



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


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<p><b>Responsible Engineer:</b>  <b>Report Author:</b>  <b>Date/s Tested:</b>  <b>Manufacturer:</b>  <b>DUT Description:</b>    <b>Test TX mode(s):</b>  <b>Max. Power output:</b>    <b>Nominal Power:</b>    <b>Tx Frequency Bands:</b>  <b>Signaling type:</b>  <b>Model(s) Tested:</b>  <b>Model(s) Certified:</b>    <b>Serial Number(s):</b>  <b>Classification:</b>  <b>FCC ID:</b>    <b>IC:</b>    <b>ISED Test Site registration:</b>  <b>FCC Test Firm Registration Number:</b></p>	<p>Kin Kting Lee (EME Engineer)                  Puteri Alifah Ilyana Binti Nor Rahim (EME Engineer)                  12/26/2019, 4/1/2020-4/2/2020                  Motorola Solutions Inc.                  Handheld Portable – APX 900 Two Knob UHF R1 Model 2 Portable                  APX 900 Two Knob UHF R1 Model 3 Portable                    CW (PTT), Bluetooth, and WLAN 802.11b/g/n                  5.70 W (380-480MHz), 10 mW (Bluetooth), 10 mW (Bluetooth LE), 22.4 mW (802.11b), 8.3 mW (802.11g), 12.6 mW (802.11n)                  5.00 W (380-480MHz), 8.9 mW (Bluetooth), 8.9 mW (Bluetooth LE), 16.6 mW (802.11b), 6.6 mW (802.11g), 10 mW (802.11n)                  LMR 380-480 MHz; Bluetooth 2402-2480 MHz; WLAN 2412-2462 MHz                  FM (LMR), FHSS (Bluetooth), 802.11b/g/n (WLAN)                  H92QDH9PW7AN (PMUE5244A), H92QDF9PW6AN (PMUE5243A)                  H92QDH9PW7AN (PMUE5244A), H92QDF9PW6AN (PMUE5243A),                  H93QDH9PW7AN                  837TTF0543, 837TTF0487                  Occupational/Controlled                  AZ489FT7097; LMR 406.125-480 MHz, Bluetooth 2.402-2.480 GHz,                  WLAN 802.11 b/g/n 2.412-2.462 GHz                  109U-89FT7097                    24843                  823256</p>
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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 FCC 47 CFR § 2.1093 and RSS-102 (Issue 5).

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 4.0 of this report (no deviation from standard methods). 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.

 <b>Tiong Nguk Ing</b> Deputy Technical Manager (Approved Signatory) Approval Date: 4/6/2020	
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**Report Revision History**

Date	Revision	Comments
4/2/2020	A	Release of PCII results
4/6/2020	B	Update model number

## 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 H92QDH9PW7AN (PMUE5244A) and H92QDF9PW6AN (PMUE5243A). These devices are classified as Occupational/Controlled. The information herein is to show evidence of Class II Permissive Change compliance based on the SAR evaluation of new battery introduce to this device (refer to Table 5).

## 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	1g-SAR
TNF	406.125-480 MHz	† 6.18	† 5.25
*DSS	2402-2480 MHz (Bluetooth)	NA	NA
DTS	2412-2462 MHz (WLAN 802.11 b/g/n)	0.0063	0.0272
Simultaneous Results		† 6.19	† 5.28

**Notes:**

- \* Results not required per KDB 447498 (refer to original filing)
- † indicates the new reported SAR value at the face is 5.25 W/kg, at the body is 6.18 W/kg and simultaneous transmission at face is 5.28 W/kg, at the body is 6.19 W/kg (Previous filed reported SAR value for face is 4.52 W/kg, at the body is 4.84 W/kg and simultaneous transmission at the face is 4.55 W/kg, at the body is 4.85 W/kg).

## 3.0 Abbreviations / Definitions

CNR: Calibration Not Required  
 CW: Continuous Wave  
 DUT: Device Under Test  
 EME: Electromagnetic Energy  
 FM: Frequency Modulation  
 LMR: Land Mobile Radio  
 NA: Not Applicable  
 PTT: Push to Talk

RF: Radio Frequency

SAR: Specific Absorption Rate

DSP: Digital Signal Processor

RSM: Remote Speaker Microphone

TNF: Licensed Non-Broadcast Transmitter Held to Face

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 (2016) 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)
- Federal Communications Commission, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio frequency Electromagnetic Fields", OET Bulletin 65, FCC, Washington, D.C.: 1997.
- IEEE 1528 (2013), 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 (2015), Limits of Human Exposure to Radio frequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz
- RSS-102 (Issue 5) – Radio Frequency (RF) Exposure Compliance of Radio communication Apparatus (All Frequency Bands)
- Australian Communications Authority Radio communications (Electromagnetic Radiation - Human Exposure) Standard (2014)
- 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).

