GENERAL DYNAMICS
C4 Systems

Exhibit 11 – RF Exposure

General Dynamics C4 Systems

PathMaker Network Radio

FCC ID: MIJPNR-1000

Model No. PNR-1000

11.0 PathMaker Network Radio SAR Analysis

The PathMaker Network Radio is a re-branding of the Max Tech SAVION-E Mesh Communicator Unit. The two radios are identical in all respects with the exception of the nameplate. Both radios utilize the same exact housings, RF transmitter, RF modulator, and the same type of antennas.

The SAVION-E Mesh Communicator Unit was tested for SAR by the Seibersdorf Laboratories in Seibersdorf, Austria during the time period from June 9th to June 17th, 2011. The attached Test Report NR EMV-E 17/11 contains the results of the SAR test. The unit was tested in voice mode in three different configurations including usage at the ear, front-of-face, and body worn. The worst case SAR measured was 0.238 W/kg as averaged across 1 gram in the body-worn configuration. This level is significantly less than the 47 CFR 15.247(i) and 47 CFR 2.1093 requirements of 1.6 W/kg as averaged across any 1 gram of tissue for the general public.

The SAR test measurements were performed with a half-wave dipole, "rubber duck", antenna having a maximum +2 dBi gain. This antenna was the P/N ANT-2.4-CW-QW manufactured by Antenna Factor. The antenna to be provided with the radio is of the same family, i.e. a half-wave dipole, "rubber duck", antenna having similar gain (+2 dBi). This antenna is the ENTEL P/N 85-P42580K. The drawings for both antennas are included after the attached SAR test report. The antenna change was implemented in order to provide a unique antenna connector, Reverse Thread (RT) SMA, to satisfy the 47 CFR Part 15.203 requirements.

The PathMaker Network Radio includes a data mode capability which has a higher duty cycle of transmission than the voice mode. An analysis was performed to calculate the resulting worst case SAR from the PathMaker radio when used in data mode.

A time domain plot of the voice mode is shown in Figure 1, which was extracted from the SAVION-E SAR Test Report. There are three pulses that occur in every 100 ms frame. The first pulse has a width of about 0.8 ms whereas the second and third pulses each have a width of about 1.1 ms. The resultant duty cycle in voice mode is (0.8 + 1.1 + 1.1)/100 = 0.03 or 3%.

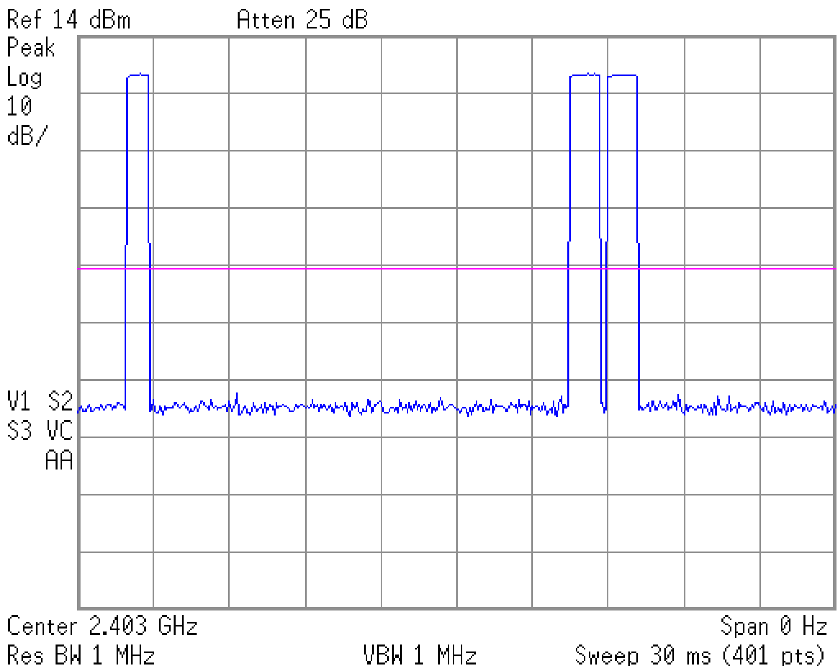

Figure 1 – Plot of Pulse Frame in Voice Mode from Figure 3.3 of Test Report NR EMV-E 17/11

The time domain plot of the data mode is shown in Figure 2. There are several 100ms frames shown in this plot to depict the behavior in data mode. As can be seen in this plot, the frames alternate between having three-pulse frames and having eight-pulse frames. The frames with three pulses are similar to the voice mode frames. A close-up plot of frames that contain eight pulses is shown in Figure 3. The eight pulse frame consists of one pulse that is 0.8 ms wide and seven pulses that are 1.1 ms wide.

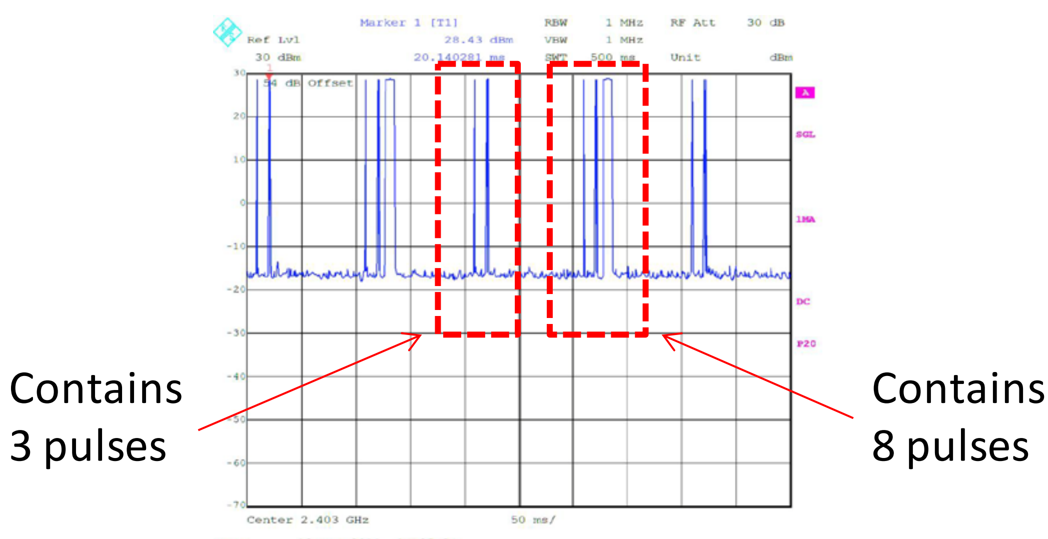

Figure 2 – Plot of Several Pulse Frames in Data Mode

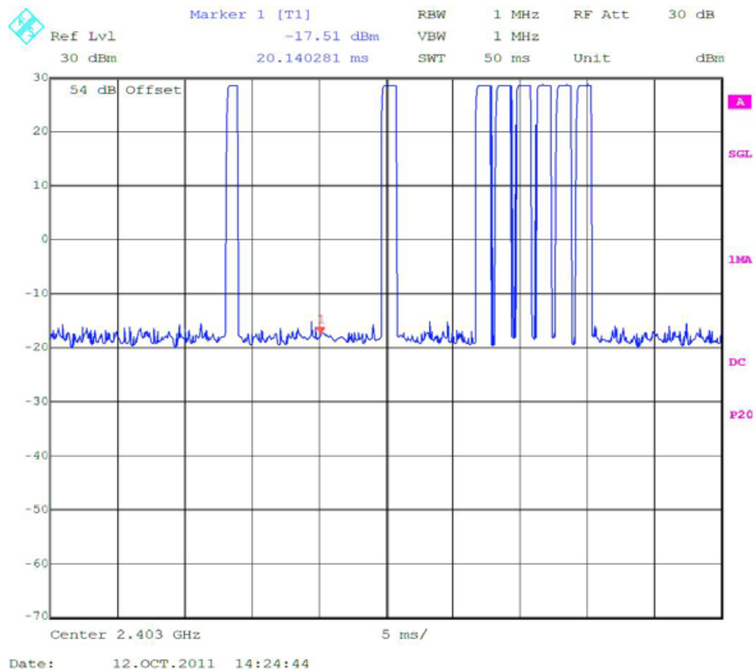

Figure 3 – Close-Up Plot of Frame with Eight Pulses

The duty cycle in data mode can be calculated as follows.

