ifi110, Waveguide R22)

Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ (k=2)

ET3DV6 SN:1383

February 24, 2005

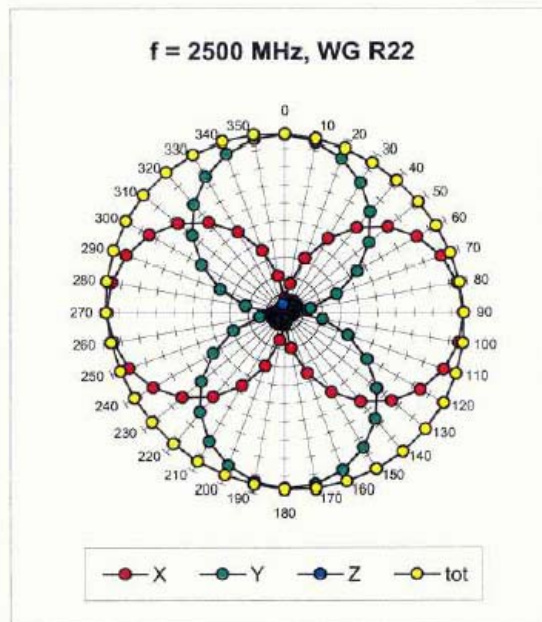
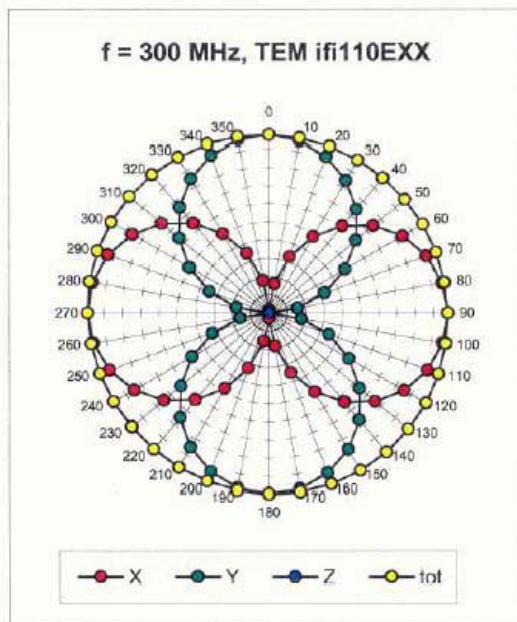
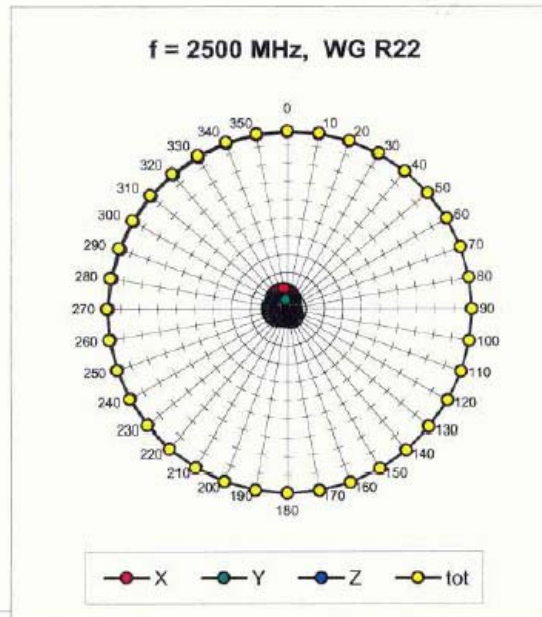
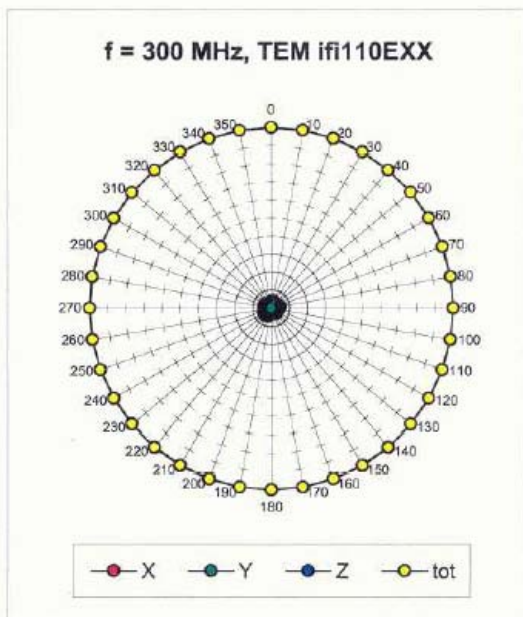
Receiving Pattern (ϕ), $\theta = 0^\circ$



Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

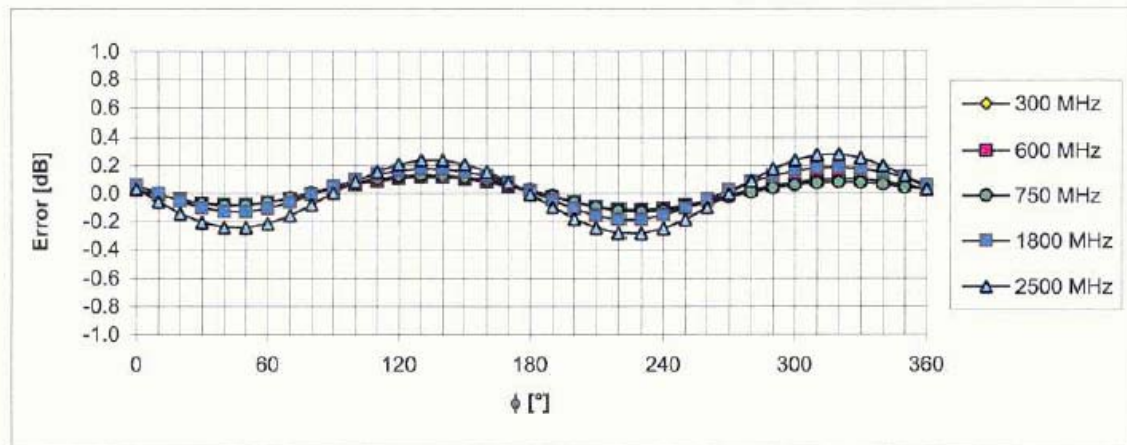
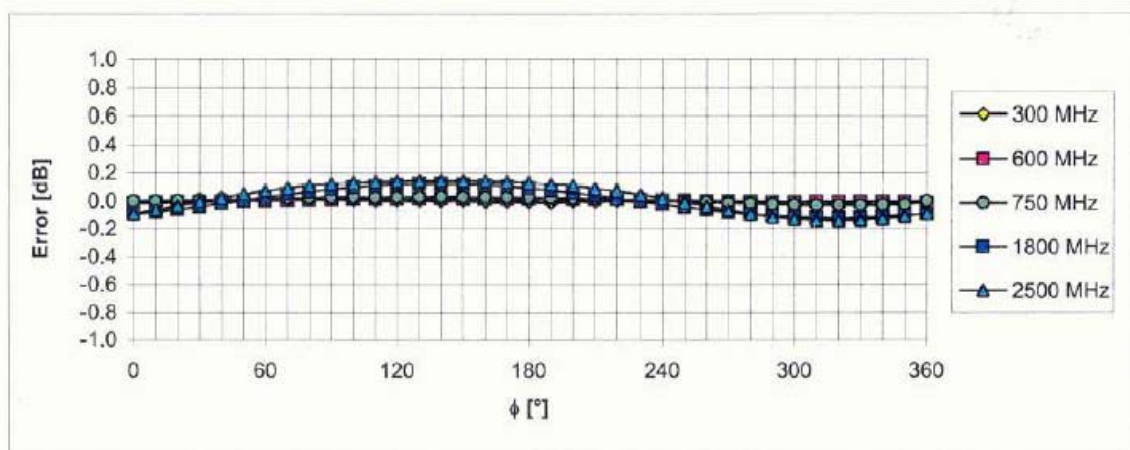
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Receiving Pattern (ϕ), $\vartheta = 90^\circ$ Receiving Pattern (ϕ), $\vartheta = 0^\circ$ 