- FCC KDB – 643646 D01 SAR Test for PTT Radios v01r03
- FCC KDB – 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04
- FCC KDB – 865664 D02 RF Exposure Reporting v01r02
- FCC KDB – 447498 D01 General RF Exposure Guidance v06

## 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)

These portable devices operate in the LMR bands using frequency modulation (FM) and TDMA signals incorporating traditional simplex two-way radio transmission protocol. These devices also contain WLAN technology for data capabilities over 802.11 b/g/n wireless networks and Bluetooth technology for short range wireless devices.

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 15 milliseconds with frame length of 60 milliseconds. 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%.

The LMR bands in these devices operate in a half duplex system. A half duplex system only allows the user to transmit or receive. These devices 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.

These devices also incorporate Class 1 Bluetooth Low energy (LE) device which is a

Frequency Hopping Spread Spectrum (FHSS) technology and LE intended to reduce power consumption. The Bluetooth radio modem is used to wireless link audio accessories. The maximum actual transmission duty cycle is imposing by Bluetooth standard. Packet types varying duty cycles: 1-slot, 3-slots and 5-slots packets. A 5-slot packet type receives on 1-slot and transmits on 5-slots, and thus maximum duty cycle = 76.1%.

WLAN 802.11 b/g/n operate using Direct Sequence Spread Spectrum (DSSS) and Orthogonal Frequency-Division Multiplexing (OFDM) accordance with the IEEE 802.11 b/g/n. With WiFi access, the radio can receive new code plug, firmware and software feature while allow users keep talking without interruption.

Table 3 below summarizes the technologies, bands, maximum duty cycles and maximum output powers. Maximum output powers are defined as upper limit of the production line final test station.

**Table 3**

Radio Type	Band (MHz)	Transmission	Duty Cycle (%)	Max Power (W)
LMR	380-480	FM	*50	5.70
BT	2402-2480	FHSS	77	0.010
BT LE	2402-2480	DSSS	76.1	0.010
WLAN	2412-2462	802.11b	100	0.0224
WLAN	2412-2462	802.11g	100	0.0083
WLAN	2412-2462	802.11n	100	0.0126

Note - \* includes 50% PTT operation

The intended operating positions are “at the face” with the DUT at least 2.5 cm 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. Operation at the body without an audio accessory attached is possible by means of BT accessories.

**7.0 Optional Accessories and Test Criteria**

These devices are offered with optional accessories. All accessories were individually evaluated during the test plan creation to determine if testing was required per the guidelines outlined in section 4.0 to assess compliance of these devices. The following sections identify the test criteria and details for each accessory category applicable for this PCII filing only. Detail listing of all approved offered accessories available in the original filing report.

**7.1 Antennas**

There is only one antenna applicable for this PCII filing. The Table below lists its descriptions.

**Table 4**

Antenna No.	Antenna Models	Description	Selected for test	Tested
1	PMAE4100A	UHF Stubby Antenna, 380-470 MHz, ¼ wave, 0 dBi gain	Yes	Yes





## 7.2 Battery

There is only one battery applicable for this PCII filing. The Table below lists its descriptions.

**Table 5**

Battery No.	Battery Models	Description	Selected for test	Tested	Comments
1	PMNN4491C	Battery IMPRES Li-ION 2100mAh Typical	Yes	Yes	

## 7.3 Body worn Accessory

There is only one body worn applicable for this PCII filing. The Table below lists its descriptions.

**Table 6**

Body worn No.	Body worn Models	Description	Selected for test	Tested	Comments
1	PMLN4651A	2 Inch Spring Action Belt Clip	Yes	Yes	

## 7.4 Audio Accessory

There is no audio accessory is applicable for this PCII filing.