{(0.8 + 1.1 + 1.1) + (0.8 + 1.1 +1.1 +1.1 +1.1+1.1 +1.1 +1.1)}/200 = 0.0575 or 5.75%.

We can calculate the worst case SAR in data mode by scaling the voice mode SAR according to the ratio of the duty cycles for data mode and voice mode. This is calculated as follows.

Data Mode SAR = 0.238 W/kg * 5.75%/3% = 0.456 W/kg as averaged across one gram of tissue.

This worst case level of 0.456 W/kg is compliant with the FCC limit of 1.6 W/kg from 47CFR2.1093.

Based on this analysis with supporting test data shown in the attached Test Report NR EMV-E 17/11, we can conclude that the PathMaker is compliant with the SAR requirements for portable devices.

SEIBERSDORF LABORATORIES

TEST REPORT No. EMV-E 17/11

On:	**Measurements of the Specific Absorption Rate (SAR) according to IEC 62209-1:2005 and IEC 62209-2:2010**
Client:	**Max Tech Networks Ltd.**
Address:	26, Haprat St. Yavne 81101 ISRAEL
Device under Test:	**SAVION-E Mesh Communicator Unit**

This Test Report consists of pages 1 to 26

Technically responsible:

Dipl.-Ing. Gernot Schmid

Test Engineer:

Dipl. Ing. Richard Überbacher

Date of issue: 22.06.2011
Internal order No.: EMC/E-1465

Remark:
The test results exclusively refer to the testes devices.
Any (re-)production or transmission of extracts of this test report is subject to authorisation by the testing laboratory
Ohne schriftliche Genehmigung der Prüfstelle darf der Bericht nicht auszugsweise vervielfältigt werden.

1. Summary

Tables 1.1 to 1.3 summarize the maximum values of the 10g-averaged and 1g-averaged spatial peak specific absorption rate (maxSAR10g) assessed at the SAM phantom according to IEC 62209-1 for DUT use at the ear and at the elliptic flat body phantom according to IEC 62209-2 for body worn or front of face usage of the DUT.

The test results summarized below refer to the condition with the DUT's push-to-talk button pressed, corresponding to a time averaged DUT output power of approximately 15 mW (measured at the antenna connector into 50 Ω).

Usage at the ear (SAM phantom)	
maxSAR10g	maxSAR1g
0.169 W/kg	0.206 W/kg

Table 1.1: Maximum spatial peak average SAR values for DUT usage at the ear (IEC 62209-1)

Front-of-Face (25 mm distance between device and flat phantom)	
maxSAR10g	maxSAR1g
0.075 W/kg	0.093 W/kg

Table 1.2: Maximum spatial peak average SAR values in Front-of-Face condition (IEC 62209-2)

On Body Use / Hand Use (DUT case touching the flat phantom shell)	
maxSAR10g	maxSAR1g
0.170 W/kg	0.238 W/kg

Table 1.3: Spatial peak average SAR values in Hand Exposure and Back-Use condition (IEC 62209-2)

In all considered conditions according to IEC 62209-1 and IEC 62209-2 **the DUT did not exceed the applicable basic restrictions** for localized exposure of the general public (i.e., 2 W/kg for head and trunk, in terms of maxSAR10g) according to the ICNIRP Guidelines 1998 [1] as well as uncontrolled environments according to IEEE Std. C95.1-2005 [2].

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2. Content

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3. Description of the Device under Test (DUT)

The DUT is a battery powered radio set operating in the frequency band 2.403 – 2.483 GHz (40 Channels, Channel spacing 2 MHz). After switching on, without the push-to-talk (PPT) button pressed, the DUT emitted periodically bursts at the channel center frequency (burst duration approx. 0.812 ms, burst repetition period approx. 100 ms, i.e., peak to average power ratio approx. 125). Burst peak power at the antenna connector measured into 50 Ω was approx. 27.5 dBm. With the PPT button pressed, two additional bursts per 100 ms frame were periodically transmitted, reducing the peak to average power ratio to approx. 37. The time averaged output power of the DUT with the PPT button pressed, measured at the antenna connector into 50 Ω was approx. 15 mW.

Figure 3.1 shows the investigated DUT and Figures 3.2 and 3.3 the emitted signal in time domain in standby mode and with the PPT button pressed.

Figure 3.1: Front view (left) and back view (with battery pack demounted, right) of the DUT

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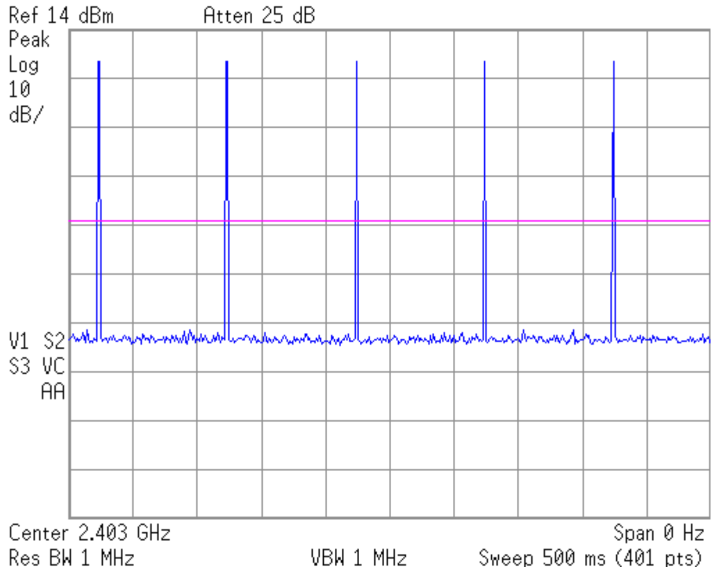

Figure 3.2: Signal in time domain emitted by the DUT switched on, without the PPT pressed (burst length approx. 812 µs, burst repetition period approx. 100 ms, amplitudes uncalibrated)

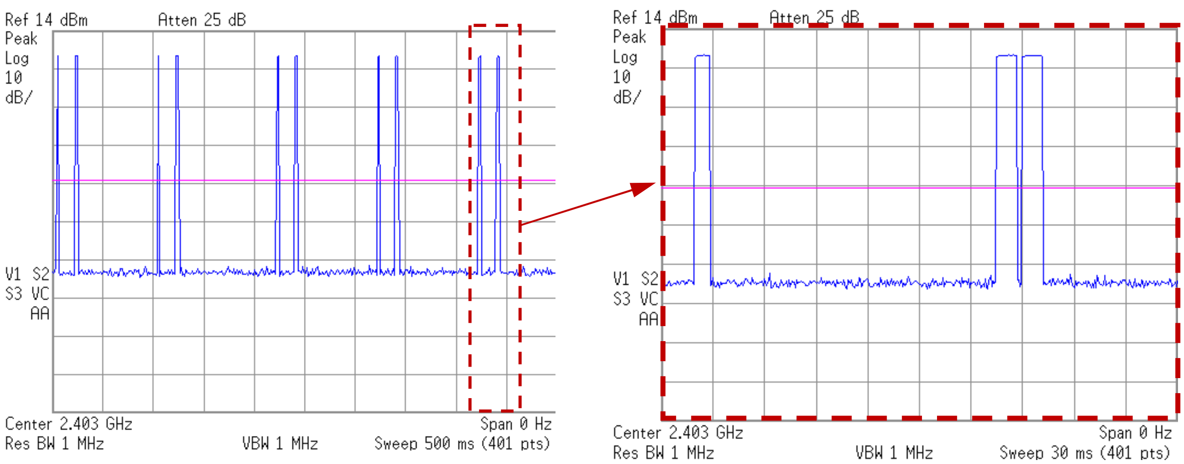

Figure 3.3: Signal in time domain emitted by the DUT with the PPT pressed (amplitudes uncalibrated)

Details of the DUT used for the tests:

Savion-E Mesh Communicator Unit: ES 0113

Antenna: 105 mm long (see figure 3.1, screwable, as originally delivered with the DUT)

All measurements were carried out without the belt clip enabling minimum distance between the DUT and the phantom when the DUT was positioned with its back side towards the phantom.

