



**MOTOROLA SOLUTIONS**



**DECLARATION OF COMPLIANCE SAR ASSESSMENT Part 1 of 2**

**Motorola Solutions Inc.**  
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**Date of Report:** 03/13/2014  
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**Responsible Engineer:** Mac Elliott (Principle Staff Engineer)  
**Report Author:** Mac Elliott (Principle Staff Engineer)  
**Date/s Tested:** 12/21/13 – 12/22/13; 1/08/14  
**Manufacturer/Location:** Motorola Solutions Inc, Penang  
**Sector/Group/Div.:** AESS – Astro Engineering Subscriber Solutions  
**Date submitted for test:** 12/17/13  
**DUT Description:** Handheld Portable - 380-470MHz, 5.0W rated power, 6.25KHz/12.5KHz/25KHz, Capable of FM and TDMA transmission  
**Test TX mode(s):** CW (PTT)  
**Max. Power output:** 5.7W (380-470MHz)  
**Nominal Power:** 5.0W (380-470MHz)  
**Tx Frequency Bands:** 380MHz-470MHz  
**Signaling type:** FM, TDMA  
**Model(s) Tested:** H84QDH9PW7AN (MUE4386)  
**Model(s) Certified:** H84QDH9PW7AN (MUE4386)  
**Serial Number(s):** 837TPX0078 & 837TPX0064  
**Classification:** Occupational/Controlled  
**FCC ID:** AZ489FT4917; Rule Part 90 (406.1-470MHz)  
 This report contains results that are immaterial for FCC equipment approval, which are clearly identified. Only apply when applicable.  
**IC:** 109U-89FT4917 (406.1-430MHz & 450-470MHz)

The test results clearly demonstrate compliance with FCC Occupational/Controlled RF Exposure limits of 8 W/kg averaged over 1 gram per the requirements of 47 CFR 2.1093(d). The 10 grams result is not applicable to FCC filing. The test results clearly demonstrate compliance with ICNIRP (1998) Guidelines for limiting exposure in time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz), Health Physics 74, 494-522 RF Exposure limits of 10 W/kg averaged over 10grams of contiguous tissue.

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 3.0 of this report. This report shall not be reproduced without written approval from an officially designated representative of the Motorola Solutions Inc EME Laboratory. I attest to the accuracy of the data and assume full responsibility for the completeness of these measurements. This reporting format is consistent with the suggested guidelines of the TIA TSB-150 December 2004. The results and statements contained in this report pertain only to the device(s) evaluated.

**Deanna Zakharia**  
**EMS EME Lab Senior Resource Manager,**  
**Laboratory Director**  
**Approval Date:** 3/13/2014

**Certification Date:** 3/5/2014

**Certification No.:** L1140301P

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**Report Revision History**

Date	Revision	Comments
02/14/2014	O	Initial release
03/04/2014	A	Added IC Model# (in parentheses) to Model Tested and Model Certified on cover page. Removed “ID” from “IC ID” on front page.
03/13/2014	B	Updated reference to model # in Section 1 to include IC Model#

### 1.0 Introduction

This report details the utilization, test setup, test equipment, and test results of the Specific Absorption Rate (SAR) measurements performed at the Motorola Solutions Inc. EME Test Laboratory for handheld portable model number H84QDH9PW7AN (MUE4386). This device is classified as Occupational/Controlled.

### 2.0 FCC SAR Summary

**TABLE 1**

Equipment Class	Frequency band (MHz)	Max Calc at Body (W/kg)		Max Calc at Face (W/kg)	
		1g-SAR	10g-SAR	1g-SAR	10g-SAR
TNF	406.1-470MHz	3.29	2.36	2.80	2.12

### 3.0 Abbreviations / Definitions

- CNR: Calibration Not Required
- C4FM: Continuous Four Level FM
- CQPSK: Compatible Differential Quadrature Phase-Shift Keying
- CW: Continuous Wave
- DUT: Device Under Test
- DSP: Digital Signal Processing
- EME: Electromagnetic Energy
- FM: Frequency Modulation
- NA: Not Applicable
- PTT: Push to Talk
- SAR: Specific Absorption Rate
- TDMA: Time Division Multiple Access
- 4FSK: 4 Level Frequency Shift Keying

Audio accessories: These accessories allow communication while the DUT is worn on the body.

Body worn accessories: These accessories allow the DUT to be worn on the body of the user.

Maximum Power: Defined as the upper limit of the production line final test station.

#### 4.0 Referenced Standards and Guidelines

This product is designed to comply with the following applicable national and international standards and guidelines.

- IEC62209-1\*(2005) 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)
- United States Federal Communications Commission, Code of Federal Regulations; Rule Part 47CFR § 2.1093 sub-part J:1999
- IEEE 1528\*(2003), Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques
- American National Standards Institute (ANSI) / Institute of Electrical and Electronics Engineers (IEEE) C95. 1-1992
- Institute of Electrical and Electronics Engineers (IEEE) C95.1-2005
- International Commission on Non-Ionizing Radiation Protection (ICNIRP) 1998
- Ministry of Health (Canada) Safety Code 6 (2009), Limits of Human Exposure to Radio frequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz
- Australian Communications Authority Radio communications (Electromagnetic Radiation - Human Exposure) Standard (2003)
- ANATEL, Brazil Regulatory Authority, Resolution No. 303 of July 2, 2002 "Regulation of the limitation of exposure to electrical, magnetic, and electromagnetic fields in the radio frequency range between 9 kHz and 300 GHz." and "Attachment to resolution # 303 from July 2, 2002"
- IEC62209-2 Edition 1.0 2010-03, Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures – Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz).  
 (\* )The IEC62209-1 and IEEE 1528 are applicable for hand-held devices used in close proximity to the ear only.
- FCC KDB – 643646 D01 SAR Test for PTT Radios v01r01 (04/04/2011)
- FCC KDB – 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r02 (12/05/2013)  
 D02 RF Exposure Reporting v01r01 (05/28/2013)
- FCC KDB – 447498 D01 General RF Exposure Guidance v05r01 (05/28/2013)

## 5.0 SAR Limits

**TABLE 2**

EXPOSURE LIMITS	SAR (W/kg)	
	(General Population / Uncontrolled Exposure Environment)	(Occupational / Controlled Exposure Environment)
Spatial Average - ANSI - (averaged over the whole body)	0.08	0.4
Spatial Peak - ANSI - (averaged over any 1-g of tissue)	1.6	8.0
Spatial Peak – ICNIRP/ANSI - (hands/wrists/feet/ankles averaged over 10-g)	4.0	20.0
Spatial Peak - ICNIRP - (Head and Trunk 10-g)	2.0	10.0

## 6.0 Description of Device Under Test (DUT)

This portable device operates using frequency modulation (FM) and TDMA signals incorporating traditional simplex two-way radio transmission protocol.

Time Division Multiple Access (TDMA) is used to allocate portions of the RF signal by dividing time into two slots. Time allocation enables each unit to transmit its voice information without interference from other transmitting units. Transmission from a unit or base station is accommodated during two time-slot lengths of 30 milliseconds with frame length of 60 milliseconds. C4FM CQPSK modulation is used at 12.5 kHz channel spacing. The TDMA technique requires sophisticated algorithms and a digital signal processor (DSP) to perform voice compressions/decompressions and RF modulation/demodulation. The maximum duty cycle for TDMA 1:2 is 50%.

This device operates in a half duplex system. A half duplex system only allows the user to transmit or receive. This device cannot transmit and receive simultaneously. The user must stop transmitting in order to receive a signal or listen for a response, regardless of PTT button or use of voice activated audio accessories. This type of operation, along with the RF safety booklet, which instructs the user to transmit no more than 50% of the time, justifies the use of 50% duty factor for this device.

The model represented under this filing utilizes optional antennas capable of transmitting in the 380-470MHz bands respectively. The nominal output power is 5.0 W with a maximum output powers of 5.7 W as defined by upper limit of the production line final test station.

The intended operating positions are “at the face” with the DUT at least 1 inch from the mouth, and “at the body” by means of the offered body worn accessories. Body worn audio and PTT operation is accomplished by means of optional remote accessories that are connected to the radio.

## 7.0 Optional Accessories and Test Criteria

This device is offered with optional accessories. Accessories were individually evaluated during the test plan creation to determine if testing was required per the guidelines outlined in “SAR Test Reduction Considerations for Occupational PTT Radios” FCC KDB 643646 to assess compliance of this device. The following sections identify the test criteria and details for each accessory category. Refer to Exhibit 7B for antenna separation distances.

### 7.1 Antennas

There are two removable antennas offered for this product. The table below lists their descriptions.

**TABLE 3**

Antenna Models	Description	Selected for test	Tested
PMAE4065A	Whip Antenna w/ GPS, 380-520MHz, 1/4 wave, -10 dBd	Yes	Yes
FAF5259A	Stubby Antenna w/ GPS, 380-470MHz, 1/4 wave, -2 dBd	Yes	Yes

### 7.2 Battery

There are three batteries offered for this product. The table below lists their descriptions.

**TABLE 4**

Battery Models	Description	Selected for test	Tested	Comments
NNTN8128B	IMPRES Li Ion Battery Slim Capacity 1900mAh	Yes	Yes	
PMNN4424AR	IMPRESS Li Ion Battery High 2300mAH	Yes	Yes	
PMNN4448AR	Li Ion Battery Ultra High 2700mAH	Yes	Yes	

### 7.3 Body worn Accessories

All body worn accessories were considered. The table below lists the body worn accessories their descriptions.

**TABLE 5**

Body worn Models	Description	Selected for test	Tested	Comments
PMLN7008A	Belt Clip 2.5 in.	Yes	Yes	
PMLN4651A	Belt Clip 2 in.	Yes	Yes	
PMLN6085A	Metal Carry Holder w/2.5 in swivel belt loop	Yes	Yes	
NTN5243A	Carry strap	Yes	Yes	Tested w/ PMLN6085A

## 7.4 Audio Accessories

All audio accessories were considered. The table below lists the offered audio accessories and their descriptions. Exhibit 7B illustrates photos of the tested audio accessories.

\*SAR testing consideration for this accessory is not required because SAR results were below SAR threshold values specified in KDB 643646.