## 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	52.10.2.1495	DAE4	EX3DV4 (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 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(s) Used	Material Parameters	Phantom Dimensions LxWxD (mm)	Material Thickness (mm)	Support Structure Material	Loss Tangent (wood)
Triple Flat	NA	200MHz -6GHz; Er = 3-5, Loss Tangent = $\leq 0.05$	280x175x175	2mm +/- 0.2mm	Wood	< 0.05
SAM	NA	300MHz -6GHz; Er = < 5, Loss Tangent = $\leq 0.05$	Human Model			
Oval Flat	√	300MHz -6GHz; Er = 4+/- 1, Loss Tangent = $\leq 0.05$	600x400x190			

## 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.

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	56.00	46.50
Diacetin	0	0
De ionized – Water	39.10	50.53
Salt	3.80	1.87
HEC	1.00	1.00
Bact.	0.10	0.10

### 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	EX3DV4	7533	11/6/2019	11/6/2020
Speag DAE	DAE4	1488	7/23/2019	7/23/2020
Bi-directional Coupler	3020A	41931	7/11/2019	7/11/2020
Power Amplifier	50W 1000C	312859	CNR	CNR
Power Meter	E4416A	MY50001037	8/30/2019	8/30/2021
Power Meter	E4418B	MY45107917	7/1/2019	7/1/2021
Power Sensor	E9301B	MY50290001	5/6/2019	5/6/2020
Power Sensor	E9301B	MY41495733	4/19/2019	4/19/2020
Vector Signal Generator	E4438C	MY47272101	10/29/2019	10/29/2021
Data Logger	DSB	16326820	11/20/2019	11/20/2020
Digital Thermometer	1523	3492108	5/3/2019	5/3/2020
Temperature Probe	PR-10-3-100-1/4-6-E	WNWR020579	7/6/2019	7/6/2020
Power Meter	E4419B	MY40330364	9/21/2018	9/21/2020
Power Sensor	E9301B	MY50290001	5/6/2019	5/6/2020
Dielectric Assessment Kit*	DAK-3.5	1156	1/8/2019	1/8/2020
Dielectric Assessment Kit	DAK-3.5	1120	7/11/2019	7/11/2020
Network Analyzer	E5071B	MY42403218	9/13/2019	9/13/2020
Speag Dipole	D450V3	1053	10/19/2018	10/19/2020

Note: \* Indicated equipment used for SAR assessment before calibration due date

### 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		
				$\sigma$	$\epsilon_r$	Sensitivity	Linearity	Isotropy
CW								
11/22/2019	Body	450	7533	0.95	54.4	Pass	Pass	Pass
11/22/2019	Head	450		0.86	42.8	Pass	Pass	Pass

## 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
7533	FCC Body	SPEAG D450V3 / 1053	4.53 +/- 10%	1.16	4.64	4/2/2020
	IEEE/ IEC Head	SPEAG D450V3 / 1053	4.57 +/- 10%	1.24	4.96	12/26/2019
				1.21	4.84	4/1/2020

## 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)	57.10 (54.30-60.00)	0.95	54.6	4/2/2020
	IEEE/ IEC Head	0.87 (0.83-0.91)	44.00 (41.80-46.20)	0.83	45.3	12/26/2019
425	FCC Body	0.94 (0.89-0.98)	57.00 (54.10-59.80)	0.96	54.3	4/2/2020
	IEEE/ IEC Head	0.87 (0.83-0.91)	43.80 (41.60-46.00)	0.84	42.2	4/1/2020
450	FCC Body	0.94 (0.89-0.99)	56.70 (53.90-59.50)	0.87	54.0	4/2/2020
	IEEE/ IEC Head	0.87 (0.83-0.91)	43.50 (41.30-45.70)		44.3	12/26/2019
				0.86	41.7	4/1/2020
462	FCC Body	0.94 (0.89-0.99)	56.70 (53.80-59.50)	0.99	53.8	4/2/2020
	IEEE/ IEC Head	0.87 (0.83-0.91)	43.40 (41.30-45.60)	0.86	41.5	4/1/2020

## 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  $\pm 2^{\circ}\text{C}$  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**

	Target	Measured
Ambient Temperature	18 – 25 °C	Range: 21.20-24.10°C Avg. 22.70°C
Tissue Temperature	18 – 25 °C	Range: 20.50 – 20.90°C Avg. 20.70°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. Oval 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**

Description		≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface		$5 \pm 1$ 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		$30^\circ \pm 1^\circ$	$20^\circ \pm 1^\circ$
Maximum area scan spatial resolution: $\Delta x_{Area}$ , $\Delta y_{Area}$		≤ 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.	
Maximum zoom scan spatial resolution: $\Delta x_{Zoom}$ , $\Delta y_{Zoom}$		≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$	≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
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 ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 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.			