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4. Exposure Limits and Compliance Requirements

Regarding localized radio frequency exposure the ICNIRP Guidelines 1998 [1] and the IEEE Std. C95.1-2005 [2] define the following basic restrictions in terms of the spatial peak SAR, averaged over 10g of contiguous tissue and averaged over any 6 minute interval (maxSAR10g):

ICNIRP Guidelines 1998 [1]		
	General Public	**Occupational Exposure**
Head and Trunk	2 W/kg	10 W/kg
Limbs	4 W/kg	20 W/kg

Table 4.1: Basic restriction for localized exposure according to ICNIRP [1]

IEEE Std. C95.1-2005 [2]		
	Action Level	**Controlled Environments**
Head and Trunk	2 W/kg	10 W/kg
Extremeties[1] and Pinnae	4 W/kg	20 W/kg
[1] Extremities are arms and legs distal from the elbows and the knees, respectively		

Table 4.2: Basic restriction for localized exposure according to IEEE Std. C95.1-2005 [2]

For routine compliance testing of hand held and body worn radio frequency emitting equipment the applicable SAR measurement procedures are defined in IEC 62209-1 [3] and IEC 62209-2 [4]. This procedure is designed to give a conservative estimate of the maxSAR10g in a persons head or body when operating the equipment under the considered conditions.

5. SAR Measurement System

All measurements were carried out in the SAR measurement room at the Seibersdorf Laboratories, using the system components described in sections 5.1 to 5.4. Figure 5.1 shows a total view of the measurement system.

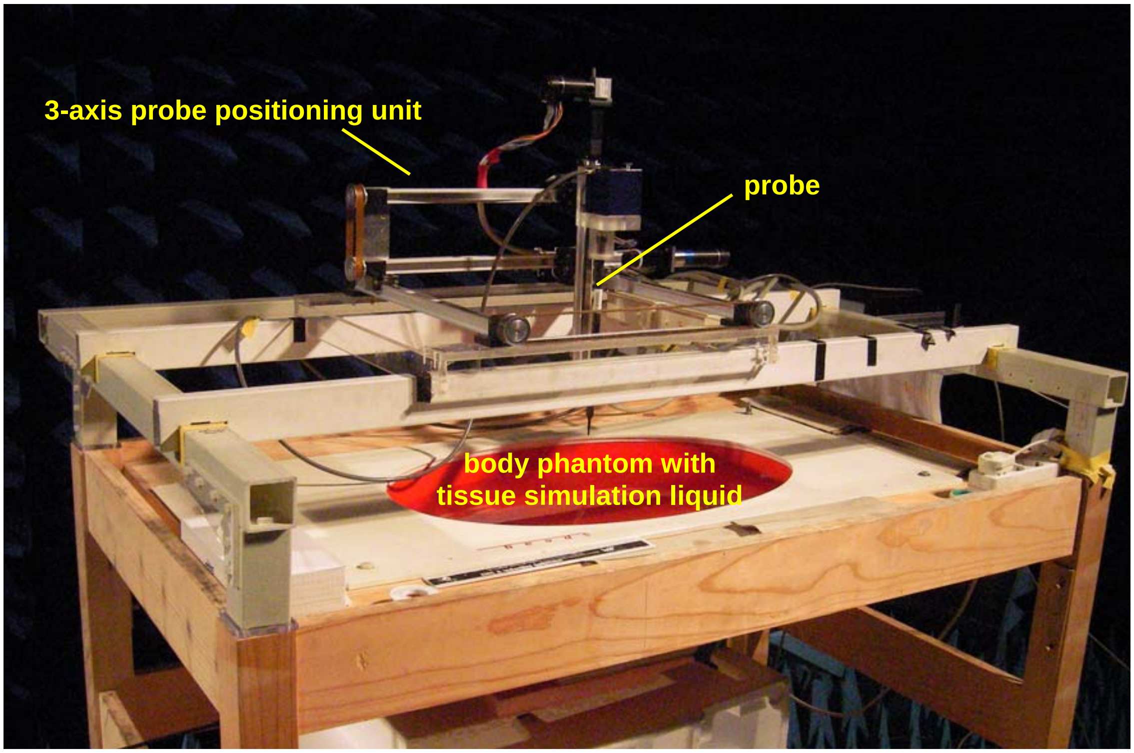

Figure 5.1: Total view of the used SAR test facility
(with the flat elliptical phantom according to IEC 62209-2)

5.1. Probe Positioning Unit

For probe positioning an inhouse 3-axis linear positioning unit was used (see Figure 5.1). Positioning accuracy is better than ± 0.1 mm.

5.2. SAR Probes, Data Acquisition and body Phantom shell

Probe:	EX3DV4 (SN 3562)
Data Acquisition Electronics:	DAE 3 mini (SN 347)
Data Interface:	EASY4 (SN 1112)
SAM Phantom:	SAM (PT-1098)
Phantom (flat elliptic 400 x 600 mm, 2mm bottom):	ELI 4 (SN 1008)

All components manufactured by Schmid & Partner Engineering AG, Zurich, Switzerland

5.3. Control and Recording Software

SARAMS 2.0, developed by Seibersdorf Laboratories under LabView™ 8.2

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5.4. Tissue Simulating Liquids

The tissue simulating liquid (TSL) was mixed using the following ingredients:

De-ionized water
Tween 20
DGBE
NaCl

After mixing the TSL its dielectric properties were measured using the commercially available dielectric probe kit HP 85070B in combination with a vector network analyzer. Calibration accuracy was checked using Methanol as reference medium. Calibration accuracy was better than ± 3% for permittivity and better than ± 4% for conductivity in the frequency range 2400 MHz – 2500 MHz.

The dielectric parameters of the TSL measured (at 20°C) before starting and after the SAR measurements were within ± 5% of the target values given in [3].

During all the SAR measurements the TSL temperature was kept between 19°C and 21°C.

The amount of TSL used during all the measurements corresponds to a filling height of the phantom of 165 mm.

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6. Test Procedure and Uncertainty

6.1. Test Procedure

Details and rational of the applied test procedure are described in IEC 62209-1 and IEC 62209-2, respectively. In the following a brief summary of the specifically applied procedures is given.

6.1.1. Measurements

After positioning and switching on the DUT, and defining der "field of view" for the measurements (outer boundaries of the considered measurement grid), the following steps are carried out automatically by the SAR measurement system:

1. An initial SAR value is measured at a reference position in the middle of the field of view.
2. A two-dimensional coarse scan on a measurement grid (step width 15 mm x 15 mm) at constant distance to the phantom bottom (3.5 ± 0.5 mm) is done. The SAR measurement value at each measurement position of the grid is recorded.
3. After the two-dimensional coarse scan is finished all maxima in the SAR distribution along the two-dimensional coarse grid are determined from the measured data and all relevant maxima, i.e., the global maximum and all local maxima which are within 2 dB of the global maximum are selected.
4. For each relevant maxima determined in 3., the following procedure is applied:

   Determine the three-dimensional SAR distribution on a fine measurement grid of size 30 mm x 30 mm x 25 mm with a constant step width of 5 mm in x-/y-/z-direction. The fine grid is (in x-/y-direction) centered at the location of the considered maximum. The lowest measurement plane of the fine grid is (as in case of the coarse scan) 3.5 ± 0.5 mm above the phantom bottom. All the obtained SAR values during the fine scan are recorded.
5. After the procedure described in 4. was applied to all relevant SAR-maxima, a final measurement at the reference position (see 1.) is taken in order to obtain any relevant drift of transmit power. In case of a transmit power drift of more than 5% drop (compared to the initial measurement) the obtained power drift value is used for correction (upscaling) of the measured SAR values during the post-processing.