**TABLE 6**

Audio Acc. Models	Description	Selected for test	Tested	Comments
PMLN6130A	IMPRES 2 WIRE W/TRANS TUBE-BGE	Yes	Yes	Default audio
NNTN7869A	Hirose Surveillance Keyload Adaptor	*NA	*NA	
ZMN6031A	3 wire kit - beige	*NA	*NA	
ZMN6032A	2 wire kit - beige	*NA	*NA	
ZMN6038A	2 wire kit - beige	*NA	*NA	
ZMN6039A	3 wire kit - beige	*NA	*NA	
BDN6664A	Receive-Only Earpiece with Standard Earphone (1-Wire), Beige	*NA	*NA	
BDN6665A	Extra Loud Receive-Only Earpiece with Standard Earphone (1-Wire), Beige	*NA	*NA	
BDN6667A	Earpiece with Microphone and Push-to-Talk Combined (2-Wire), Beige	*NA	*NA	
BDN6668A	Earpiece with Microphone and Push-to-Talk Separate (3-Wire), Beige	*NA	*NA	
BDN6669A	Extra Loud Earpiece with Microphone and Push-to-Talk Combined (2-Wire), Beige	*NA	*NA	
BDN6726A	Receive-Only Earpiece with Standard Earphone (1-Wire), Black	*NA	*NA	
BDN6727A	Extra Loud Receive-Only Earpiece with Standard Earphone (1-Wire), Black	*NA	*NA	
BDN6730A	Earpiece with Microphone and Push-to-Talk Separate (3-Wire), Black	*NA	*NA	
BDN6731A	Extra Loud Earpiece with Microphone and Push-to-Talk Combined (2-Wire), Black	*NA	*NA	
BDN6729A	Earpiece with Microphone and Push-to-Talk Combined (2-Wire), Black	*NA	*NA	
PMLN6123A	Impress 3 Wire W/ Trans Tube - Black	*NA	*NA	
PMLN6124A	Impress 3 Wire W/ Trans Tube - Beige	*NA	*NA	
PMLN6127A	Impress 2 Wire Surveillance Kit - Black	*NA	*NA	
PMLN6128A	Impress 2 Wire Surveillance Kit - Beige	*NA	*NA	
PMLN6129A	Impress 2 wire W/ Translucent Tube - Black	*NA	*NA	
RLN5886A	Low Noise Kit Tube	*NA	*NA	
RLN5887A	High Noise Kit	*NA	*NA	
PMLN6125A	1 Wire Surveillance Kit - Black	*NA	*NA	
PMLN6126A	1 Wire Surveillance Kit - Beige	*NA	*NA	

TABLE 6 Continued

Audio Acc. Models	Description	Selected for test	Tested	Comments
PMMN4040A	IMPRES IP57 Submersible Remote Speaker Microphone	*NA	*NA	
PMMN4046A	IMPRES SPEAKER MIC W/VOL, IP57	*NA	*NA	
PMMN4050A	IMPRES REMOTE SPEAKER MIC, NC	*NA	*NA	
PMLN5102A	CORE ULTRA-LITE HEADSET	*NA	*NA	
PMLN5096B	CORE EARSET - D-SHELL	*NA	*NA	
PMLN5097A	IMPRES 3 WIRE SURVEILLANCE-BLACK	*NA	*NA	
PMLN5106A	IMPRES 3 WIRE SURVEILLANCE-BEIGE	*NA	*NA	
PMLN5653A	IMPRES Ear Mic System	*NA	*NA	
HMN4101B	Display RSM w/o Display and w/o Channel Knob	*NA	*NA	
HMN4103B	Display RSM w/o Channel Knob	*NA	*NA	
HMN4104B	IMPRES Display Submersible RSM w/jack & Ch. Selector	*NA	*NA	
PMMN4062A	Large Plus Noise cancelling RSM IP55 3.5MM jack RX only	*NA	*NA	
PMMN4065A	Standard Large IP57 RSM (based on PMM4046 w/ larger speaker)	*NA	*NA	
PMMN4024A	Core RSM	*NA	*NA	
PMMN4025A	Smart RSM	*NA	*NA	
RLN6424A	Rx-Only Secondary Audio Accessory for DRSM	*NA	*NA	
PMMN4069A	APX Basic Smart RSM, IP55	*NA	*NA	
PMLN5101A	Impress Temple Transducer	*NA	*NA	
PMLN5275C	Core H/D Headset	*NA	*NA	
RMN5058A	Core L/W Headset	*NA	*NA	
RMN5116A	Temple Transducer Headset	*NA	*NA	
AARLN4885B	3.5mm RX ONLY EARBUD FOR REM SPK MIC short coiled cbl	*NA	*NA	
RLN4941A	3.5mm RX ONLY EARPIECE W/TRANSLUCENT TUBE-Short coiled cbl	*NA	*NA	
WADN4190B	3.5mm EAR RCVR W/COIL CBL-Short cbl	*NA	*NA	
BDN6783A	3.5 mm Audio Adapter	*NA	*NA	
PMLN4620B	Rx only earpiece	*NA	*NA	

## 8.0 Description of Test System



### 8.1 Descriptions of Robotics/Probes/Readout Electronics

**TABLE 7**

Dosimetric System type	System version	DAE type	Probe Type
Schmid & Partner Engineering AG SPEAG DASY 5	52.8.2.969	DAE4	ES3DV3 (E-Field)

The DASY5™ system is operated per the instructions in the DASY5™ Users Manual. The complete manual is available directly from SPEAG™. All measurement equipment used to assess EME SAR compliance was calibrated according to ISO/IEC 17025 A2LA guidelines. Section 9.0 presents additional test equipment information. Appendices B and C present the applicable calibration certificates. The E-field probe first scans a coarse grid over a large area inside the phantom in order to locate the interpolated maximum SAR distribution. After the coarse scan measurement, the probe is automatically moved to a position at the interpolated maximum. The subsequent scan can directly use this position as reference for the cube evaluations.

**8.2 Description of Phantom(s)**

**TABLE 8**

Phantom type	Phantom ID (s)	Material Parameters	Phantom Dimensions LxWxD (mm)	Material Thickness (mm)	Support Structure Material	Loss Tangent (wood)
Dual Flat	NA	300MHz -6GHz; Er = 4+/- 1, Loss Tangent = ≤0.05	600x400x190	2mm +/- 0.2mm	Wood	< 0.05
SAM	NA					
Elliptical	OVAL 1011 OVAL 1020					

**8.3 Description of Simulated Tissue**

The sugar based simulate tissue is produced by placing the correct measured amount of De-ionized water into a large container. Each of the dried ingredients are weighed and added to the water carefully to avoid clumping. If the solution has a high sugar concentration the water is pre-heated to aid in dissolving the ingredients. For Diacetin and similar type simulates, sugar and HEC ingredients are not needed. The solution is mixed thoroughly, covered, and allowed to sit overnight prior to use.

The simulated tissue mixture was mixed based on the Simulated Tissue Composition indicated in Table 9. During the daily testing of this product, the applicable mixture was used to measure the Di-electric parameters at each of the tested frequencies to verify that the Di-electric parameters were within the tolerance of the tissue specifications.

**Simulated Tissue Composition (percent by mass)**

**TABLE 9**

Ingredients	450MHz	
	Head	Body
Sugar	56.0	46.5
Diacetin	0	0
De ionized – Water	39.1	50.53
Salt	3.8	1.87
HEC	1.0	1.0
Bact.	0.1	0.1

**9.0 Additional Test Equipment**

The table below lists additional test equipment used during the SAR assessment.

**TABLE 10**

Equipment Type	Model Number	Serial Number	Calibration Date	Calibration Due Date
Speag Probe	ES3DV3	3301	8/27/2013	8/27/2014
Speag DAE	DAE4	1231	3/12/2013	3/12/2014
Power Meter (Agilent)	E4419B	MY45103725	3/1/2013	3/1/2014
E-Series Avg. Power Sensor (Agilent)	E9301B	MY41495593	3/7/2013	3/7/2014
E-Series Avg. Power Sensor (Agilent)	E9301B	MY41495594	2/11/2013	2/11/2014
Bi-Directional Coupler (NARDA)	3020A	40295	9/23/2013	9/23/2015
Signal Generator (Agilent)	E4438C	MY42082269	1/24/2012	1/24/2014
AMP (Amplifier Research)	10WD1000	28782	CNR	CNR
AMP (ComTech PST)	AR88258-10	N1R1A00-1015	CNR	CNR
Power Meter (Agilent)	E4418B	US39251152	3/1/2013	3/1/2014
Power Sensor (Agilent)	8482B	3318A06774	3/7/2013	3/7/2014
Dickson Temperature Recorder	TM325	12121144	5/8/2013	5/8/2014
Omega Digital Thermometer with J Type TC Probe	HH202A	18812	6/10/2013	6/10/2014
Agilent PNA-L Network Analyzer	N5230C	MY49002155	8/1/2013	8/1/2014
Dielectric Probe Kit (DAK)	DAK-3.5	1059	5/28/2013	5/28/2014
Dielectric Probe Kit (DAK)	DAK-12	1013	5/28/2013	5/28/2014
Speag Dipole	D450V3	1075	7/23/2013	7/23/2015

**10.0 SAR Measurement System Validation and Verification**

DASY output files of the probe/dipole calibration certificates and system verification test results are included in appendices B, C & D respectively.

**10.1 System Validation**

The SAR measurement system was validated according to procedures in KDB 865664. The validation status summary table is below.

**TABLE 11**

Dates	Probe Calibration Point		Probe SN	Measured Tissue Parameters		Validation for CW		
				$\sigma$	$\epsilon_r$	Sensitivity	Linearity	Isotropy
09/30/2013	Body	450	3301	0.94	56.8	Pass	Pass	Pass
10/07/2013	Body	450	3301	0.92	56.5			
09/27/2013	Head	450	3301	0.83	42.2	Pass	Pass	Pass
10/07/2013	Head	450	3301	0.85	43.5			

## 10.2 System Verification

System verification checks were conducted each day during the SAR assessment. The results are normalized to 1W. APPENDIX D includes DASY plots for each day during the SAR assessment. The table below summarizes the daily system check results used for the SAR assessment.

**TABLE 12**

Probe Serial #	Tissue Type	Dipole Kit / Serial #	Ref SAR @ 1W (W/kg)	System Check Results Measured (W/kg)	System Check Test Results when normalized to 1W (W/kg)	Tested Date
3301	FCC Body	SPEAG D450V3 / 1075	*4.51 +/- 10%	1.08	4.32	12/21/2013
				1.08	4.32	12/22/2013
				1.05	4.20	01/08/2014
	IEEE/IEC Head	SPEAG D450V3 / 1075	*4.73 +/- 10%	1.07	4.28	12/22/2013

\*Dipole manufacture's reference target

## 10.3 Equivalent Tissue Test Results

Simulated tissue prepared for SAR measurements is measured daily and within 24 hours prior to actual SAR testing to verify that the tissue is within +/- 5% of target parameters at the center of the transmit band. This measurement is done using the applicable equipment indicated in section 9.0. The table below summarizes the measured tissue parameters used for the SAR assessment.