## 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.

## 12.3 DUT Positioning Procedures

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

### 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” in the data Tables is determined by scaling the measured SAR to account for power leveling variations and drift. Appendix F includes a shortened scan to justify SAR scaling for drift. For this device the “Max Calc. 1g-SAR” are scaled using the following formula:

$$\text{Max\_Calc} = \text{SAR\_meas} \cdot 10^{\frac{-\text{Drift}}{10}} \cdot \frac{P_{\text{max}}}{P_{\text{int}}} \cdot \text{DC}$$

$P_{\text{max}}$  = Maximum Power (W)

$P_{\text{int}}$  = Initial Power (W)

Drift = DASY drift results (dB)

$\text{SAR\_meas}$  = 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  $P_{\text{int}} > P_{\text{max}}$ , then  $P_{\text{max}}/P_{\text{int}} = 1$ .

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 DUT was assessed at the body and face using the highest applicable configuration found during initial compliance assessment on filed with the FCC. LMR tests were performed in CW and 50% duty cycle was applied to PTT configurations in the final results.



### 13.0 DUT Test Data

#### 13.1 Assessment at the Body and Face

The new Battery PMNN4491C was assessed using the accessories indicated in section 7.0 which represent the highest applicable configurations at the body and face found during the initial compliance assessment on filed with the FCC. SAR plots of the results are presented in Appendix E.

**Table 16**

Antenna	Battery	Carry Accessory	Cable Accessory	Test Freq (MHz)	Init Pwr (W)	SAR Drift (dB)	Meas. 1g-SAR (W/kg)	Max Calc. 1g-SAR (W/kg)	Run#
Body									
PMAE4100A	PMNN4491C	PMLN4651A	None	406.1250	5.60	-0.63	10.50	<b>6.18</b>	ZZ-AB-200402-02
Face									
PMAE4100A	PMNN4491C	None	None	406.1250	5.61	-0.59	9.02	<b>5.25</b>	AM-FACE-191226-09

#### 13.2 Assessment for ISED, Canada

As per ISED Notice 2016-DRS001, additional tests were required for the low, mid and high frequency channels for the configuration with the highest SAR value. The SAR results are in Tables below. SAR plot of the highest results per Tables (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)	Max Calc. 1g-SAR (W/kg)	Run#
Body									
PMAE4100A	PMNN4491C	PMLN4651A	None	406.1250	5.60	-0.63	10.50	<b>6.18</b>	ZZ-AB-200402-02
PMAE4100A	PMNN4491C	PMLN4651A	None	424.6000	5.66	-0.57	7.15	4.11	ZZ-AB-200402-03
PMAE4100A	PMNN4491C	PMLN4651A	None	461.5000	5.32	-0.57	4.12	2.52	ZZ-AB-200402-05
Face									
PMAE4100A	PMNN4491C	None	None	406.1250	5.61	-0.59	9.02	<b>5.25</b>	AM-FACE-191226-09
PMAE4100A	PMNN4491C	None	None	424.6000	5.59	-0.51	6.22	3.57	ZZ-FACE-200401-21
PMAE4100A	PMNN4491C	None	None	461.5000	5.66	-0.46	2.75	1.54	ZZ-FACE-200401-23

### 13.3 Shortened Scan Assessment

A “shortened” scan using the highest FCC SAR configuration from above was performed to validate the SAR drift of the full DASY5™ coarse and zoom scans. Note that the shortened scan represents the zoom scan performance result; this is obtained by first running a coarse scan to find the peak area and then, using a newly charged battery, a zoom scan only was performed. The results of the shortened cube scan presented in Appendix F demonstrate that the scaling methodology used to determine the calculated SAR results presented herein are valid. The SAR result from the Table below is provided in Appendix F.

**Table 18**

Antenna	Battery	Carry Accessory	Cable Accessory	Test Freq (MHz)	Init Pwr (W)	SAR Drift (dB)	Meas. 1g-SAR (W/kg)	Max Calc. 1g-SAR (W/kg)	Run#
PMAE4100A	PMNN4491C	PMLN4651A	None	406.1250	5.68	-022	11.00	<b>5.81</b>	ZZ-AB-200402-06

### 14.0 Simultaneous Transmission between LMR, WLAN and BT

These devices use a single transmitter module and antenna for both WLAN and BT. WLAN and BT cannot transmit simultaneously. Simultaneous transmission for BT had been excluded as derived in initial filing. WLAN 802.11b measured SAR is used in conjunction with LMR for simultaneous results.