In addition, stability of the DUT's output power was monitored continuously during the measurements.

6.1.2. Postprocessing

Using the recorded data from the fine scans around the positions of all relevant maxima, the following post-processing procedures are applied for all relevant maxima:

1. A 2D spline interpolation in each of the 6 x-/y-planes of the fine scan data is applied to come from a x-/y-resolution of 5 mm by 5 mm (as measured) to a resolution of 0.5 mm by 0.5 mm.
2. For each x-/y-coordinate pair of the new data set (already interpolated in x-/y-direction), a 1D spline inter- and extrapolation of the SAR data along z-direction is applied. The resolution in z-direction after inter-/extrapolation is 0.5 mm and the extrapolation extends to the phantom bottom. In other words, when assuming z=0 at the phantom bottom: For

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each x-/y- coordinate pair we have SAR values at z=3.5, 8.5, 13.5, 18.5, 23.5, and 28.5 mm prior to the 1D inter- and extrapolation; and after the 1D inter- and extrapolation we have SAR values from the phantom bottom up to 28.5 mm inside the phantom at a resolution of 0.5 mm for all x-/y-coordinate pairs, i.e., at a 3D grid with 0.5 mm grid step and an extension of 30 mm x 30 mm x 28.5 mm around the considered maximum.

3. Search for the maximum 1g averaged and 10g averaged SAR inside the highly resolved SAR distribution obtained from steps 1. and 2. In case of SAR1g this is done simply by calculating the average SAR over all possible cubes of size 10 mm x 10 mm x 10 mm inside the inter-/extrapolated grid and record the maximum value. In case of SAR10g the same is done for all cubes of size 21.5 mm x 21.5 mm x 21.5 mm inside the inter-/extrapolated grid.
4. Search the maximum SAR1g and SAR10g values out of all relevant maxima investigated, which is finally recorded as the maxSAR1g and maxSAR10g value, respectively.

6.2. Uncertainty

The overall expanded (CI 95%) measurement uncertainty was assessed according to the procedures described in [3] and yielded less than ± 27.3% with respect to the maximum 10g-averaged SAR and ± 27.5% with respect to the maximum 1g-averaged SAR in the frequency range 2400 MHz to 2500 MHz.

In general the uncertainty is dependent on several factors which vary over the different test conditions (e.g., the uncertainty due to DUT positioning is dependent on the distance between DUT and phantom). The above given uncertainty numbers reflect the worst case condition.

Details of the uncertainty budget are listed in the Annex.

6.3. System Validation Results

System validation was performed at 2450 MHz using standard dipole sources and showed agreement with target values according to IEC 62209-1 and IEC 62209-2 within ± 5% (see table 6.1).

System validation measurements @ 2450 MHz		
	maxSAR10g @ 1W	**maxSAR1g @ 1W**
measured	24.7 W/kg	51.0 W/kg
target according to IEC 62209-1/2	24.0 W/kg	52.4 W/kg

Table 6.1: Results of System validation measurements for 1 W antenna input power

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7. Investigated Test Configurations

All tests were carried out following the procedures described in IEC 62209-1 [3] and IEC 62209-2 [4], respectively.

All measurements were carried out with the PPT button pressed. This corresponds to a time averaged DUT output power of approximately 15 mW (measured at the antenna connector into 50 Ω).

7.1. Usage of DUT at the ear

The procedures described in IEC 62209-1 [3] were applied, i.e., measurements at a transmit channel (Ch 20) next to the center of the transmit band on the left and right side of the SAM head phantom, considering cheek and tilt position of the DUT, were carried out, respectively. For the configuration yielding to the maximum maxSAR10g value, additional measurements at the lower and upper edge of the transmit band were performed.

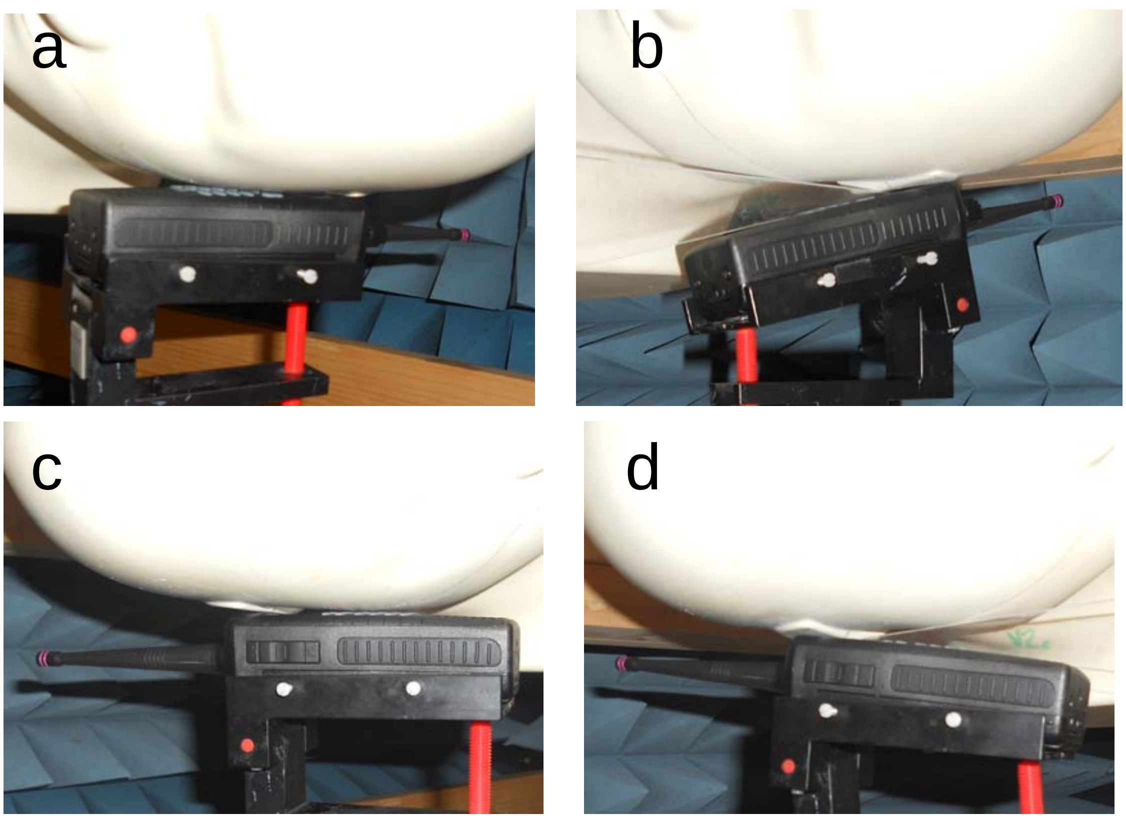

Figure 7.1: DUT positioning at the SAM head phantom.
a: "cheek position" at left head side, b: "tilt position" at left head side,
c: "cheek position" at right head side, d: "tilt position" at right head side

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7.2. Front of Face Condition

The *Front of Face* condition reflects the situation when the DUT is hand held and operated in front of the face. For such situations IEC 62209-2 recommends that the DUT is positioned with the speaker and the microphone towards the phantom (DUT case aligned in parallel to the phantom bottom) at a separation distance of 25 mm. Figure 7.2 shows the position of the DUT during all tests in *Front of Face* condition (25 mm distance ensured by a lossless spacer). Measurements were carried out at the lower bound (Ch 1), the center (Ch 20) and the upper bound (Ch 40) of the transmit frequency band.