**TABLE 13**

Frequency (MHz)	Tissue Type	Conductivity Target (S/m)	Dielectric Constant Target	Conductivity Meas. (S/m)	Dielectric Constant Meas.	Tested Date
406	FCC Body	0.93 (0.89-0.98)	57.1 (54.3-60.0)	0.91	56.8	12/21/2013
				0.90	56.0	01/08/2014
406	IEEE/IEC Head	0.87 (0.83-0.91)	44.0 (41.6-46.0)	0.86	45.0	12/22/2013
450	FCC Body	0.94 (0.89-0.99)	56.8 (54.0-59.7)	0.94	56.2	12/21/2013
				0.94	56.4	12/22/2013
450	IEEE/IEC Head	0.87 (0.83-0.91)	43.0 (41.3-45.7)	0.90	44.1	12/22/2013
380	FCC Body	0.93 (0.88-0.98)	57.4 (54.5-60.3)	0.89	57.4	12/22/2013
380	IEEE/IEC Head	0.87 (0.83-0.91)	44.3 (42.1-46.6)	0.84	45.6	12/22/2013
393	FCC Body	0.93 (0.89-0.98)	57.3 (54.4-60.1)	0.89	57.2	12/22/2013
393	IEEE/IEC Head	0.87 (0.83-0.91)	44.2 (42.0-46.4)	0.85	45.3	12/22/2013

**11.0 Environmental Test Conditions**

The EME Laboratory’s ambient environment is well controlled resulting in very stable simulated tissue temperature and therefore stable dielectric properties. Simulated tissue temperature is measured prior to each scan to insure it is within +/- 2°C of the temperature at which the dielectric properties were determined. The liquid depth within the phantom used for measurements was at least 15cm. Additional precautions are routinely taken to ensure the stability of the simulated tissue such as covering the phantoms when scans are not actively in process in order to minimize evaporation. The lab environment is continuously monitored. The table below presents the range and average environmental conditions during the SAR tests reported herein:

**TABLE 14**

	<b>Target</b>	<b>Measured</b>
<b>Ambient Temperature</b>	18 – 25 °C	Range: 21.0 – 24.0°C Avg. 21.9 °C
<b>Relative Humidity</b>	30 – 70 %	Range: 30.4 – 67.5 % Avg. 52.5 %
<b>Tissue Temperature</b>	NA	Range: 20.8-21.7°C Avg. 21.3°C

Relative humidity target range is a recommended target

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 SAR scans are repeated.

**12.0 DUT Test Setup and Methodology**

**12.1 Measurements**

SAR measurements were performed using the DASY system described in section 8.0 using zoom scans. Elliptical flat phantoms filled with applicable simulated tissue were used for body and face testing.

The table below includes the step sizes and resolution of area and zoom scans per KDB 865664 requirements.

**TABLE 15**

<b>Description</b>	<b>≤ 3 GHz</b>	<b>&gt; 3 GHz</b>
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 1 mm	$\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5$ mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: ΔxArea, ΔyArea	≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
	When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	

**TABLE 15 (cont.)**

Description		≤ 3 GHz	> 3 GHz
Note: $\delta$ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details. * When zoom scan is required and the reported SAR from the area scan based 1-g SAR estimation procedures of KDB 447498 is $\leq 1.4$ W/kg, $\leq 8$ mm, $\leq 7$ mm and $\leq 5$ mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.			
Maximum zoom scan spatial resolution: $\Delta x_{Zoom}$ , $\Delta y_{Zoom}$		$\leq 2$ GHz: $\leq 8$ mm $2 - 3$ GHz: $\leq 5$ mm*	$3 - 4$ GHz: $\leq 5$ mm* $4 - 6$ GHz: $\leq 4$ mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$	$\leq 5$ mm	$3 - 4$ GHz: $\leq 4$ mm $4 - 5$ GHz: $\leq 3$ mm $5 - 6$ GHz: $\leq 2$ mm

**12.2 DUT Configuration(s)**

The DUT is a portable device operational at the body and face as described in section 6.0 while using the applicable accessories listed in section 7.0. All accessories listed in section 7.0 of this report were considered when implementing the guidelines specified in KDB 643646.

**12.3 DUT Positioning Procedures**

The positioning of the device for each body location is described below and illustrated in APPENDIX H.

**12.3.1 Body**

The DUT was positioned in normal use configuration against the phantom with the offered body worn accessory as well as with the offered audio accessories as applicable.

**12.3.2 Head**

Not applicable.

**12.3.3 Face**

The DUT was positioned with its' front side separated 2.5cm from the phantom.

## 12.4 DUT Test Channels

The number of test channels was determined by using the following IEEE 1528 equation. The use of this equation produces the same or more test channels compared to the FCC KDB 447498 number of test channels formula.

$$N_c = 2 * \text{roundup}[10 * (f_{high} - f_{low}) / f_c] + 1$$

Where

$N_c$  = Number of channels

$F_{high}$  = Upper channel

$F_{low}$  = Lower channel

$F_c$  = Center channel

## 12.5 SAR Result Scaling Methodology

The calculated 1-gram and 10-gram averaged SAR results indicated as “Max Calc. 1g-SAR” and “Max Calc.10g-SAR” in the data tables is determined by scaling the measured SAR to account for power leveling variations and power slump. A table and graph of output power versus time is provided in APPENDIX G. For this device the “Max Calc. 1g-SAR” and “Max Calc.10g-SAR” are scaled using the following formula:

$$Max\_Calc = SAR\_meas \cdot 10^{\frac{-Drift}{10}} \cdot \frac{P\_max}{P\_int} \cdot DC$$

$P\_max$  = Maximum Power (W)

$P\_int$  = Initial Power (W)

Drift = DASY drift results (dB)

$SAR\_meas$  = Measured 1-g or 10-g Avg. SAR (W/kg)

DC = Transmission mode duty cycle in % where applicable

50% duty cycle is applied for PTT operation

Note: for conservative results, the following are applied:

If  $P\_int > P\_max$ , then  $P\_max/P\_int = 1$ .

Drift = 1 for positive drift

Additional SAR scaling was applied using the methodologies outlined in FCC KDB 865664 using tissue sensitivity values. SAR was scaled for conditions where the tissue permittivity was measured above the nominal target and for tissue conductivity that was measured below the nominal target. Negative or reduced SAR scaling is not permitted.

## 12.6 DUT Test Plan

The guidelines and requirements outlined in “SAR Test Reduction Considerations for Occupational PTT Radios” FCC KDB 643646 were used to assess compliance of this device. All modes of operation identified in section 6.0 were considered during the development of the test plan. All tests were performed in CW mode and then 50% duty cycle was applied to the final results.

**13.0 DUT Test Data**

**13.1 Assessments at the Body for 406.1 – 470MHz band**

Battery NNTN8128B was selected as the default battery for assessments at the Body because it is the thinnest battery (refer to Exhibit 7B for the dimension of the battery). The default battery was used during conducted power measurements for all test channels within Part 90 frequency range (406.1-470MHz) which are listed in Table 16. The channel with the highest conducted power will be identified as the default channel per KDB 643646 SAR Test for PTT Radios. SAR plots of the highest results per table (bolded) are presented in APPENDIX E.

**TABLE 16**

Test Freq (MHz)	Power (W)
406.1250	5.67
422.1000	5.58
438.1000	5.48
454.0000	5.47
470.0000	5.50

**Assessments at the Body with Body worn PMLN7008A**

DUT assessment with offered antennas, default battery, audio, and body worn accessory per KDB 643646 SAR Test for PTT Radios – Body SAR Test Considerations for Body worn Accessories. Optional batteries were tested per the requirements of KDB 643646. Refer to Table 16 for highest output power channel. SAR plots of the highest results per table (bolded) are presented in APPENDIX E.

**TABLE 17**

Antenna	Battery	Carry Accessory	Cable Accessory	Test Freq (MHz)	Init Pwr (W)	SAR Drift (dB)	Meas. 1g-SAR (W/kg)	Meas. 10g-SAR (W/kg)	Max Calc. 1g-SAR (W/kg)	Max Calc. 10g-SAR (W/kg)	Run#
PMAE4065A	NNTN8128B	PMLN7008A	PMLN6130A	406.1250	5.49	1.52	5.52	3.94	2.87	2.05	HvH-Ab131221-02
				422.1000							
				438.1000							
				454.0000							
				470.0000							
FAF5259A	NNTN8128B	PMLN7008A	PMLN6130A	406.1250	5.49	1.91	4.32	3.06	2.24	1.59	HvH-Ab131221-03
				422.1000							
				438.1000							
				454.0000							
				470.0000							
<b>Assessment of additional batteries</b>											
PMAE4065A	PMNN4424AR	PMLN7008A	PMLN6130A	406.1250	5.59	0.39	5.58	4.0	2.84	2.04	HvH-Ab131221-04
				422.1000							
				438.1000							
				454.0000							
				470.0000							

**TABLE 17 (cont.)**

Antenna	Battery	Carry Accessory	Cable Accessory	Test Freq (MHz)	Init Pwr (W)	SAR Drift (dB)	Meas. 1g-SAR (W/kg)	Meas. 10g-SAR (W/kg)	Max Calc. 1g-SAR (W/kg)	Max Calc. 10g-SAR (W/kg)	Run#
PMAE4065A	PMNN4448AR	PMLN7008A	PMLN6130A	406.1250	5.42	0.4	5.99	4.31	<b>3.15</b>	2.27	HvH-Ab131221-05
				422.1000							
				438.1000							
				454.0000							
				470.0000							

**Assessment at the Body with other audio accessories**

Assessment per “KDB 643646 Body SAR Test Consideration for Audio Accessories without Built-in Antenna; Sec 1, A. when overall < 4.0 W/kg, SAR tested for that audio accessory is not necessary.” This was applicable to all remaining accessories.