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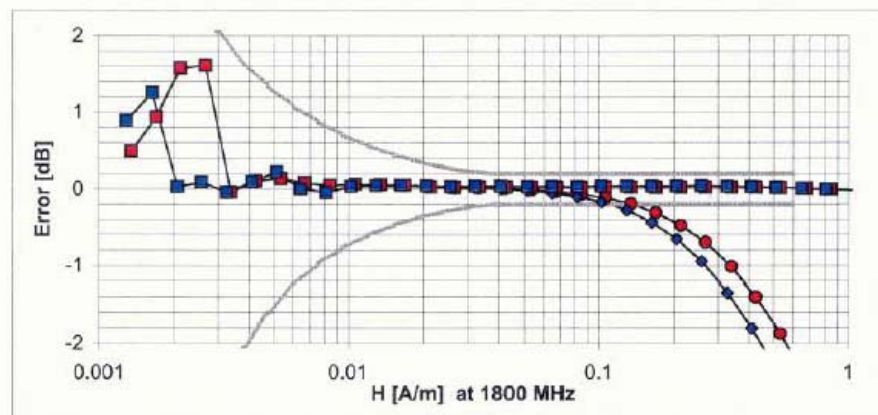
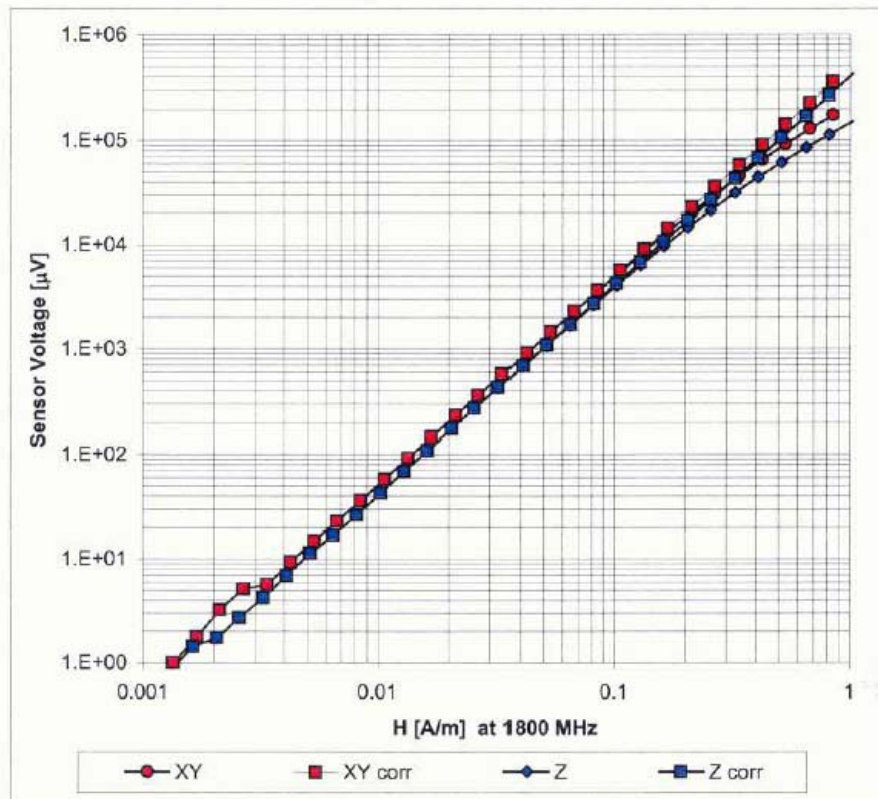
Receiving Pattern (ϕ), $\vartheta = 90^\circ$ Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)**Receiving Pattern (ϕ), $\vartheta = 0^\circ$** Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

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Dynamic Range f(H-field)

(Waveguide R22, $f = 1800$ MHz)

Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

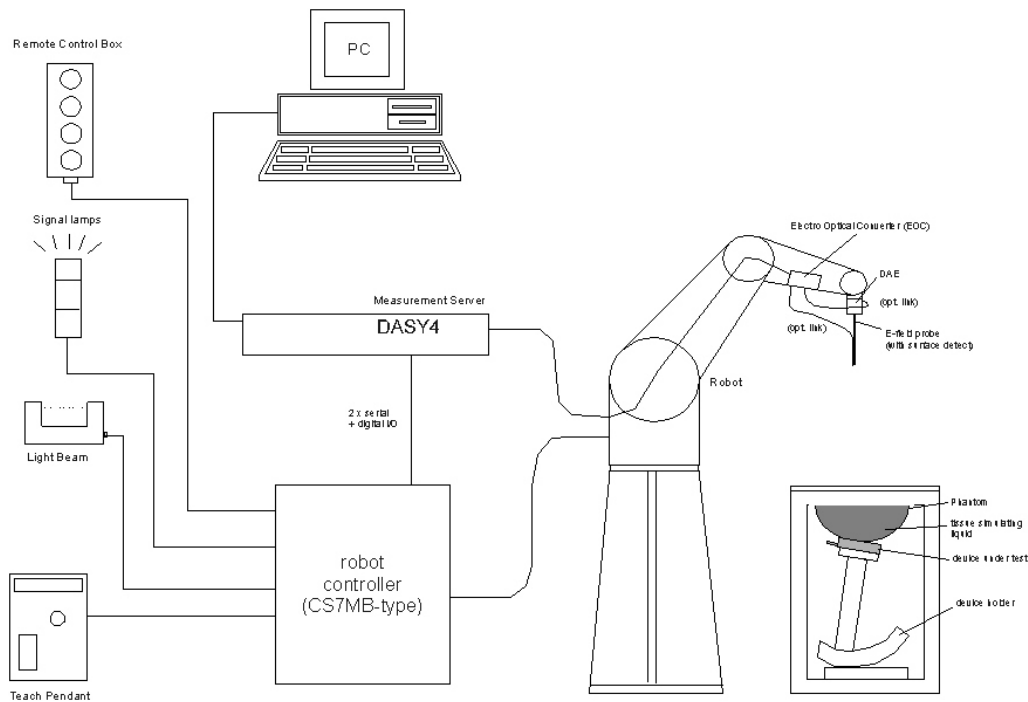
Appendix D

Details of Automated Scanning Method and Computations:

Chapter 11

System Description and Setup

11.1 System Description



The DASY4 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot (Stäubli RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.

- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 2000 or Windows XP.
- DASY4 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing to validate the proper functioning of the system.

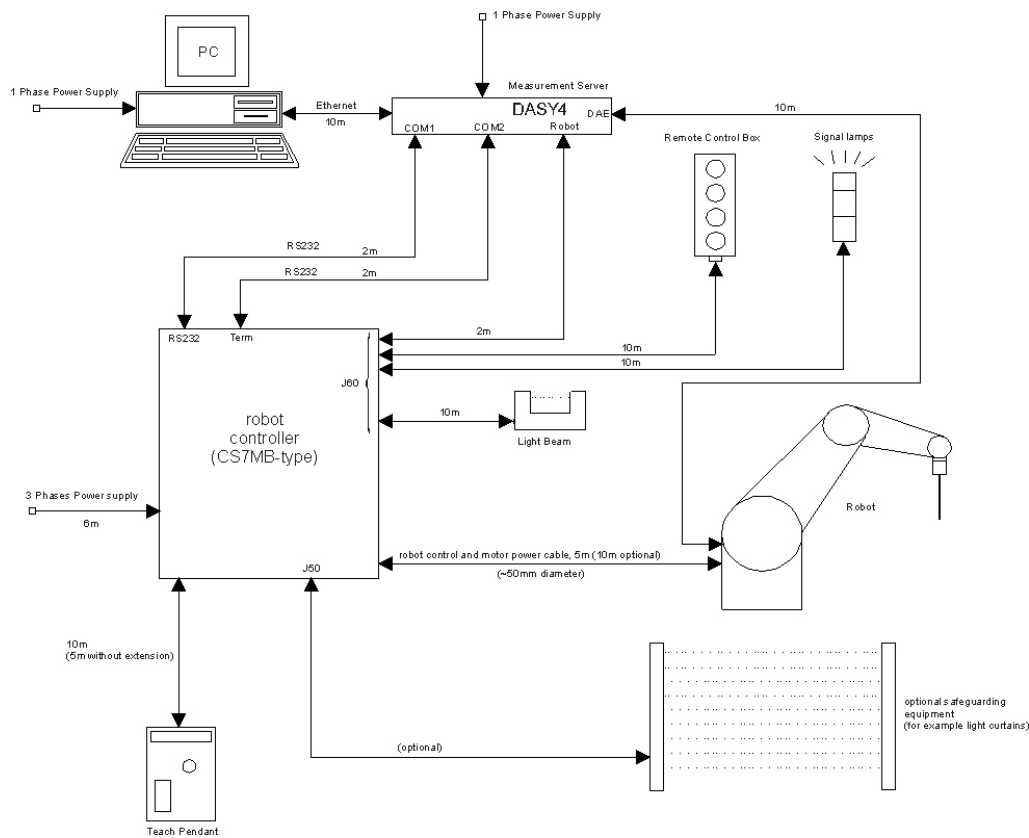
OPTIONS

- Isotropic E-field probe optimized and calibrated for E-field measurements in free space.
- Isotropic H-field probe optimized and calibrated for H-field measurements in any non-magnetic media.
- Flat Phantom (only for body-mounted transceivers operating below 800 MHz).