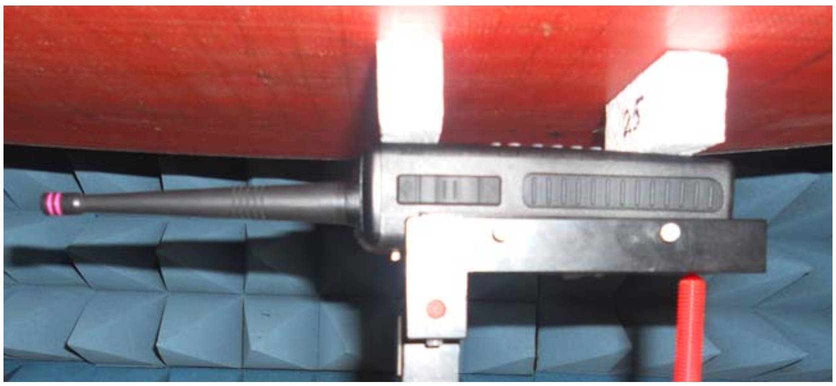

Figure 7.2: DUT position during the tests in Front of Face condition

7.3. On Body and Hand Exposure condition

A further practical use condition of the DUT is that it is carried directly on the body or in the pocket of a vest. Due to the fact that the vest may consist of just a thin textile tissue the distance between the DUT and the body can become very close. Therefore, in this test configuration the DUT was brought in touch with the phantom, considering both the situation where the DUT is oriented with the front side towards the phantom as well as the situation where the DUT is oriented with the its back side towards the phantom. Moreover, these test conditions are currently recommended by IEC 62209-2 in order to assess the exposure of the users hand when holding the transmitting DUT. Measurements were carried out at the lower bound (Ch 1), the center (Ch 20) and the upper bound (Ch 40) of the transmit frequency band.

Figure 7.3: DUT positions during On Body and Hand Use conditions. Left: DUT's back towards the phantom, right: DUT's front towards the phantom

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8. Test Results

All results were obtained during measurements in the time period June 9th to June 17th, 2011.

The test results listed below refer to the condition with the DUT's push-to-talk button pressed, corresponding to a time averaged DUT output power of approximately 15 mW (measured at the antenna connector into 50 Ω).

Usage at the ear (SAM phantom)		
left head side, cheek		
Frequency	**maxSAR10g**	**maxSAR1g**
Channel 20 (f = 2.443 GHz)	0.037 W/kg	0.044 W/kg
left head side, tilt		
Channel 20 (f = 2.443 GHz)	0.041 W/kg	0.068 W/kg
right head side, cheek		
Frequency	**maxSAR10g**	**maxSAR1g**
Channel 20 (f = 2.443 GHz)	0.112 W/kg	0.133 W/kg
right head side, tilt		
Frequency	**maxSAR10g**	**maxSAR1g**
Channel 1 (f = 2.403 GHz)	0.155 W/kg	0.192 W/kg
Channel 20 (f = 2.443 GHz)	0.169 W/kg	0.206 W/kg
Channel 40 (f = 2.483 GHz)	0.163 W/kg	0.188 W/kg

Table 8.1: Spatial peak average SAR values for DUT usage at the ear (IEC 62209-1)

Front-of-Face (25 mm distance between device and flat phantom)		
Frequency	**maxSAR10g**	**maxSAR1g**
Channel 1 (f = 2.403 GHz)	0.062 W/kg	0.068 W/kg
Channel 20 (f = 2.443 GHz)	0.072 W/kg	0.093 W/kg
Channel 40 (f = 2.483 GHz)	0.075 W/kg	0.082 W/kg

Table 8.2: Spatial peak average SAR values in Front-of-Face condition (IEC 62209-2)

On Body / Hand Use (DUT case touching the flat phantom shell)		
DUT's front side directed towards the phantom		
Frequency	**maxSAR10g**	**maxSAR1g**
Channel 1 (f = 2.403 GHz)	0.137 W/kg	0.197 W/kg
Channel 20 (f = 2.443 GHz)	0.137 W/kg	0.196 W/kg
Channel 40 (f = 2.483 GHz)	0.119 W/kg	0.179 W/kg
DUT's back side directed towards the phantom		
Frequency	**maxSAR10g**	**maxSAR1g**
Channel 1 (f = 2.403 GHz)	0.170 W/kg	0.238 W/kg
Channel 20 (f = 2.443 GHz)	0.149 W/kg	0.202 W/kg
Channel 40 (f = 2.483 GHz)	0.131 W/kg	0.177 W/kg

Table 8.3: Spatial peak average SAR values in On Body and Hand Use condition (IEC 62209-2)

In all considered conditions according to IEC 62209-1 and IEC 62209-2 **the DUT did not exceed the applicable basic restrictions** for localized exposure of the general public according to the ICNIRP Guidelines 1998 [1] as well as uncontrolled environments according to IEEE Std. C95.1-2005 [2].

9. References

[1] International Commission for Non-Ionizing Radiation Protection (ICNIRP) 1998. Guidelines for limiting exposure to time varying electric, magnetic, and electromagnetic fields (up to 300 GHz). Health Physics, Vol. 74:494-522

[2] IEEE Std. C95.1-2005. IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

[3] IEC 62209-1:2005. Human exposure to radio frequency fields from hand-held and body mounted wireless communication devices – Human models, instrumentation, and procedures – Part 1: Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)

[4] IEC 62209-2:2010. Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices - Human models, Instrumentation, and Procedures - Part 2: Procedure to determine the specific absorption rate (SAR) for mobile wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)

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10. Annexes

10.1. Uncertainty Budget

2400 - 2500 MHz								
Source of uncertainty	**Tolerance/ uncertainty value, ± %**	**Probability Distribution**	**Div.**	**c_i (1 g)**	**C_i (10 g)**	**u_i ± %, (1 g)**	**u_i ± %, (10 g)**	**v_i, v_{eff}**
Measurement System								
Probe Calibration	9.0	N	1	1	1	9.0	9.0	∞
Isotropy	5.5	R	√3	1	1	3.2	3.2	∞
Linearity	1.0	R	√3	1	1	0.6	0.6	∞
Probe modulation response	0	R	√3	1	1	0	0	∞
Detection Limits	0	R	√3	1	1	0	0	∞
Boundary Effect	0.5	R	√3	1	1	0.3	0.3	∞
Readout Electronics	3.0	N	1	1	1	3.0	3.0	∞
Response Time	0	R	√3	1	1	0	0	∞
Integration Time	0	R	√3	1	1	0	0	∞
RF ambient conditions – noise	0	R	√3	1	1	0	0	∞
RF ambient conditions – reflections	0	R	√3	1	1	0	0	∞
Probe Positioner Mech. Restrictions	1.5	R	√3	1	1	0.9	0.9	∞
Probe Positioning with respect to Phantom Shell	3.0	R	√3	1	1	1.7	1.7	∞
Post-Processing	2.0	R	√3	1	1	1.2	1.2	∞
Test Sample Related								
Test Sample Positioning	8.0	N	1	1	1	8.0	8.0	*M*-1
Phantom and Set-up								
Phantom Uncertainty (shape and thickness tolerances)	4.0	R	√3	1	1	2.3	2.3	∞
Algorithm for correcting SAR for deviations in permittivity and conductivity	1,9	N	1	1	0,84	1.9	1,6	∞
Liquid Conductivity (meas.)	4.0	N	1	0,78	0,71	3.1	2.8	*M*-1
Liquid Permittivity (meas.)	3.0	N	1	0,23	0,26	0.7	0.8	*M*
Liquid Permittivity – temperature uncertainty	1.0	R	√3	0.78	0.71	0.5	0.4	∞
Liquid Conductivity – temperature uncertainty	1.0	R	√3	0.23	0.26	0.1	0.2	∞
Combined standard uncertainty	-	*RSS*	-	-	-	*13.75*	*13.65*	-
Expanded uncertainty (95 % conf. interval)	**-**	**-**	**-**	**-**	**-**	**27.5**	**27.3**	

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10.2. Probe Calibration Data

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

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
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Accreditation No.: **SCS 108**

Client **AIT GmbH**

Certificate No: **EX3-3562_Apr10**

CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:3562

Calibration procedure(s): QA CAL-01.v6, QA CA-12.v6, QA CAL-14.v3, QA CAL-23.v3 and QA CAL-25.v2
Calibration procedure for dosimetric E-field probes