**Assessments at the Body with Body worn PMLN4651A**

DUT assessment with offered antennas, default battery, audio, and body worn accessory per KDB 643646 SAR Test for PTT Radios – Body SAR Test Considerations for Body worn Accessories. Optional batteries were tested per the requirements of KDB 643646. Refer to Table 16 for highest output power channel. SAR plots of the highest results per table (bolded) are presented in APPENDIX E

**TABLE 18**

Antenna	Battery	Carry Accessory	Cable Accessory	Test Freq (MHz)	Init Pwr (W)	SAR Drift (dB)	Meas. 1g-SAR (W/kg)	Meas. 10g-SAR (W/kg)	Max Calc. 1g-SAR (W/kg)	Max Calc. 10g-SAR (W/kg)	Run#
PMAE4065A	NNTN8128B	PMLN4651A	PMLN6130A	406.1250	5.50	1.01	5.25	3.79	2.72	1.96	HvH-Ab131221-06
				422.1000							
				438.1000							
				454.0000							
				470.0000							
FAF5259A	NNTN8128B	PMLN4651A	PMLN6130A	406.1250	5.46	1.38	4.63	3.32	2.42	1.73	HvH-Ab131221-07
				422.1000							
				438.1000							
				454.0000							
				470.0000							
<b>Assessment of additional batteries</b>											
PMAE4065A	PMNN4424AR	PMLN4651A	PMLN6130A	406.1250	5.45	0.32	5.85	4.23	3.06	2.21	HvH-Ab131221-08
				422.1000							
				438.1000							
				454.0000							
				470.0000							

**TABLE 18 (Cont.)**

Antenna	Battery	Carry Accessory	Cable Accessory	Test Freq (MHz)	Init Pwr (W)	SAR Drift (dB)	Meas. 1g-SAR (W/kg)	Meas. 10g-SAR (W/kg)	Max Calc. 1g-SAR (W/kg)	Max Calc. 10g-SAR (W/kg)	Run#
PMAE4065A	PMNN4448AR	PMLN4651A	PMLN6130A	406.1250	5.13	0.62	5.92	4.24	<b>3.29</b>	2.36	HvH-Ab-140108-02
				422.1000							
				438.1000							
				454.0000							
				470.0000							

**Assessment at the Body with other audio accessories**

Assessment per “KDB 643646 Body SAR Test Consideration for Audio Accessories without Built-in Antenna; Sec 1, A. when overall < 4.0 W/kg, SAR tested for that audio accessory is not necessary.” This was applicable to all remaining accessories.

**Assessments at the Body with Body worn PMLN6085A**

DUT assessment with offered antennas, default battery, audio, and body worn accessory per KDB 643646 SAR Test for PTT Radios – Body SAR Test Considerations for Body worn Accessories. Optional batteries were tested per the requirements of KDB 643646. Refer to Table 16 for highest output power channel. SAR plots of the highest results per table (bolded) are presented in APPENDIX E

**TABLE 19**

Antenna	Battery	Carry Accessory	Cable Accessory	Test Freq (MHz)	Init Pwr (W)	SAR Drift (dB)	Meas. 1g-SAR (W/kg)	Meas. 10g-SAR (W/kg)	Max Calc. 1g-SAR (W/kg)	Max Calc. 10g-SAR (W/kg)	Run#
PMAE4065A	NNTN8128B	PMLN6085A	PMLN6130A	406.1250	5.43	0.95	1.93	1.48	1.01	0.78	HvH-Ab131221-10
				422.1000							
				438.1000							
				454.0000							
				470.0000							
FAF5259A	NNTN8128B	PMLN6085A	PMLN6130A	406.1250	5.42	0.77	1.00	0.76	0.52	0.40	HvH-Ab131221-11
				422.1000							
				438.1000							
				454.0000							
				470.0000							
Assessment of additional batteries											
PMAE4065A	PMNN4424AR	PMLN6085A	PMLN6130A	406.1250	5.53	0.22	1.86	1.42	0.96	0.73	HvH-Ab131221-12
				422.1000							
				438.1000							
				454.0000							
				470.0000							

**TABLE 19 (Cont.)**

Antenna	Battery	Carry Accessory	Cable Accessory	Test Freq (MHz)	Init Pwr (W)	SAR Drift (dB)	Meas. 1g-SAR (W/kg)	Meas. 10g-SAR (W/kg)	Max Calc. 1g-SAR (W/kg)	Max Calc. 10g-SAR (W/kg)	Run#
PMAE4065A	PMNN4448AR	PMLN6085A	PMLN6130A	406.1250	5.42	0.27	1.94	1.48	<b>1.02</b>	0.78	HvH-Ab131221-13
				422.1000							
				438.1000							
				454.0000							
				470.0000							

**Assessment at the Body with other audio accessories**

Assessment per “KDB 643646 Body SAR Test Consideration for Audio Accessories without Built-in Antenna; Sec 1, A. when overall < 4.0 W/kg, SAR tested for that audio accessory is not necessary.” This was applicable to all remaining accessories.

**Assessments at the Body with Body worn PMLN6085A w/ NTN5243A**

DUT assessment with offered antennas, default battery, audio, and body worn accessory per KDB 643646 SAR Test for PTT Radios – Body SAR Test Considerations for Body worn Accessories. Optional batteries were tested per the requirements of KDB 643646. Refer to Table 16 for highest output power channel. SAR plots of the highest results per table (bolded) are presented in APPENDIX E

**TABLE 20**

Antenna	Battery	Carry Accessory	Cable Accessory	Test Freq (MHz)	Init Pwr (W)	SAR Drift (dB)	Meas. 1g-SAR (W/kg)	Meas. 10g-SAR (W/kg)	Max Calc. 1g-SAR (W/kg)	Max Calc. 10g-SAR (W/kg)	Run#
PMAE4065A	NNTN8128B	PMLN6085A w/ NTN5243A	PMLN6130A	406.1250	5.47	1.29	4.34	3.20	2.26	1.67	HvH-Ab131221-14
				422.1000							
				438.1000							
				454.0000							
				470.0000							
FAF5259A	NNTN8128B	PMLN6085A w/ NTN5243A	PMLN6130A	406.1250	5.42	1.14	2.87	2.12	1.51	1.11	HvH-Ab131221-15
				422.1000							
				438.1000							
				454.0000							
				470.0000							
<b>Assessment of additional batteries</b>											
PMAE4065A	PMNN4424AR	PMLN6085A w/ NTN5243A	PMLN6130A	406.1250	5.49	0.16	4.45	3.21	2.31	1.67	HvH-Ab131221-16
				422.1000							
				438.1000							
				454.0000							
				470.0000							

**TABLE 20 (Cont.)**

Antenna	Battery	Carry Accessory	Cable Accessory	Test Freq (MHz)	Init Pwr (W)	SAR Drift (dB)	Meas. 1g-SAR (W/kg)	Meas. 10g-SAR (W/kg)	Max Calc. 1g-SAR (W/kg)	Max Calc. 10g-SAR (W/kg)	Run#
PMAE4065A	PMNN4448AR	PMLN6085A w/ NTN5243A	PMLN6130A	406.1250	5.43	0.51	4.55	3.28	<b>2.39</b>	1.72	HvH-Ab131221-17
				422.1000							
				438.1000							
				454.0000							
				470.0000							

**Assessment at the Body with other audio accessories**

Assessment per “KDB 643646 Body SAR Test Consideration for Audio Accessories without Built-in Antenna; Sec 1, A. when overall < 4.0 W/kg, SAR tested for that audio accessory is not necessary.” This was applicable to all remaining accessories.

**13.2 Assessments at the Face for 406.1 - 470MHz band**

Battery PMNN4448AR was selected as the default battery for assessments at the Body because it has the highest capacity (refer to Exhibit 7B for the dimension of the battery). The default battery was used during conducted power measurements for all test channels within Part 90 frequency range (406.1-470MHz) which are listed in Table 21. The channel with the highest conducted power will be identified as the default channel per KDB 643646 SAR Test for PTT Radios. SAR plots of the highest results per table (bolded) are presented in APPENDIX E.

**TABLE 21**

Test Freq (MHz)	Power (W)
406.1250	5.67
422.1000	5.58
438.1000	5.48
454.0000	5.47
470.0000	5.50

DUT assessment with offered antennas, default battery with front of DUT positioned 2.5cm facing phantom per KDB 643646 SAR Test for PTT Radios – Head SAR Test Considerations. Optional batteries were tested per the requirements of KDB 643646. Refer to Table 21 for highest output power channel. SAR plots of the highest results per table (bolded) are presented in APPENDIX E.

**TABLE 22**

Antenna	Battery	Carry Accessory	Cable Accessory	Test Freq (MHz)	Init Pwr (W)	SAR Drift (dB)	Meas. 1g-SAR (W/kg)	Meas. 10g-SAR (W/kg)	Max Calc. 1g-SAR (W/kg)	Max Calc. 10g-SAR (W/kg)	Run#
PMAE4065A	PMNN4448AR	None	None	406.1250	5.42	0.32	5.32	4.03	<b>2.80</b>	2.12	HvH-Face-131222-02
				422.1000							
				438.1000							
				454.0000							
				470.0000							
FAF5259A	PMNN4448AR	None	None	406.1250	5.55	0.52	3.47	2.62	1.78	1.35	HvH-Face-131222-03
				422.1000							
				438.1000							
				454.0000							
				470.0000							
<b>Assessment of additional batteries</b>											
PMAE4065A	PMNN4424AR	None	None	406.1250	5.48	0.30	5.02	3.78	2.61	1.97	HvH-Face-131222-04
				422.1000							
				438.1000							
				454.0000							
				470.0000							
PMAE4065A	NNTN8128B	None	None	406.1250	5.43	0.82	4.91	3.70	2.58	1.94	HvH-Face-131222-05
				422.1000							
				438.1000							
				454.0000							
				470.0000							

**13.3 Assessment Outside of Part 90 Frequency Bands**

The worst case configurations from the evaluation inside of the FCC Part 90 frequency band both at the body and the face (sections 13.1 and 13.2) were selected to evaluate compliance of the DUT in the operational frequency bands outside of Part 90. SAR plots of the highest results per table (bolded) are presented in APPENDIX F.