### 16.0 Results Summary

Based on the test guidelines from section 4.0 and satisfying frequencies within FCC and ISED Canada frequencies bands, the highest Operational Maximum Calculated 1-gram average SAR values found for this filing:

**Table 19**

Designator	Frequency band (MHz)	Max Calc at Body (W/kg)	Max Calc at Face (W/kg)
		1g-SAR	1g-SAR
<b>FCC US</b>			
LMR	406.125-480	† 6.18	† 5.25
WLAN	2412-2462	0.0063	0.0272
<b>ISED Canada</b>			
LMR	406.125-430 / 450- 470	† 6.18	† 5.25
WLAN	2412-2462	0.0063	0.0272

All results are scaled to the maximum output power.

**Note:**

† indicates the new reported FCC US / ISED Canada SAR value at the face is 5.25 W/kg and at the body is 6.18 W/kg (Previous filed SAR value for face is 4.52 W/kg and at the body is 4.84 W/kg)

The highest combined 1g-SAR results for simultaneous is indicated in the following Table:

**Table 20**

Designator	Frequency band (MHz)	Max Calc at Body (W/kg)	Max Calc at Face (W/kg)
		1g-SAR	1g-SAR
FCC US	LMR and WLAN band	† 6.19	† 5.28
ISED Canada	LMR and WLAN band	† 6.19	† 5.28

**Note:**

† indicates the new reported SAR value for simultaneous transmission at face is 5.28 W/kg and at the body is 6.19 W/kg (Previous filed reported SAR value for simultaneous transmission at the face is 4.55 W/kg and at the body is 4.85 W/kg).

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 FCC 47 CFR § 2.1093 and RSS-102 (Issue 5).

### 17.0 Variability Assessment

Per the guidelines in KDB 865664 SAR variability assessment is required because SAR results are above 4.0 W/kg (Occupational).

The Table below includes test results of the original measurement(s), the repeated measurement(s), and the ratio ( $SAR_{high}/SAR_{low}$ ) for the applicable test configuration(s).

**Table 21**

Run#	Antenna	Battery	Carry Accessory	Cable Accessory	Test Freq. (MHz)	Adj Calc. 1g-SAR (W/kg)	Ratio	Comments
ZZ-AB-200402-02	PMAE4100A	PMNN4491C	PMLN4651A	None	406.1250	6.07	1.05	No additional repeated scans is required due to the Ratio ( $SAR_{high}/SAR_{low}$ ) < 1.20
ZZ-AB-200402-06						5.79		

### 18.0 System Uncertainty

A system uncertainty analysis is not required for this report per KDB 865664 because the highest report SAR value 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 450 MHz

<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	$e = f(d,k)$	<i>f</i>	<i>g</i>	$h = c \times f / e$	$i = c \times g / e$	<i>k</i>
Uncertainty Component	IEEE 1528 section	Tol. ( $\pm$ %)	Prob Dist	Div.	$c_i$ (1 g)	$c_i$ (10 g)	1 g $u_i$ ( $\pm$ %)	10 g $u_i$ ( $\pm$ %)	$v_i$
<b>Measurement System</b>									
Probe Calibration	E.2.1	6.7	N	1.00	1	1	6.7	6.7	$\infty$
Axial Isotropy	E.2.2	4.7	R	1.73	0.707	0.707	1.9	1.9	$\infty$
Hemispherical Isotropy	E.2.2	9.6	R	1.73	0.707	0.707	3.9	3.9	$\infty$
Boundary Effect	E.2.3	1.0	R	1.73	1	1	0.6	0.6	$\infty$
Linearity	E.2.4	4.7	R	1.73	1	1	2.7	2.7	$\infty$
System Detection Limits	E.2.5	1.0	R	1.73	1	1	0.6	0.6	$\infty$
Readout Electronics	E.2.6	0.3	N	1.00	1	1	0.3	0.3	$\infty$
Response Time	E.2.7	1.1	R	1.73	1	1	0.6	0.6	$\infty$
Integration Time	E.2.8	1.1	R	1.73	1	1	0.6	0.6	$\infty$
RF Ambient Conditions - Noise	E.6.1	3.0	R	1.73	1	1	1.7	1.7	$\infty$
RF Ambient Conditions - Reflections	E.6.1	0.0	R	1.73	1	1	0.0	0.0	$\infty$
Probe Positioner Mech. Tolerance	E.6.2	0.4	R	1.73	1	1	0.2	0.2	$\infty$
Probe Positioning w.r.t Phantom	E.6.3	1.4	R	1.73	1	1	0.8	0.8	$\infty$
Max. SAR Evaluation (ext., int., avg.)	E.5	3.4	R	1.73	1	1	2.0	2.0	$\infty$
<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	$\infty$
<b>Phantom and Tissue Parameters</b>									
Phantom Uncertainty	E.3.1	4.0	R	1.73	1	1	2.3	2.3	$\infty$
Liquid Conductivity (target)	E.3.2	5.0	R	1.73	0.64	0.43	1.8	1.2	$\infty$
Liquid Conductivity (measurement)	E.3.3	3.3	N	1.00	0.64	0.43	2.1	1.4	$\infty$
Liquid Permittivity (target)	E.3.2	5.0	R	1.73	0.6	0.49	1.7	1.4	$\infty$
Liquid Permittivity (measurement)	E.3.3	1.9	N	1.00	0.6	0.49	1.1	0.9	$\infty$
<b>Combined Standard Uncertainty</b>			RSS				12	11	482
<b>Expanded Uncertainty</b> (95% CONFIDENCE LEVEL)			$k=2$				23	23	