ADDITIONAL UTILITIES FOR SAR-MEASUREMENTS NOT PROVIDED BY SPEAG

- System to operate the device in a defined mode. For compliance testing, no cable should be attached. This is usually accomplished with tester communication via an air link or by special device software.
- System to measure the dielectric properties of the tissue simulating liquids. For the time being we recommend the usage of the HP 85070 dielectric probe kit. An alternative is the slotted coaxial line method. Both methods require a network analyzer.
- Signal generator, amplifier, power meter (precision <0.1 dB), coupler and cable in order to perform the system check. A power level of larger than 14 dBm is required (preferably 20-25 dBm).
- Utilities to prepare tissue simulating solution
 - Stirrer (magneto-stirrer with heating plate is recommended)
 - Balance (1 g accuracy, 500 to 2'000 g range)
 - Glass flask 31 to 101 for mixing liquid

11.2 System Setup



11.3 Requirements for the Room

- Approximately constant room temperature is recommended (because of the sensitivity of the liquid parameters). The floor should be easy to clean (liquid in phantom), stable, flat and vibration free.
- The circuit breaker for the 3-phase power for the robot depends on the power main voltage. For 3 phases 400 V (Europe) 4 Amp are needed and for 3 phases 208 V (USA, Asia) 10 Amp.

11.4 RF-Absorber in Operating Room or Laboratory

For dosimetric measurements, no RF-absorbers are needed. If you perform free space measurements other than only in the immediate near-field, moveable absorbers are useful to avoid reflections from the walls, robot etc. Shielding and absorbers might be necessary to avoid interference with other devices (e.g., sensitive measurement systems, base stations).

11.5 Wiring for Power Connection in USA

An open ended 4 wire cable for power connection with the following configuration is delivered with the DASY system:

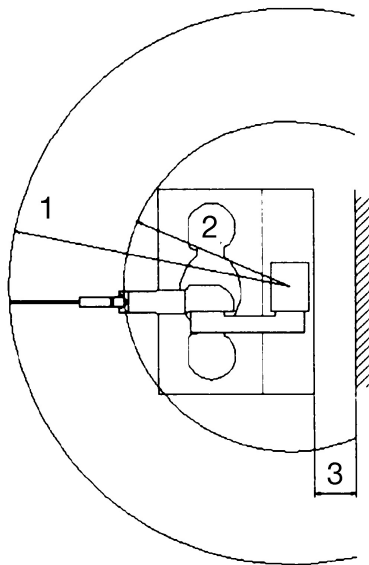
- 3 phases Δ 208 V
- Ground (Safety Ground)

Customer needs to organize a wall-mounted plug and a corresponding connector for the installation.

11.6 Wiring for Power Connection in Europe

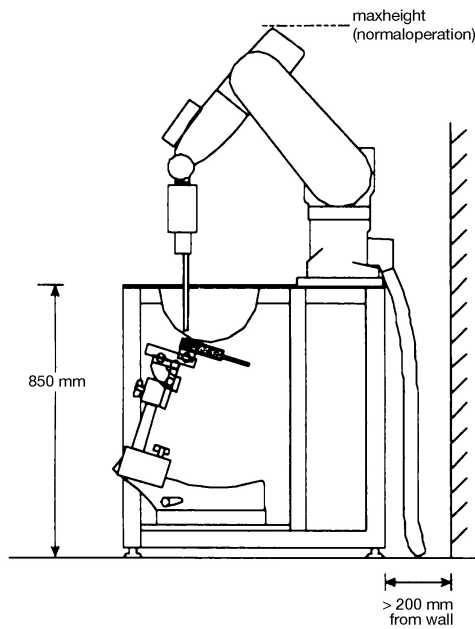
A standard CEE 16 Amp plug connector is delivered (3-phase + safety ground).

11.7 Dimensions of DASY4 Compact Version



TOP VIEW

1. Range for horizontal aligned probes (e.g., free space measurements): 1350 mm
2. Range for vertical aligned probes (max distance to phantom): 800 mm
3. Minimum distance from wall or absorber: 200 mm