The results are presented in Tables 24 and 25

**Table 24 – Assessment at Body**

Antenna	Battery	Carry Accessory	Cable Accessory	Test Freq (MHz)	Init Pwr (W)	SAR Drift (dB)	Meas. 1g-SAR (W/kg)	Meas. 10g-SAR (W/kg)	Max Calc. 1g-SAR (W/kg)	Max Calc. 10g-SAR (W/kg)	Run#
PMAE4065A	PMNN4448AR	PMLN4651A	PMLN6130A	380.0	5.59	0.09	4.37	3.16	2.19	1.58	HvH-Ab-131222-09
PMAE4065A	PMNN4448AR	PMLN4651A	PMLN6130A	393.1	5.42	0.36	4.52	3.25	<b>2.38</b>	1.71	HvH-Ab-131222-10

**Table 25 – Assessment at Face**

Antenna	Battery	Carry Accessory	Cable Accessory	Test Freq (MHz)	Init Pwr (W)	SAR Drift (dB)	Meas. 1g-SAR (W/kg)	Meas. 10g-SAR (W/kg)	Max Calc. 1g-SAR (W/kg)	Max Calc. 10g-SAR (W/kg)	Run#
PMAE4065A	PMNN4448AR	None	None	380.0	5.61	0.13	4.29	3.23	<b>2.18</b>	1.64	HvH-Face-131222-06
PMAE4065A	PMNN4448AR	None	None	393.1	5.42	0.40	4.01	3.03	2.11	1.59	HvH-Face-131222-07

**14.0 Results Summary**

Based on the test guidelines from KDB 643646 and satisfying frequencies with Part 90 FCC band to be in compliance with Industry Canada Frequency range, the highest Operational Maximum Calculated 1-gram and 10-gram average SAR values found for this filing:

**TABLE 26**

Designator	Frequency band (MHz)	Max Calc at Body (W/kg)		Max Calc at Face (W/kg)	
		1g-SAR	10g-SAR	1g-SAR	10g-SAR
FCC/ Industry Canada	406.1-470	3.29	2.36	2.80	2.12
Overall	380-470	3.29	2.36	2.80	2.12

All results are scaled to the maximum output power

The test results clearly demonstrate compliance with FCC Occupational/Controlled RF Exposure limits of 8 W/kg averaged over 1 gram per the requirements of 47 CFR 2.1093(d). The 10 grams result is not applicable to FCC filing.

**15.0 Variability Assessment**

Per the guidelines in KDB 865664 SAR variability assessment is not required because SAR results are below 4.0W/kg (Occupational).

**16.0 System Uncertainty**

A system uncertainty analysis is not required for this report per KDB 865664 because the highest report SAR value for Occupational exposure is less than 7.5W/kg.

Per the guidelines of ISO 17025 a reported system uncertainty is required and therefore measurement uncertainty budget is included in APPENDIX A.

**APPENDIX A**  
**Measurement Uncertainty Budget**

### Uncertainty Budget for Device Under Test, for 100 MHz to 800 MHz

<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e = f(d,k)</i>	<i>f</i>	<i>g</i>	<i>h = c x f / e</i>	<i>i = c x g / e</i>	<i>k</i>
Uncertainty Component	IEEE 1528 section	Tol. (± %)	Prob Dist	Div.	<i>c<sub>i</sub></i> (1 g)	<i>c<sub>i</sub></i> (10 g)	1 g <i>u<sub>i</sub></i> (±%)	10 g <i>u<sub>i</sub></i> (±%)	<i>v<sub>i</sub></i>
<b>Measurement System</b>									
Probe Calibration	E.2.1	6.7	N	1.00	1	1	6.7	6.7	∞
Axial Isotropy	E.2.2	4.7	R	1.73	0.707	0.707	1.9	1.9	∞
Hemispherical Isotropy	E.2.2	9.6	R	1.73	0.707	0.707	3.9	3.9	∞
Boundary Effect	E.2.3	1.0	R	1.73	1	1	0.6	0.6	∞
Linearity	E.2.4	4.7	R	1.73	1	1	2.7	2.7	∞
System Detection Limits	E.2.5	1.0	R	1.73	1	1	0.6	0.6	∞
Readout Electronics	E.2.6	0.3	N	1.00	1	1	0.3	0.3	∞
Response Time	E.2.7	1.1	R	1.73	1	1	0.6	0.6	∞
Integration Time	E.2.8	1.1	R	1.73	1	1	0.6	0.6	∞
RF Ambient Conditions - Noise	E.6.1	3.0	R	1.73	1	1	1.7	1.7	∞
RF Ambient Conditions - Reflections	E.6.1	0.0	R	1.73	1	1	0.0	0.0	∞
Probe Positioner Mech. Tolerance	E.6.2	0.4	R	1.73	1	1	0.2	0.2	∞
Probe Positioning w.r.t Phantom	E.6.3	1.4	R	1.73	1	1	0.8	0.8	∞
Max. SAR Evaluation (ext., int., avg.)	E.5	3.4	R	1.73	1	1	2.0	2.0	∞
<b>Test sample Related</b>									
Test Sample Positioning	E.4.2	3.2	N	1.00	1	1	3.2	3.2	29
Device Holder Uncertainty	E.4.1	4.0	N	1.00	1	1	4.0	4.0	8
SAR drift	6.6.2	5.0	R	1.73	1	1	2.9	2.9	∞
<b>Phantom and Tissue Parameters</b>									
Phantom Uncertainty	E.3.1	4.0	R	1.73	1	1	2.3	2.3	∞
Liquid Conductivity (target)	E.3.2	5.0	R	1.73	0.64	0.43	1.8	1.2	∞
Liquid Conductivity (measurement)	E.3.3	3.3	N	1.00	0.64	0.43	2.1	1.4	∞
Liquid Permittivity (target)	E.3.2	5.0	R	1.73	0.6	0.49	1.7	1.4	∞
Liquid Permittivity (measurement)	E.3.3	1.9	N	1.00	0.6	0.49	1.1	0.9	∞
<b>Combined Standard Uncertainty</b>							12	11	482
<b>Expanded Uncertainty (95% CONFIDENCE LEVEL)</b>							23	23	

Notes for uncertainty budget tables:

- a) Column headings *a-k* are given for reference.
- b) Tol. - tolerance in influence quantity.
- c) Prob. Dist. – Probability distribution
- d) N, R - normal, rectangular probability distributions
- e) Div. - divisor used to translate tolerance into normally distributed standard uncertainty
- f) *c<sub>i</sub>* - sensitivity coefficient that should be applied to convert the variability of the uncertainty component into a variability of SAR.
- g) *u<sub>i</sub>* – SAR uncertainty
- h) *v<sub>i</sub>* - degrees of freedom for standard uncertainty and effective degrees of freedom for the expanded uncertainty

**APPENDIX B**  
**Probe Calibration Certificates**

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



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

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

Accreditation No.: **SCS 108**

Client **Motorola EME**

Certificate No: **ES3-3301\_Aug13**

**CALIBRATION CERTIFICATE**

Object **ES3DV3 - SN:3301**

Calibration procedure(s) **QA CAL-01.v9, QA CAL-12.v8, QA CAL-14.v4, QA CAL-23.v5,  
QA CAL-25.v6  
Calibration procedure for dosimetric E-field probes**

Calibration date: **August 27, 2013**

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	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	31-Jan-13 (No. DAE4-660_Jan13)	Jan-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: August 28, 2013

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

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

Accreditation No.: **SCS 108**

**Glossary:**

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

**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:**

- *NORM<sub>x,y,z</sub>*: Assessed for E-field polarization θ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not affect the E<sup>2</sup>-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)<sub>x,y,z</sub> = NORM<sub>x,y,z</sub> \* 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*.
- *DCP<sub>x,y,z</sub>*: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR*: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; D<sub>x,y,z</sub>; VR<sub>x,y,z</sub>*: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- *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 *NORM<sub>x,y,z</sub> \* 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.

ES3DV3 – SN:3301

August 27, 2013

# Probe ES3DV3

## SN:3301

Manufactured: August 27, 2010  
Calibrated: August 27, 2013

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

ES3DV3- SN:3301

August 27, 2013

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3301

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup>	1.48	1.02	1.24	$\pm 10.1\%$
DCP (mV) <sup>B</sup>	100.0	103.1	101.7	

### Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	172.9	$\pm 3.0\%$
		Y	0.0	0.0	1.0		142.1	
		Z	0.0	0.0	1.0		157.6	
10108-CAB	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	6.10	66.1	19.2	5.80	108.6	$\pm 1.2\%$
		Y	6.21	66.9	19.7		123.8	
		Z	6.51	67.8	20.2		137.5	
10109-CAB	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, 16-QAM)	X	7.12	66.8	19.8	6.43	116.7	$\pm 1.4\%$
		Y	7.21	67.6	20.3		130.3	
		Z	7.50	68.3	20.6		146.1	
10110-CAB	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, QPSK)	X	5.86	65.8	19.1	5.75	107.0	$\pm 1.2\%$
		Y	5.90	66.4	19.5		120.2	
		Z	6.15	67.1	19.8		134.4	
10111-CAB	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, 16-QAM)	X	6.84	66.4	19.7	6.44	111.7	$\pm 1.2\%$
		Y	6.89	67.1	20.1		126.3	
		Z	7.26	68.0	20.5		142.9	
10112-CAB	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, 64-QAM)	X	7.36	67.0	20.0	6.59	116.8	$\pm 1.7\%$
		Y	7.47	67.9	20.5		133.1	
		Z	7.80	68.6	20.8		149.5	
10113-CAB	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, 64-QAM)	X	7.08	66.6	19.9	6.62	113.1	$\pm 1.4\%$
		Y	7.16	67.5	20.3		128.9	
		Z	7.51	68.2	20.7		144.8	
10142-CAB	LTE-FDD (SC-FDMA, 100% RB, 3 MHz, QPSK)	X	6.17	67.5	20.1	5.73	148.0	$\pm 1.2\%$
		Y	5.75	66.4	19.5		119.5	
		Z	5.99	67.0	19.8		132.7	
10143-CAB	LTE-FDD (SC-FDMA, 100% RB, 3 MHz, 16-QAM)	X	6.60	66.4	19.6	6.35	109.0	$\pm 1.4\%$
		Y	6.66	67.2	20.1		124.9	
		Z	6.97	67.7	20.3		139.8	
10145-CAB	LTE-FDD (SC-FDMA, 100% RB, 1.4 MHz, QPSK)	X	5.85	67.1	19.9	5.76	142.6	$\pm 1.2\%$
		Y	5.50	66.3	19.5		115.9	
		Z	5.74	66.6	19.6		129.0	
10146-CAB	LTE-FDD (SC-FDMA, 100% RB, 1.4 MHz, 16-QAM)	X	6.80	68.1	20.6	6.41	147.0	$\pm 1.4\%$
		Y	6.32	67.1	20.1		119.0	
		Z	6.69	67.7	20.4		133.0	