Notes for uncertainty budget Tables:

- Column headings a-k are given for reference.
- Tol. - tolerance in influence quantity.
- Prob. Dist. – Probability distribution
- N, R - normal, rectangular probability distributions
- Div. - divisor used to translate tolerance into normally distributed standard uncertainty
- $c_i$  - sensitivity coefficient that should be applied to convert the variability of the uncertainty component into a variability of SAR.
- $u_i$  – SAR uncertainty
- $v_i$  - degrees of freedom for standard uncertainty and effective degrees of freedom for the expanded uncertainty

### Uncertainty Budget for System Validation(Dipole & flat phantom) for 450 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	1	1	2.7	2.7	∞
Spherical Isotropy	E.2.2	9.6	R	1.73	0	0	0.0	0.0	∞
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	0.0	R	1.73	1	1	0.0	0.0	∞
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 Mechanical 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>Dipole</b>									
Dipole Axis to Liquid Distance	8, E.4.2	2.0	R	1.73	1	1	1.2	1.2	∞
Input Power and SAR Drift Measurement	8, 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	R	1.73	0.64	0.43	1.2	0.8	∞
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	R	1.73	0.6	0.49	0.6	0.5	∞
<b>Combined Standard Uncertainty</b>			RSS				10	9	99999
<b>Expanded Uncertainty</b> (95% CONFIDENCE LEVEL)			<i>k</i> =2				19	18	

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  
**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 0108**

Client **Motorola Solutions MY**

Certificate No: **EX3-7533\_Nov19**

**CALIBRATION CERTIFICATE**

Object: **EX3DV4 - SN:7533**

Calibration procedure(s): **QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v5, QA CAL-23.v5, QA CAL-25.v7**  
**Calibration procedure for dosimetric E-field probes**

Calibration date: **November 6, 2019**

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 NRP	SN: 104778	03-Apr-19 (No. 217-02892/02893)	Apr-20
Power sensor NRP-Z91	SN: 103244	03-Apr-19 (No. 217-02892)	Apr-20
Power sensor NRP-Z91	SN: 103245	03-Apr-19 (No. 217-02893)	Apr-20
Reference 20 dB Attenuator	SN: 55277 (20x)	04-Apr-19 (No. 217-02894)	Apr-20
DAE4	SN: 660	07-Oct-19 (No. DAE4-660_Oct19)	Oct-20
Reference Probe ES3DV2	SN: 3013	31-Dec-18 (No. ES3-3013_Dec18)	Dec-19
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
RF generator HP 8548C	SN: US3642U01700	04-Aug-99 (in house check Jun-18)	In house check: Jun-20
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-19)	In house check: Oct-20

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

Issued: November 8, 2019

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  
Swiss Calibration Service

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

Accreditation No.: **SCS 0108**

**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
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

**Calibration is Performed According to the Following Standards:**

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- c) IEC 62209-2, "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)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

**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.
- **Connector Angle**: The angle is assessed using the information gained by determining the NORM<sub>x</sub> (no uncertainty required).

EX3DV4 – SN:7533

November 6, 2019

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:7533

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>A</sup>	0.42	0.47	0.41	± 10.1 %
DGP (mV) <sup>B</sup>	96.5	99.1	103.6	

### Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Max dev.	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	145.2	±3.8 %	±4.7 %
		Y	0.0	0.0	1.0		159.8		
		Z	0.0	0.0	1.0		148.5		

Note: For details on UID parameters see Appendix

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 Norm X,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Pages 5 and 6).