SIDE VIEW

1. Minimum free height: approx. 1700 mm
2. Height of table: 850 mm

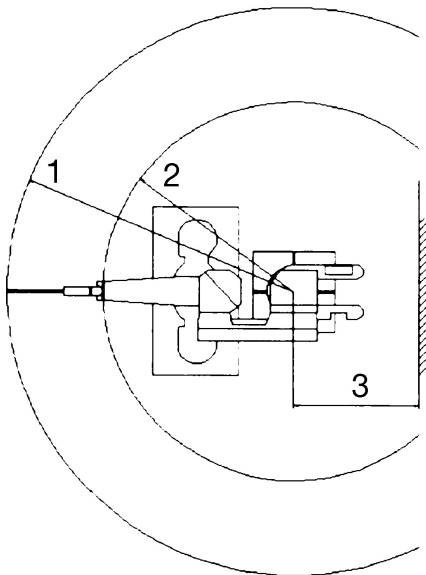
TYPICAL SHIPPING DIMENSIONS

Approx. 5 pallets, gross weight approx. 413 kg

Maximum pallet size: 120x80x100 cm

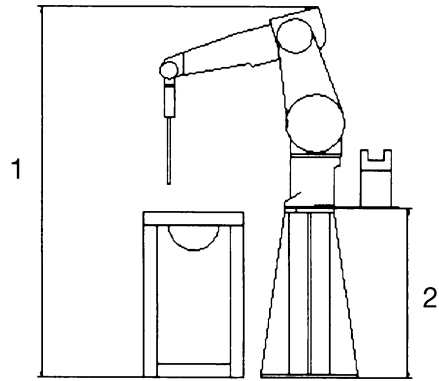
Maximum pallet weight: approx. 138 kg

11.8 Dimensions of DAS4 Professional Version



TOP VIEW

1. Range for horizontal aligned probes (e.g., free space measurements):
RX90L: 1590 mm, RX90: 1390 mm
2. Range for vertical aligned probes (max. distance to phantom):
RX90L: 1100 mm, RX90: 900 mm
3. Minimum distance from wall or absorber:
750 mm



SIDE VIEW

1. Minimum free height: approx. 1900 mm
2. Height of robot socket: 850 mm

TYPICAL SHIPPING DIMENSIONS

Approx. 6 pallets, gross weight approx. 615 kg

Maximum pallet size: 120x80x100 cm

Maximum pallet weight: approx. 145 kg

Chapter 19

Data Storage and Evaluation

19.1 Data Storage

The DASY4 software stores the assessed data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all the necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension `.DA4`. The postprocessing software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of erroneous parameter settings. For example, if a measurement has been performed with an incorrect crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be reevaluated.

To avoid unintentional parameter changes or data manipulations, the parameters in measured files are locked. In the administrator access mode of the software, the parameters can be unlocked (see Section [6.10 Unlocking a Setup](#)). After changing the parameters, the measured scans can be reevaluated in the postprocessing engine.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type (e.g., [V/m], [A/m] or [mW/g]). Some of these units are not available in certain situations or give meaningless results, e.g., a SAR-output in a lossless media will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

19.2 Data Evaluation

The DASY4 postprocessing software (SEMCAD) automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe parameters:	- Sensitivity	$Norm_i, a_{i0}, a_{i1}, a_{i2}$
	- Conversion factor	$ConvF_i$
	- Diode compression point	dcp_i
Device parameters:	- Frequency	f
	- Crest factor	cf
Media parameters:	- Conductivity	σ
	- Density	ρ

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY components. In the direct measuring mode of the multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i} \quad (19.1)$$

with V_i = compensated signal of channel i (i = x, y, z)
 U_i = input signal of channel i (i = x, y, z)
 cf = crest factor of exciting field (DASY parameter)
 dcp_i = diode compression point (DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

$$\text{E - fieldprobes :} \quad E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

$$\text{H - fieldprobes :} \quad H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1}f + a_{i2}f^2}{f}$$

with V_i = compensated signal of channel i (i = x, y, z)
 $Norm_i$ = sensor sensitivity of channel i (i = x, y, z)
 $\mu\text{V}/(\text{V/m})^2$ for E-field Probes
 $ConvF$ = sensitivity enhancement in solution
 a_{ij} = sensor sensitivity factors for H-field probes
 f = carrier frequency [GHz]
 E_i = electric field strength of channel i in V/m
 H_i = magnetic field strength of channel i in A/m

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

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2} \quad (19.2)$$

The primary field data are used to calculate the derived field units.

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1'000} \quad (19.3)$$

with SAR = local specific absorption rate in mW/g
 E_{tot} = total field strength in V/m
 σ = conductivity in [mho/m] or [Siemens/m]
 ρ = equivalent tissue density in g/cm³

Note that the density is set to 1, to account for actual head tissue density rather than the density of the tissue simulating liquid.