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10154-CAB	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	6.31	67.6	20.2	5.75	149.1	±1.2 %
		Y	5.93	66.6	19.6		122.0	
		Z	6.18	67.2	19.9		135.0	
10155-CAB	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, 16-QAM)	X	6.84	66.4	19.7	6.43	110.9	±1.2 %
		Y	6.88	67.1	20.0		129.0	
		Z	7.24	68.0	20.5		143.3	
10156-CAB	LTE-FDD (SC-FDMA, 50% RB, 5 MHz, QPSK)	X	6.09	67.3	20.1	5.79	145.5	±1.2 %
		Y	5.68	66.2	19.5		119.4	
		Z	5.97	66.9	19.8		132.3	
10157-CAB	LTE-FDD (SC-FDMA, 50% RB, 5 MHz, 16-QAM)	X	6.58	66.3	19.7	6.49	106.7	±1.2 %
		Y	6.59	66.9	20.0		123.8	
		Z	7.00	67.9	20.5		138.6	
10158-CAB	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, 64-QAM)	X	7.04	66.5	19.7	6.62	111.3	±1.4 %
		Y	7.09	67.2	20.1		130.3	
		Z	7.54	68.3	20.8		145.1	
10159-CAB	LTE-FDD (SC-FDMA, 50% RB, 5 MHz, 64-QAM)	X	6.67	66.3	19.7	6.56	107.7	±1.2 %
		Y	6.69	67.0	20.1		124.5	
		Z	7.14	68.0	20.6		139.8	
10166-CAB	LTE-FDD (SC-FDMA, 50% RB, 1.4 MHz, QPSK)	X	5.22	66.6	19.6	5.46	134.3	±0.9 %
		Y	4.89	65.9	19.2		112.2	
		Z	5.15	66.4	19.5		124.6	
10167-CAB	LTE-FDD (SC-FDMA, 50% RB, 1.4 MHz, 16-QAM)	X	6.12	67.5	20.3	6.21	135.5	±1.2 %
		Y	5.71	66.9	20.0		112.6	
		Z	6.11	67.5	20.3		126.3	
10175-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	5.04	66.7	19.9	5.72	128.1	±0.9 %
		Y	4.99	67.3	20.3		146.6	
		Z	5.01	66.6	19.8		118.6	
10176-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, 16-QAM)	X	5.82	67.8	20.8	6.52	127.4	±1.2 %
		Y	5.74	68.6	21.4		144.6	
		Z	5.76	67.6	20.6		118.3	
10177-CAC	LTE-FDD (SC-FDMA, 1 RB, 5 MHz, QPSK)	X	5.06	66.8	19.9	5.73	128.2	±0.9 %
		Y	5.09	67.9	20.7		146.2	
		Z	5.02	66.7	19.8		118.5	
10178-CAB	LTE-FDD (SC-FDMA, 1 RB, 5 MHz, 16-QAM)	X	5.83	67.8	20.8	6.52	127.4	±1.2 %
		Y	5.80	68.9	21.6		146.0	
		Z	5.78	67.7	20.7		118.4	
10179-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, 64-QAM)	X	5.81	67.8	20.7	6.50	127.6	±1.2 %
		Y	5.76	68.8	21.4		144.7	
		Z	5.75	67.6	20.6		118.2	
10180-CAB	LTE-FDD (SC-FDMA, 1 RB, 5 MHz, 64-QAM)	X	5.82	67.9	20.8	6.50	127.5	±1.2 %
		Y	5.74	68.7	21.4		144.5	
		Z	5.79	67.8	20.7		118.8	

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10184-CAB	LTE-FDD (SC-FDMA, 1 RB, 3 MHz, QPSK)	X	5.03	66.6	19.8	5.73	127.1	±0.9 %
		Y	5.05	67.7	20.5		145.7	
		Z	5.02	66.6	19.8		119.3	
10185-CAB	LTE-FDD (SC-FDMA, 1 RB, 3 MHz, 16-QAM)	X	5.79	67.6	20.7	6.51	127.2	±1.2 %
		Y	5.74	68.6	21.4		144.0	
		Z	5.81	67.8	20.7		118.5	
10187-CAB	LTE-FDD (SC-FDMA, 1 RB, 1.4 MHz, QPSK)	X	5.05	66.7	19.9	5.73	128.0	±0.9 %
		Y	5.08	67.8	20.6		145.3	
		Z	5.02	66.6	19.8		119.3	
10188-CAB	LTE-FDD (SC-FDMA, 1 RB, 1.4 MHz, 16-QAM)	X	5.81	67.7	20.7	6.52	127.6	±0.9 %
		Y	5.71	68.4	21.2		142.0	
		Z	5.80	67.7	20.7		119.2	
10298-AAA	LTE-FDD (SC-FDMA, 50% RB, 3 MHz, QPSK)	X	5.93	67.2	19.9	5.72	142.2	±1.2 %
		Y	5.54	66.3	19.5		115.7	
		Z	5.85	66.9	19.8		132.3	
10299-AAA	LTE-FDD (SC-FDMA, 50% RB, 3 MHz, 16-QAM)	X	6.95	68.3	20.7	6.39	149.5	±1.4 %
		Y	6.47	67.3	20.2		119.7	
		Z	6.86	68.0	20.5		137.0	

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%.

<sup>A</sup> The uncertainties of NormX,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Pages 7 and 8).

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

<sup>E</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

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**DASY/EASY - Parameters of Probe: ES3DV3 - SN:3301****Calibration Parameter Determined in Head Tissue Simulating Media**

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
300	45.3	0.87	7.40	7.40	7.40	0.27	1.18	± 13.4 %
450	43.5	0.87	6.85	6.85	6.85	0.20	2.30	± 13.4 %
750	41.9	0.89	6.39	6.39	6.39	0.29	1.93	± 12.0 %
900	41.5	0.97	6.06	6.06	6.06	0.34	1.77	± 12.0 %
1810	40.0	1.40	5.17	5.17	5.17	0.67	1.27	± 12.0 %
1950	40.0	1.40	5.00	5.00	5.00	0.49	1.54	± 12.0 %
2300	39.5	1.67	4.83	4.83	4.83	0.67	1.33	± 12.0 %
2450	39.2	1.80	4.55	4.55	4.55	0.66	1.43	± 12.0 %
2600	39.0	1.96	4.38	4.38	4.38	0.80	1.32	± 12.0 %
3500	37.9	2.91	4.22	4.22	4.22	1.00	1.18	± 13.1 %
3700	37.7	3.12	3.98	3.98	3.98	1.00	1.12	± 13.1 %

<sup>C</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

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## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3301

### Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
300	58.2	0.92	7.07	7.07	7.07	0.22	1.61	± 13.4 %
450	56.7	0.94	7.11	7.11	7.11	0.09	1.20	± 13.4 %
750	55.5	0.96	6.01	6.01	6.01	0.38	1.77	± 12.0 %
900	55.0	1.05	5.89	5.89	5.89	0.51	1.49	± 12.0 %
1810	53.3	1.52	4.80	4.80	4.80	0.68	1.32	± 12.0 %
1950	53.3	1.52	4.76	4.76	4.76	0.58	1.56	± 12.0 %
2300	52.9	1.81	4.40	4.40	4.40	0.80	1.22	± 12.0 %
2450	52.7	1.95	4.23	4.23	4.23	0.80	1.04	± 12.0 %
2600	52.5	2.16	4.04	4.04	4.04	0.80	1.01	± 12.0 %
3500	51.3	3.31	3.81	3.81	3.81	1.00	1.01	± 13.1 %
3700	51.0	3.55	3.58	3.58	3.58	1.00	1.22	± 13.1 %

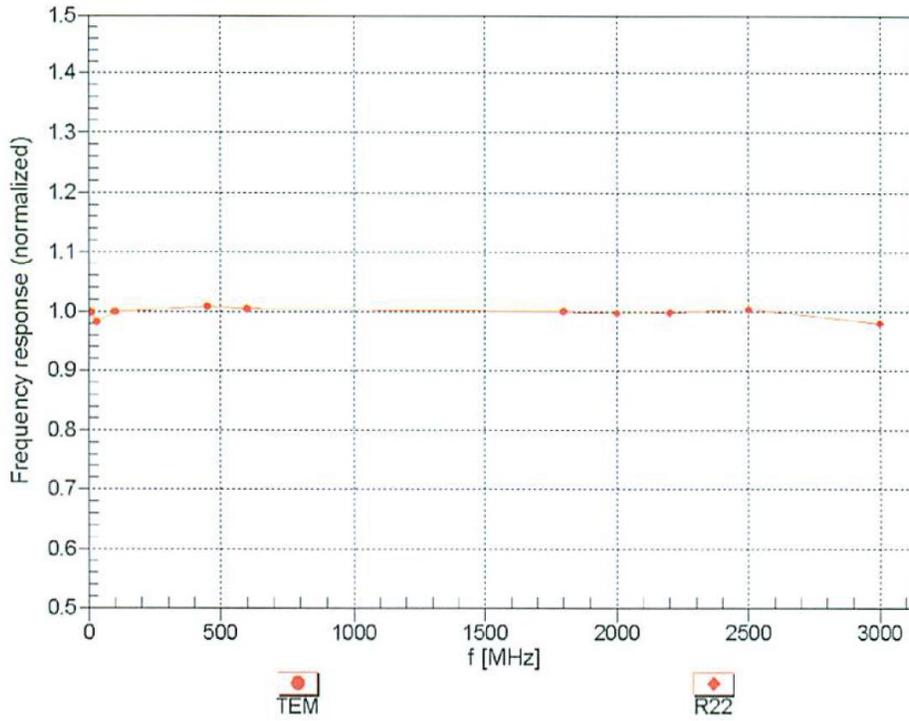
<sup>C</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

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



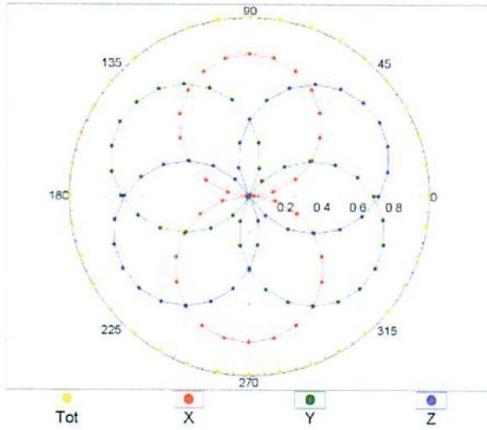
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