<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: EX3DV4 - SN:7533

**Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	88.9
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	1.4 mm

EX3DV4- SN:7533

November 6, 2019

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:7533

### 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 <sup>g</sup>	Depth (mm) <sup>h</sup>	Unc (k=2)
150	52.3	0.76	13.81	13.81	13.81	0.00	1.00	± 13.3 %
300	45.3	0.87	12.94	12.94	12.94	0.08	1.20	± 13.3 %
450	43.5	0.87	11.84	11.84	11.84	0.12	1.30	± 13.3 %
750	41.9	0.89	10.71	10.71	10.71	0.38	0.93	± 12.0 %
835	41.5	0.90	10.47	10.47	10.47	0.46	0.86	± 12.0 %
900	41.5	0.97	10.25	10.25	10.25	0.31	1.01	± 12.0 %
2450	39.2	1.80	7.67	7.67	7.67	0.32	0.92	± 12.0 %
5250	35.9	4.71	5.35	5.35	5.35	0.40	1.80	± 13.1 %
5500	35.6	4.96	4.89	4.89	4.89	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.74	4.74	4.74	0.40	1.80	± 13.1 %
5750	35.4	5.22	4.90	4.90	4.90	0.40	1.80	± 13.1 %

<sup>c</sup> Frequency validity above 300 MHz 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. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.

<sup>f</sup> At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) 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 (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>g</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

EX3DV4- SN:7533

November 6, 2019

## DASY/EASY - Parameters of Probe: EX3DV4 - SN:7533

### 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 <sup>g</sup>	Depth (mm) <sup>g</sup>	Unc (k=2)
150	61.9	0.80	13.50	13.50	13.50	0.00	1.00	± 13.3 %
300	58.2	0.92	12.69	12.69	12.69	0.03	1.20	± 13.3 %
450	56.7	0.94	12.06	12.06	12.06	0.06	1.30	± 13.3 %
750	55.5	0.96	10.58	10.58	10.58	0.44	0.86	± 12.0 %
835	55.2	0.97	10.23	10.23	10.23	0.45	0.80	± 12.0 %
900	55.0	1.05	9.95	9.95	9.95	0.50	0.80	± 12.0 %
2450	52.7	1.95	7.79	7.79	7.79	0.35	0.92	± 12.0 %
5250	48.9	5.36	4.80	4.80	4.80	0.50	1.90	± 13.1 %
5500	48.6	5.65	4.22	4.22	4.22	0.50	1.90	± 13.1 %
5600	48.5	5.77	4.10	4.10	4.10	0.50	1.90	± 13.1 %
5750	48.3	5.94	4.23	4.23	4.23	0.50	1.90	± 13.1 %

<sup>c</sup> Frequency validity above 300 MHz 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. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.

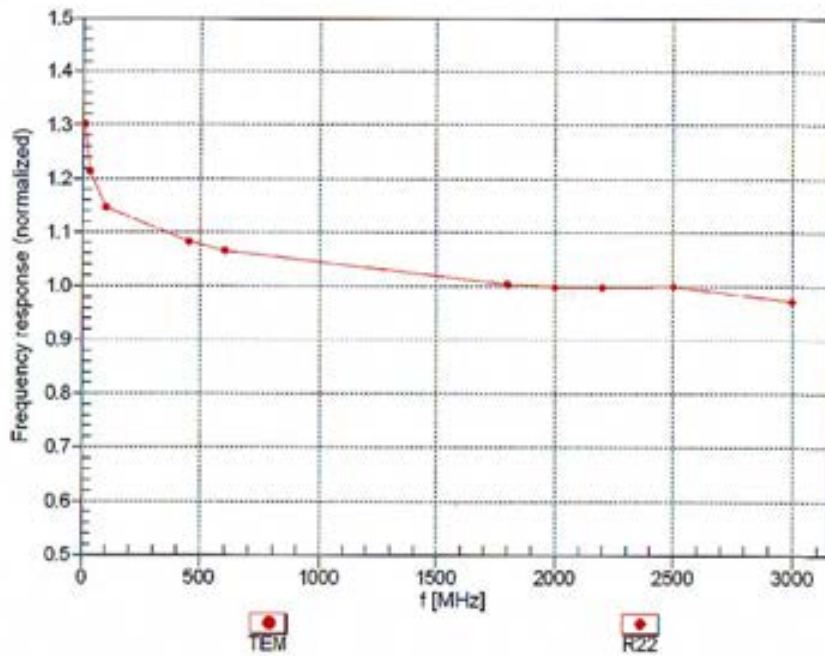
<sup>f</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\epsilon$  and  $\sigma$ ) is restricted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

<sup>g</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

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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)