Calibration date: April 23, 2010

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	1-Apr-10 (No. 217-01136)	Apr-11
Power sensor E4412A	MY41495277	1-Apr-10 (No. 217-01136)	Apr-11
Power sensor E4412A	MY41498087	1-Apr-10 (No. 217-01136)	Apr-11
Reference 3 dB Attenuator	SN: S5054 (3c)	30-Mar-10 (No. 217-01159)	Mar-11
Reference 20 dB Attenuator	SN: S5086 (20b)	30-Mar-10 (No. 217-01161)	Mar-11
Reference 30 dB Attenuator	SN: S5129 (30b)	30-Mar-10 (No. 217-01160)	Mar-11
Reference Probe ES3DV2	SN: 3013	30-Dec-09 (No. ES3-3013_Dec09)	Dec-10
DAE4	SN: 660	29-Sep-09 (No. DAE4-660_Sep09)	Sep-10

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Oct-09)	In house check: Oct-11
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-09)	In house check: Oct10

	Name	Function	Signature
Calibrated by:	Katja Pokovic	Technical Manager	
Approved by:	Fin Bomholt	R&D Director	F. Bomholt

Issued: April 24, 2010

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

Certificate No: EX3-3562_Apr10 Page 1 of 10

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Calibration Laboratory of
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Zeughausstrasse 43, 8004 Zurich, Switzerland

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Accreditation No.: **SCS 108**

Glossary:

TSL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMx,y,z
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., ϑ = 0 is normal to probe axis

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not effect the E^2-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *Ax,y,z; Bx,y,z; Cx,y,z, VRx,y,z: A, B, C* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy)*: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.

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Probe EX3DV4

SN:3562

Manufactured: February 14, 2005
Last calibrated: August 28, 2007
Recalibrated: April 23, 2010

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

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DASY - Parameters of Probe: EX3DV4 SN:3562

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.44	0.44	0.46	± 10.1%
DCP (mV)[B]	87.2	87.7	86.0	

Modulation Calibration Parameters

UID	Communication System Name	PAR		A dB	B dBuV	C	VR mV	Unc[E] (k=2)
10000	CW	0.00	X	0.00	0.00	1.00	300	± 1.5%
			Y	0.00	0.00	1.00	300	
			Z	0.00	0.00	1.00	300	

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] The uncertainties of NormX,Y,Z do not affect the E^2-field uncertainty inside TSL (see Pages 5 and 6).

[B] Numerical linearization parameter: uncertainty not required.

[E] Uncertainty is determined using the maximum deviation from linear response applying recatangular distribution and is expressed for the square of the field value.

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EX3DV4 SN:3562 April 23, 2010

DASY - Parameters of Probe: EX3DV4 SN:3562

Calibration Parameter Determined in Head Tissue Simulating Media

f [MHz]	Validity [MHz][C]	Permittivity	Conductivity	ConvF X	ConvF Y	ConvF Z	Alpha	Depth Unc (k=2)
300	± 50 / ± 100	45.3 ± 5%	0.87 ± 5%	9.38	9.38	9.38	0.28	1.28 ± 13.3%
450	± 50 / ± 100	43.5 ± 5%	0.87 ± 5%	8.08	8.08	8.08	0.12	1.00 ± 13.3%
900	± 50 / ± 100	41.5 ± 5%	0.97 ± 5%	7.87	7.87	7.87	0.65	0.67 ± 11.0%
1810	± 50 / ± 100	40.0 ± 5%	1.40 ± 5%	6.94	6.94	6.94	0.93	0.56 ± 11.0%
2450	± 50 / ± 100	39.2 ± 5%	1.80 ± 5%	6.28	6.28	6.28	0.40	0.76 ± 11.0%
3700	± 50 / ± 100	37.7 ± 5%	3.12 ± 5%	5.65	5.65	5.65	0.49	1.04 ± 13.1%
5200	± 50 / ± 100	36.0 ± 5%	4.66 ± 5%	4.36	4.36	4.36	0.45	1.90 ± 13.1%
5800	± 50 / ± 100	35.3 ± 5%	5.27 ± 5%	3.90	3.90	3.90	0.52	1.90 ± 13.1%

[C] The validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2). The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

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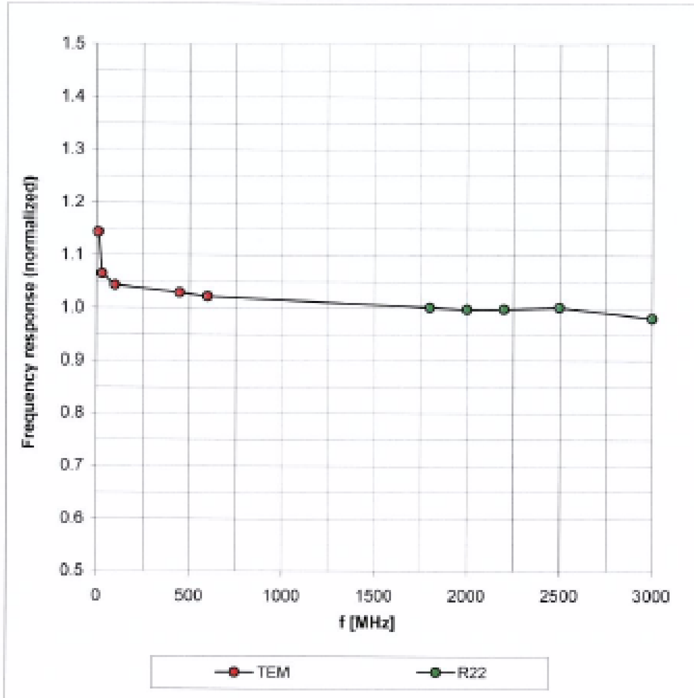
EX3DV4 SN:3562

April 23, 2010

Frequency Response of E-Field

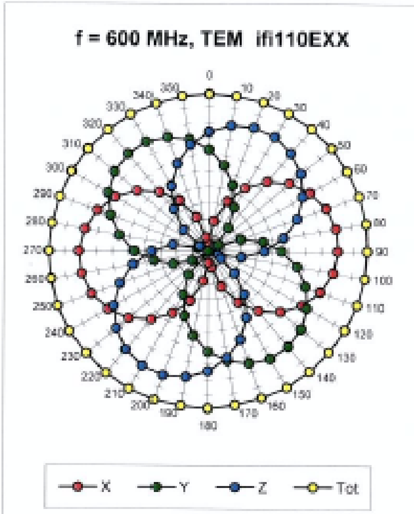
(TEM-Cell:ifi110 EXX, Waveguide: R22)

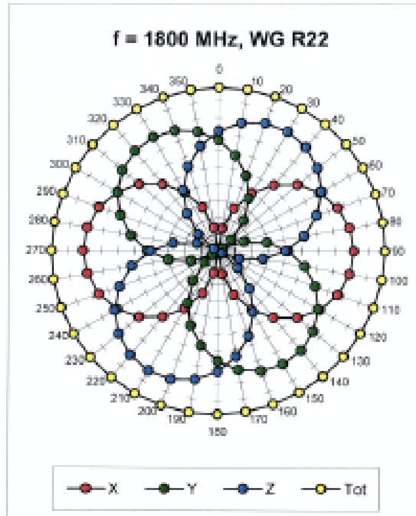


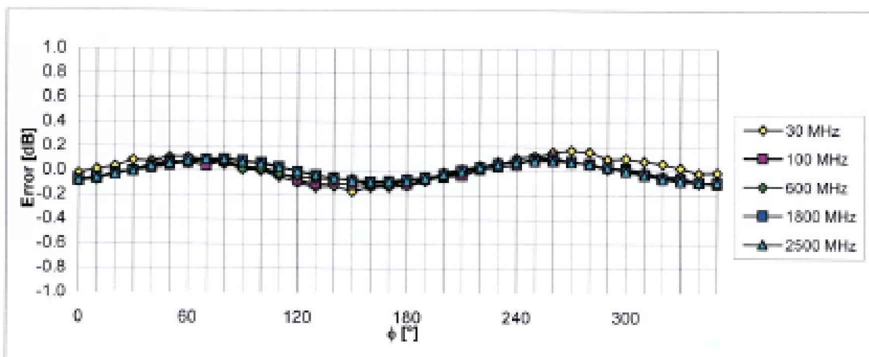
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