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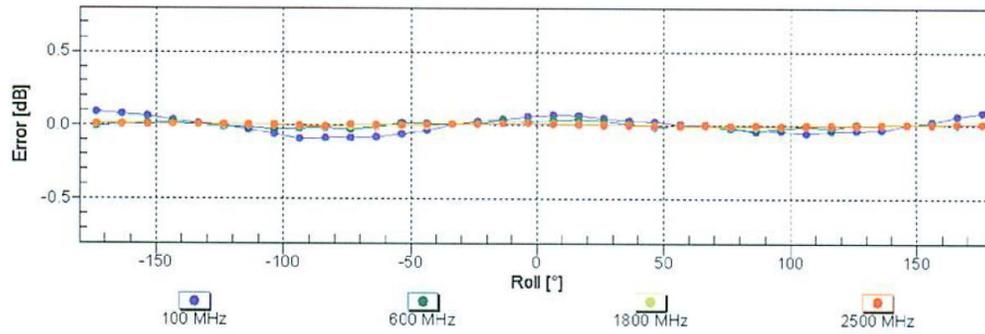
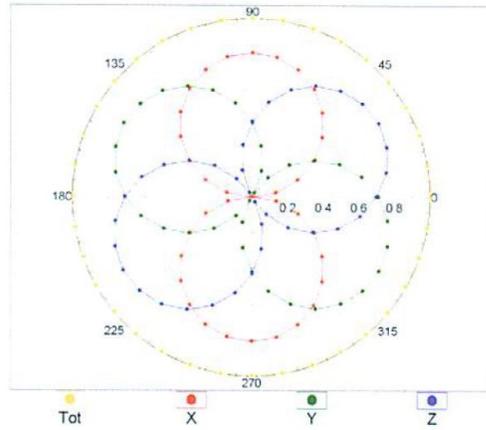
August 27, 2013

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

f=600 MHz,TEM



f=1800 MHz,R22

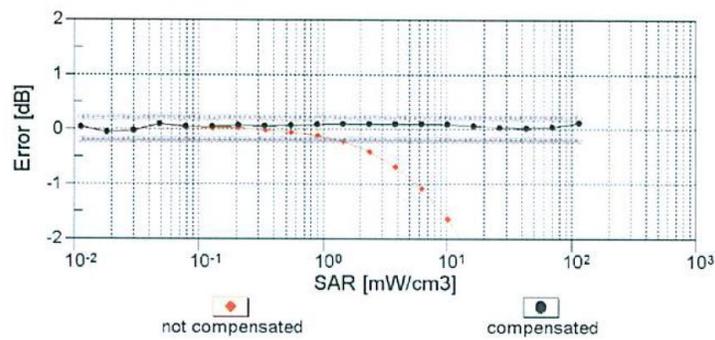
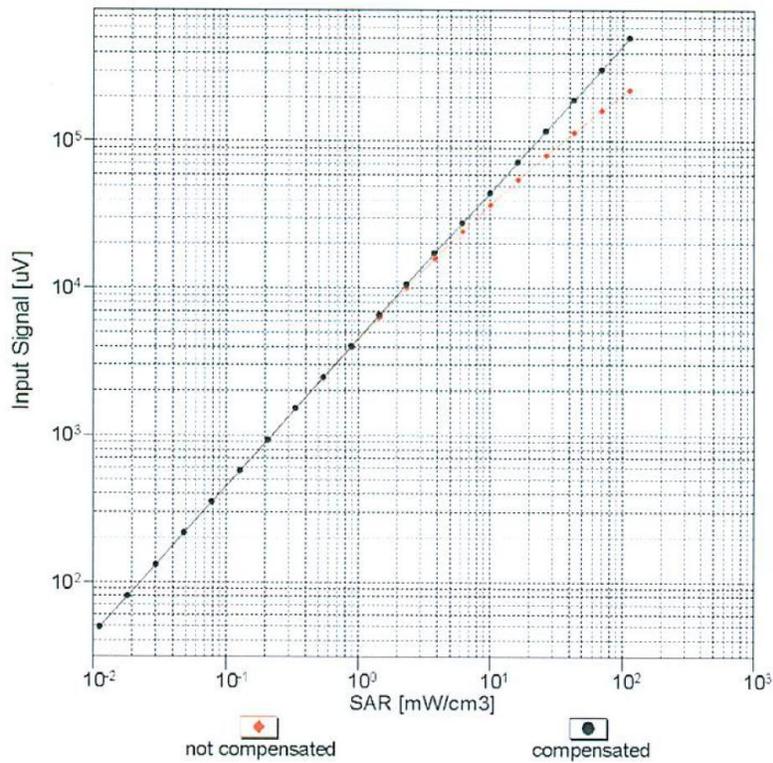


Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)

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### Dynamic Range f(SAR<sub>head</sub>) (TEM cell , f = 900 MHz)

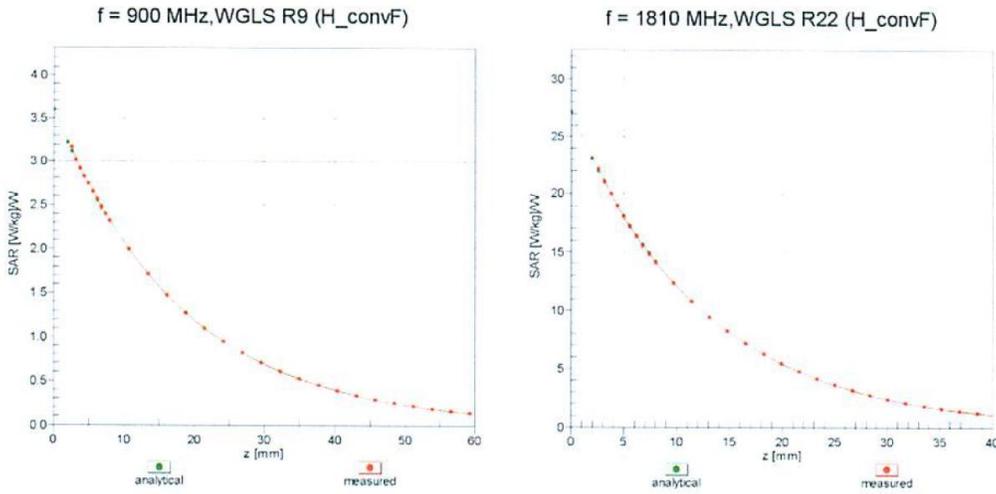


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

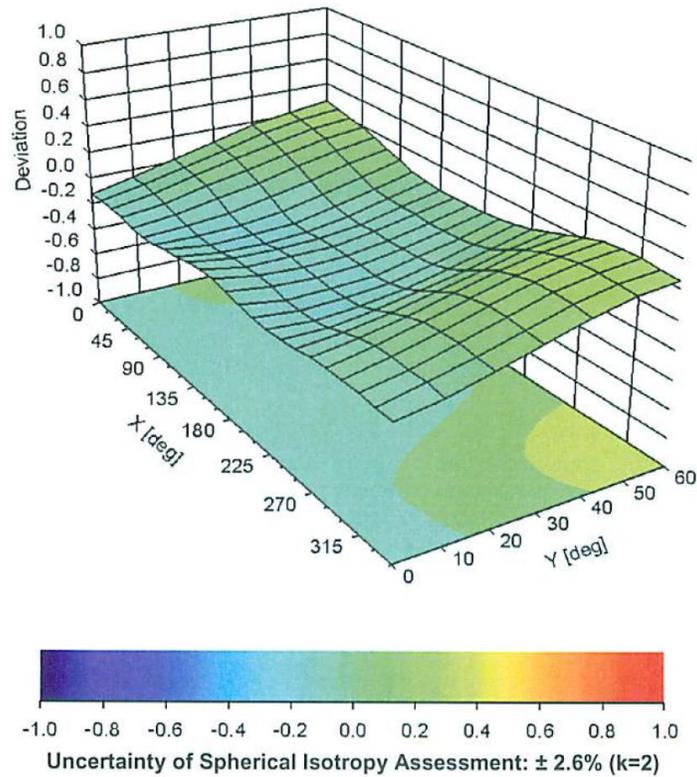
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### Conversion Factor Assessment



### Deviation from Isotropy in Liquid Error ( $\phi, \theta$ ), f = 900 MHz



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## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3301

### Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-73.6
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm

Schmid & Partner Engineering AG

**s p e a g**

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### Additional Conversion Factors for Dosimetric E-Field Probe

Type:	<b>ES3DV3</b>
Serial Number:	<b>3301</b>
Place of Assessment:	<b>Zurich</b>
Date of Assessment:	<b>August 29, 2013</b>
Probe Calibration Date:	<b>August 27, 2013</b>

Schmid & Partner Engineering AG hereby certifies that conversion factor(s) of this probe have been evaluated on the date indicated above. The assessment was performed using the FDTD numerical code SEMCAD of Schmid & Partner Engineering AG. Since the evaluation is coupled with measured conversion factors, it has to be recalculated yearly, i.e., following the re-calibration schedule of the probe. The uncertainty of the numerical assessment is based on the extrapolation from measured value at 450, 900 or at 1810 MHz.

Assessed by:



Schmid & Partner Engineering AG

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**Dosimetric E-Field Probe ES3DV3 SN:3291**

Conversion factor ( $\pm$  standard deviation)

150 $\pm$ 50 MHz	<i>ConvF</i>	8.24 $\pm$ 10%	$\epsilon_r = 52.3 \pm 5\%$ $\sigma = 0.76 \pm 5\%$ mho/m (head tissue)
250 $\pm$ 50 MHz	<i>ConvF</i>	7.67 $\pm$ 10%	$\epsilon_r = 47.6 \pm 5\%$ $\sigma = 0.83 \pm 5\%$ mho/m (head tissue)
150 $\pm$ 50 MHz	<i>ConvF</i>	7.85 $\pm$ 10%	$\epsilon_r = 61.9 \pm 5\%$ $\sigma = 0.80 \pm 5\%$ mho/m (body tissue)
250 $\pm$ 50 MHz	<i>ConvF</i>	7.57 $\pm$ 10%	$\epsilon_r = 59.4 \pm 5\%$ $\sigma = 0.88 \pm 5\%$ mho/m (body tissue)

**Important Note:**

**For numerically assessed probe conversion factors, parameters Alpha and Delta in the DASY software must have the following entries: Alpha = 0 and Delta = 1.**

Please see also DASY Manual.

**APPENDIX B**  
**Dipole Calibration Certificates**

**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  
**S** Swiss Calibration Service

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

Accreditation No.: **SCS 108**

Client **Motorola EME**

Certificate No: **D450V3-1075\_Jul13**

**CALIBRATION CERTIFICATE**

Object **D450V3 - SN: 1075**

Calibration procedure(s) **QA CAL-15.v7  
Calibration procedure for dipole validation kits below 700 MHz**

Calibration date: **July 23, 2013**

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	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe ET3DV6	SN: 1507	28-Dec-12 (No. ET3-1507_Dec12)	Dec-13
DAE4	SN: 654	18-Jul-13 (No. DAE4-654_Jul13)	Jul-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: July 23, 2013

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

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



**S** Schweizerischer Kalibrierdienst  
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Accreditation No.: **SCS 108**

**Glossary:**

TSL                    tissue simulating liquid  
ConvF                sensitivity in TSL / NORM x,y,z  
N/A                    not applicable or not measured

**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
- c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

**Additional Documentation:**

- d) DASY4/5 System Handbook

**Methods Applied and Interpretation of Parameters:**

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- *Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

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

**Measurement Conditions**

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

<b>DASY Version</b>	DASY5	V52.8.7
<b>Extrapolation</b>	Advanced Extrapolation	
<b>Phantom</b>	ELI4 Flat Phantom	Shell thickness: $2 \pm 0.2$ mm
<b>Distance Dipole Center - TSL</b>	15 mm	with Spacer
<b>Zoom Scan Resolution</b>	dx, dy, dz = 5 mm	
<b>Frequency</b>	450 MHz $\pm$ 1 MHz	

**Head TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Head TSL parameters</b>	22.0 °C	43.5	0.87 mho/m
<b>Measured Head TSL parameters</b>	(22.0 $\pm$ 0.2) °C	44.0 $\pm$ 6 %	0.89 mho/m $\pm$ 6 %
<b>Head TSL temperature change during test</b>	< 0.5 °C	----	----

**SAR result with Head TSL**

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Head TSL</b>	Condition	
SAR measured	250 mW input power	1.20 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>4.73 W/kg <math>\pm</math> 18.1 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Head TSL</b>	condition	
SAR measured	250 mW input power	0.794 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>3.13 W/kg <math>\pm</math> 17.6 % (k=2)</b>

**Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
<b>Nominal Body TSL parameters</b>	22.0 °C	56.7	0.94 mho/m
<b>Measured Body TSL parameters</b>	(22.0 $\pm$ 0.2) °C	56.1 $\pm$ 6 %	0.95 mho/m $\pm$ 6 %
<b>Body TSL temperature change during test</b>	< 0.5 °C	----	----

**SAR result with Body TSL**

<b>SAR averaged over 1 cm<sup>3</sup> (1 g) of Body TSL</b>	Condition	
SAR measured	250 mW input power	1.14 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>4.51 W/kg <math>\pm</math> 18.1 % (k=2)</b>

<b>SAR averaged over 10 cm<sup>3</sup> (10 g) of Body TSL</b>	condition	
SAR measured	250 mW input power	0.754 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>2.99 W/kg <math>\pm</math> 17.6 % (k=2)</b>

**Appendix**

**Antenna Parameters with Head TSL**

Impedance, transformed to feed point	57.8 Ω - 2.2 jΩ
Return Loss	- 22.5 dB

**Antenna Parameters with Body TSL**

Impedance, transformed to feed point	56.5 Ω - 4.4 jΩ
Return Loss	- 22.6 dB

**General Antenna Parameters and Design**

Electrical Delay (one direction)	1.202 ns
----------------------------------	----------

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

**Additional EUT Data**

Manufactured by	SPEAG
Manufactured on	June 24, 2010

**DASY5 Validation Report for Head TSL**

Date: 23.07.2013

Test Laboratory: The name of your organization

**DUT: Dipole 450 MHz; Type: D450V3; Serial: D450V3 - SN: 1075**

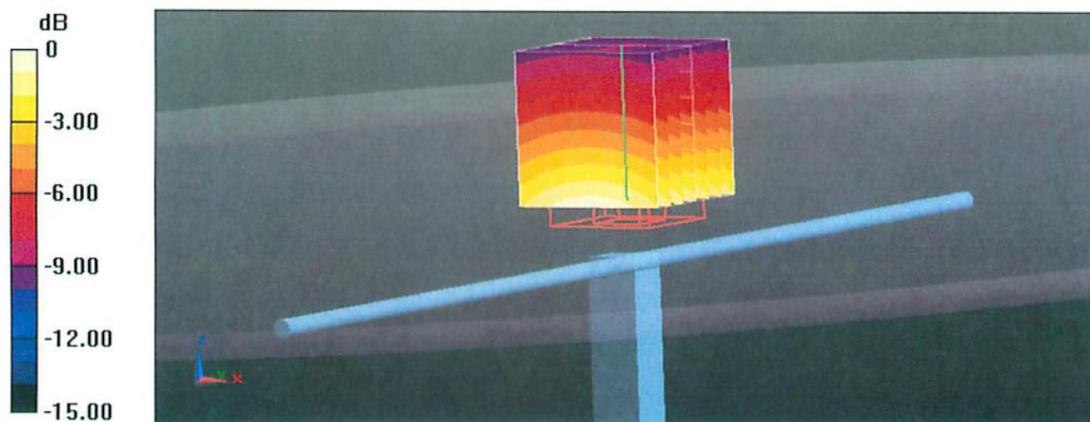
Communication System: UID 0 - CW ; Frequency: 450 MHz  
 Medium parameters used:  $f = 450 \text{ MHz}$ ;  $\sigma = 0.89 \text{ S/m}$ ;  $\epsilon_r = 44$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Flat Section  
 Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

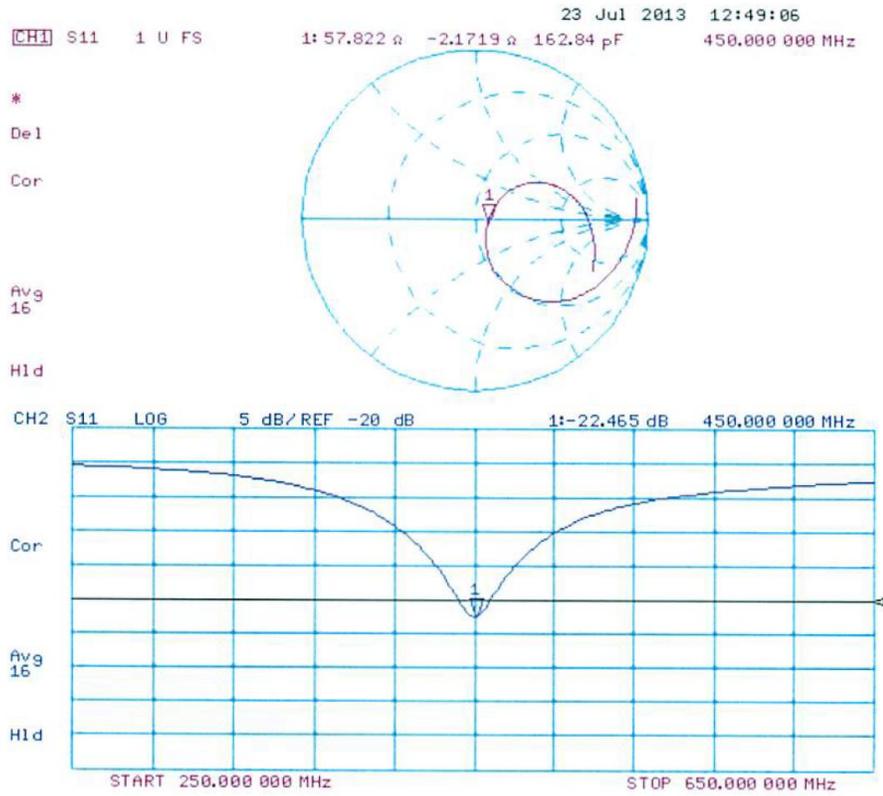
- Probe: ET3DV6 - SN1507; ConvF(6.59, 6.59, 6.59); Calibrated: 28.12.2012;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 18.07.2013
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1003
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

**Dipole Calibration for Head Tissue/d=15mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:**

Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$   
 Reference Value = 39.426 V/m; Power Drift = -0.04 dB  
 Peak SAR (extrapolated) = 1.84 W/kg  
**SAR(1 g) = 1.2 W/kg; SAR(10 g) = 0.794 W/kg**  
 Maximum value of SAR (measured) = 1.28 W/kg



### Impedance Measurement Plot for Head TSL



**DASY5 Validation Report for Body TSL**

Date: 23.07.2013

Test Laboratory: The name of your organization

**DUT: Dipole 450 MHz; Type: D450V3; Serial: D450V3 - SN: 1075**

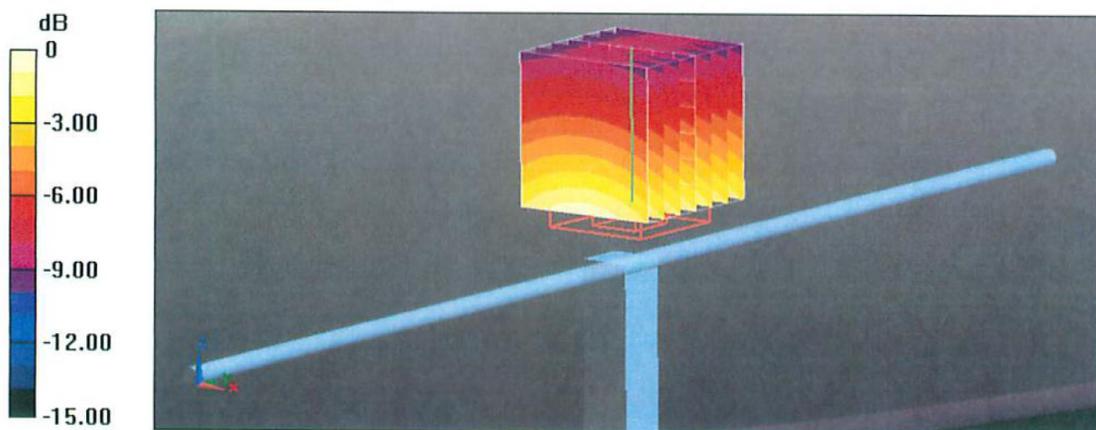
Communication System: UID 0 - CW ; Frequency: 450 MHz  
 Medium parameters used:  $f = 450 \text{ MHz}$ ;  $\sigma = 0.95 \text{ S/m}$ ;  $\epsilon_r = 56.1$ ;  $\rho = 1000 \text{ kg/m}^3$   
 Phantom section: Flat Section  
 Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(7.03, 7.03, 7.03); Calibrated: 28.12.2012;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 18.07.2013
- Phantom: ELI 4.0; Type: QDOVA001BA; Serial: 1003
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

**Dipole Calibration for Body Tissue/d=15mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:**

Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$   
 Reference Value = 39.426 V/m; Power Drift = -0.04 dB  
 Peak SAR (extrapolated) = 1.78 W/kg  
**SAR(1 g) = 1.14 W/kg; SAR(10 g) = 0.754 W/kg**  
 Maximum value of SAR (measured) = 1.22 W/kg



0 dB = 1.22 W/kg = 0.86 dBW/kg

### Impedance Measurement Plot for Body TSL