Certificate No: EX3-3562_Apr10

Receiving Pattern (φ), ϑ = 0°





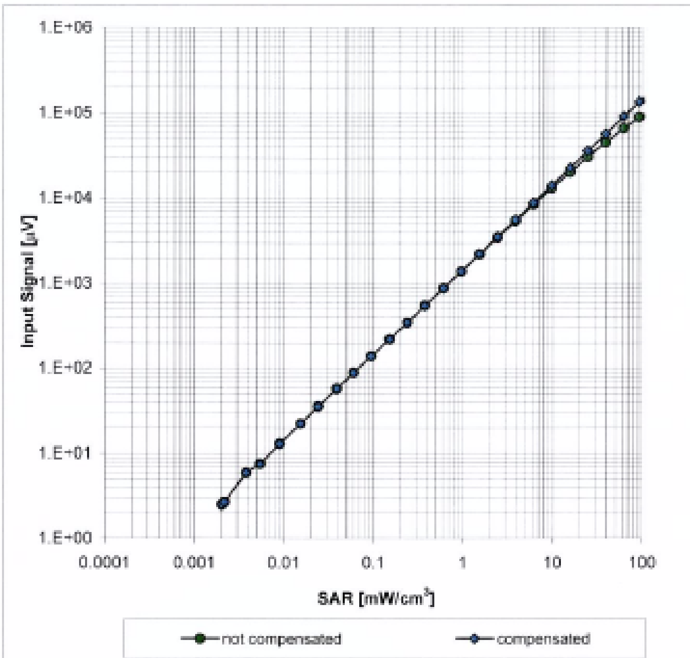


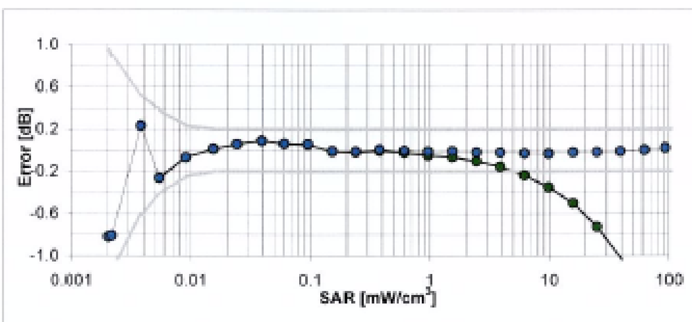
Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

EX3DV4 SN:3562 **April 23, 2010**

Dynamic Range f(SAR_{head})

(Waveguide R22, f = 1800 MHz)





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

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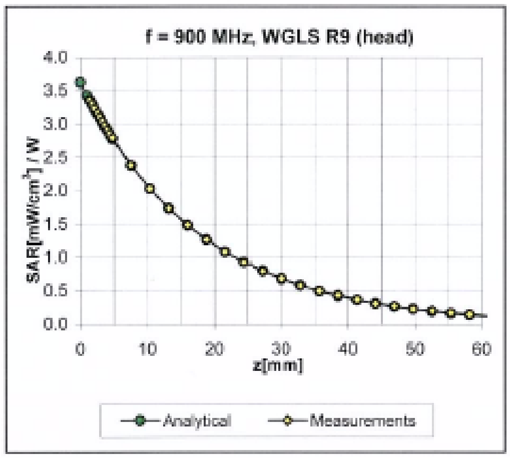
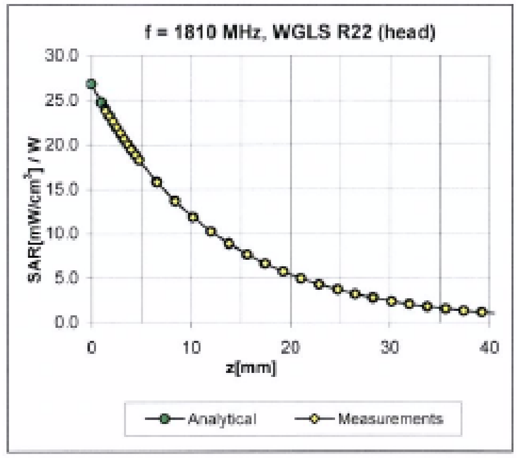
EX3DV4 SN:3562 April 23, 2010

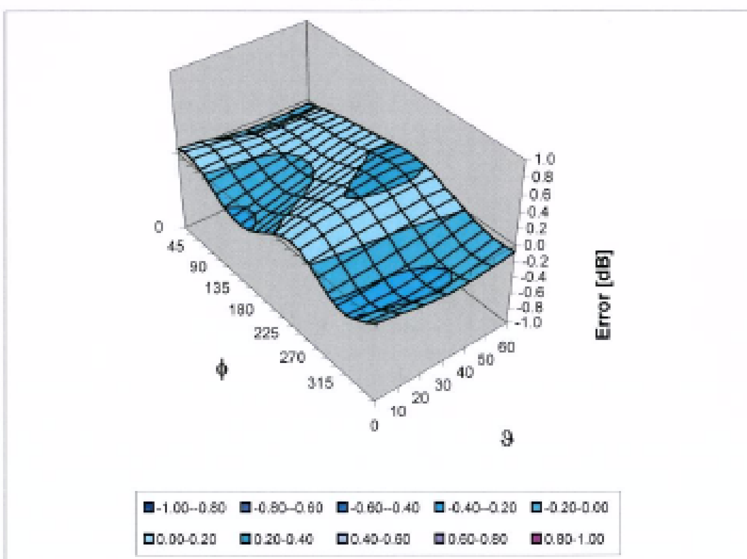
Conversion Factor Assessment





Deviation from Isotropy in HSL

Error (ϕ, ϑ), f = 900 MHz



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

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Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	Not applicable
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	2 mm

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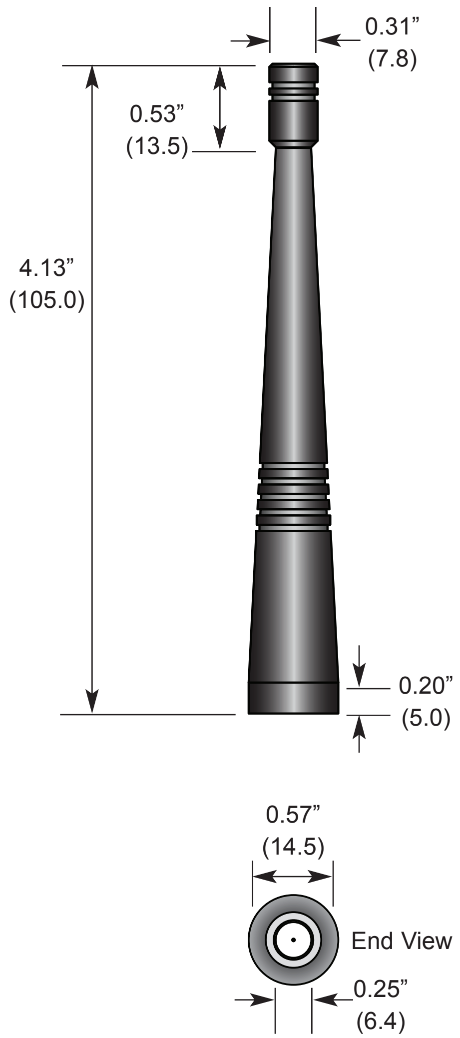
ANT-2.4-CW-QW DATA SHEET

Product Dimensions



Description

CW Series 1/2-wave antennas deliver outstanding performance in a rugged and cosmetically attractive package. The internal ground reference reduces dependance on an external ground plane. These antennas are available with standard SMA or FCC Part 15 compliant RP-SMA connectors. RP-SMA connectors allow for easy field replacement while complying with FCC requirements. A wide variety of matching connectors permit numerous mounting options.

Features

- Low cost
- Excellent performance
- Omni-directional pattern
- Wide bandwidth
- Very low VSWR
- Fully weatherized
- Flexible main shaft
- Rugged & damage-resistant
- SMA or Part 15 compliant RP-SMA connector
- Use with plastic or metal enclosures

Electrical Specifications

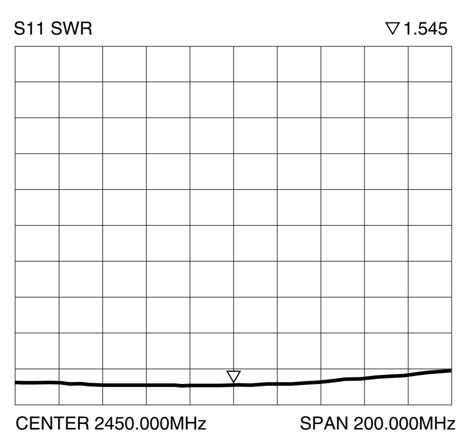
• Center Freq.	2.45GHz
• Recommended Freq. Range	2.35-2.60GHz
• Wavelength	1/2-wave
• VSWR	<1.9 typ. at center
• Impedance	50 ohms
• Connector	SMA or RP-SMA

Electrical specifications and plots measured on 4.00” x 4.00” reference ground plane

Ordering Information

- ANT-2.4-CW-QW-RPS (with RP-SMA connector)
- ANT-2.4-CW-QW-SMA (with SMA connector)

VSWR Graph



Typical VSWR

Antenna Factor 159 Ort Lane Merlin, OR 97532 **www.antennafactor.com**
541-956-0931 (phone) 541-471-6251 (fax)

A4(297x210)

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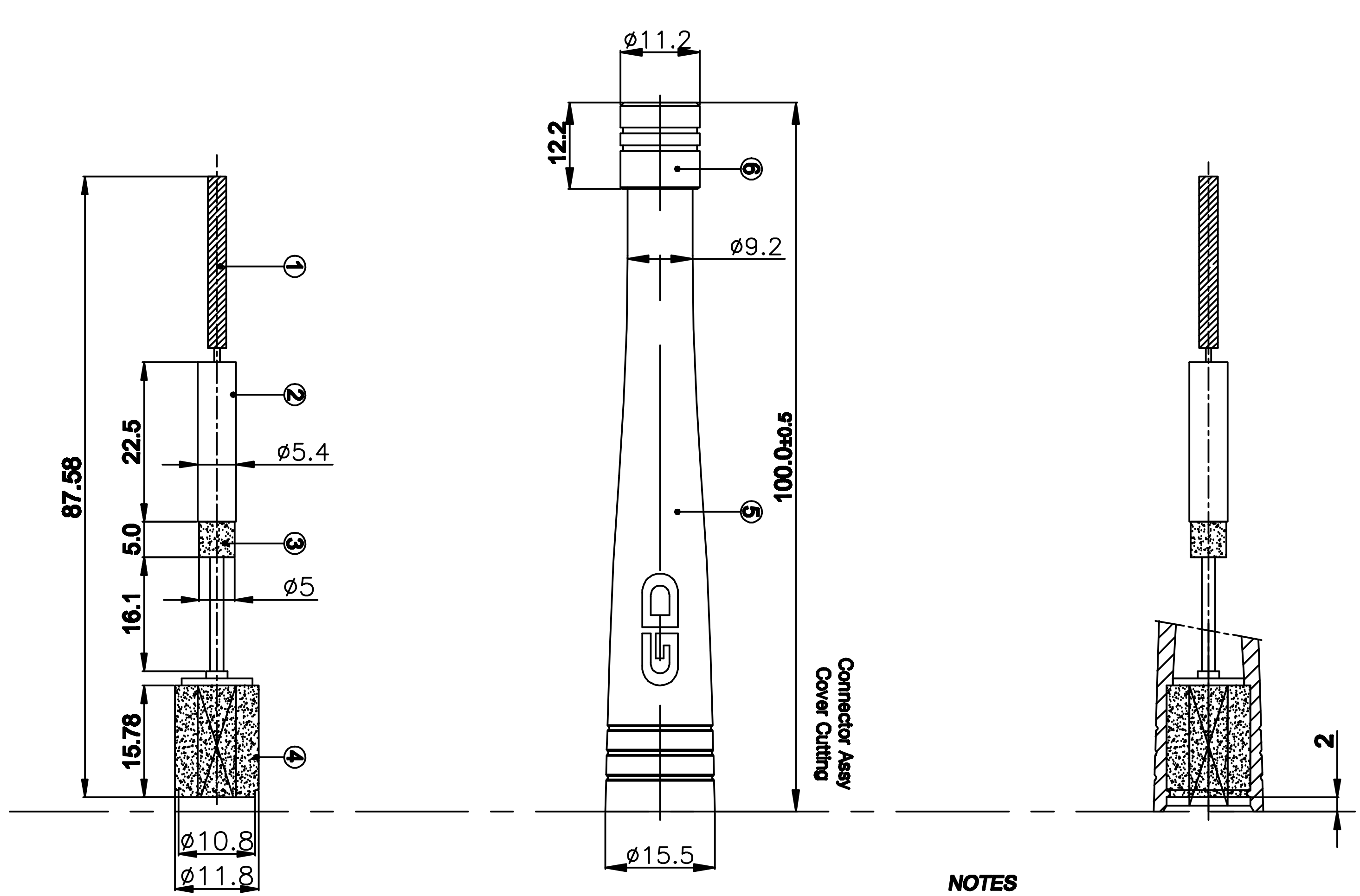
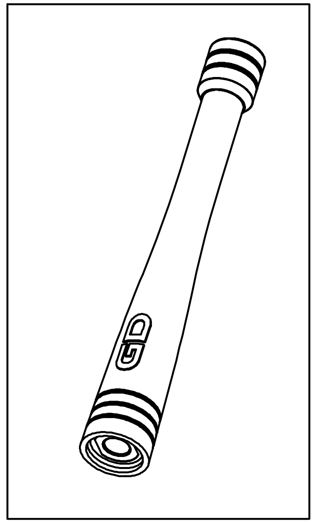
AMEND	DATE	CODE	CONTENTS	ECO NO.	APP NO.	SIGNATURE
		1	*Development of new Antenna (for GD) which is optimized 2dBi performance.*	*MEE110038*	*MEA110039*	*H.M.PARK*





NOTES
1. MATERIAL : Refer to Part List in Drawing
2. IF YOU HAVE ANY QUESTION ABOUT THIS DRAWING ASK TO DESIGNER.

NO.	PART NAME	MATERIAL SIZE	Q'TY
6	CAP	PVC ø11.2x12.2L	1
5	Cover	Keyflex ø15.5x98.0L	1
4	Connector Molding	ABS ø11.8x15.78L	1
3	Bobin	ABS ø7.5x6.5L	1
2	Dipole	BsBm ø5.4x22.5L	1
1	Wire	ø2.6x24.2L	1

Approval
2012.02.21
Entel Korea Mechanical Team
Revision Quotation Manufacture Reference

TOLERANCE (±)		1–4	4–16	16–63	63–250	250–1000	ANGLE	SCALE	REV.	Entel	
	A	0.05	0.07	0.1	0.15	0.2	±	1/1	00	DATE	2012.02.21
	B	0.10	0.20	0.3	0.5	0.8					
	C	0.25	0.35	0.5	0.7	1.5					
DRAW & DESIGN		CHECKED		APPROVAL			UNIT MM/INCH	MODEL NAME		PRN - 1000	
H.M.PARK							RoHS	PART NAME		ANTENNA,GD(2dBi)	
							■Yes □No	PART NUMBER		85-P42580K	DWG. NO