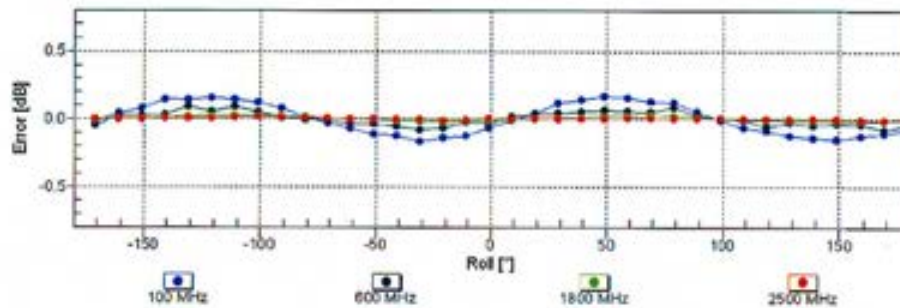
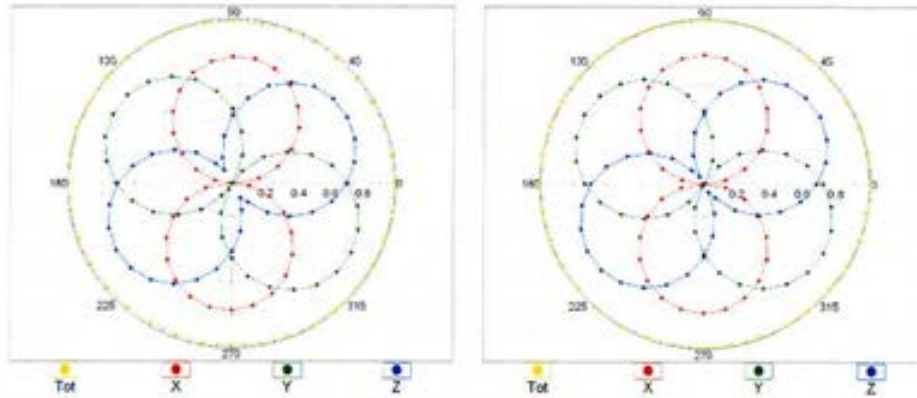
EX3DV4- SN:7533

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

f=600 MHz,TEM

f=1800 MHz,R22



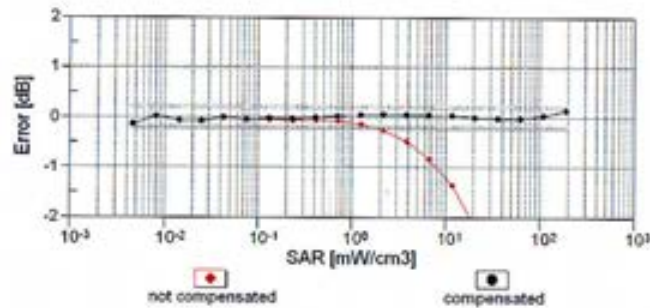
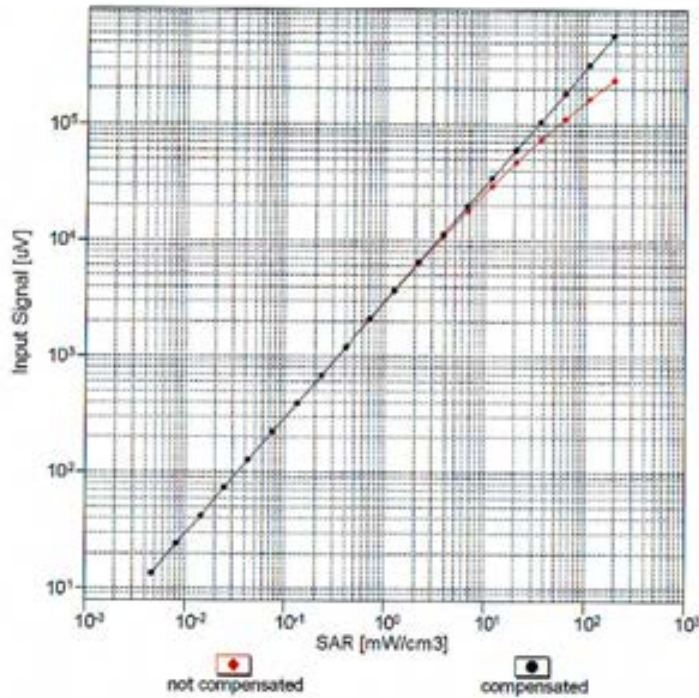
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)



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November 6, 2019

### Dynamic Range f(SAR<sub>head</sub>) (TEM cell, f<sub>eval</sub>= 1900 MHz)

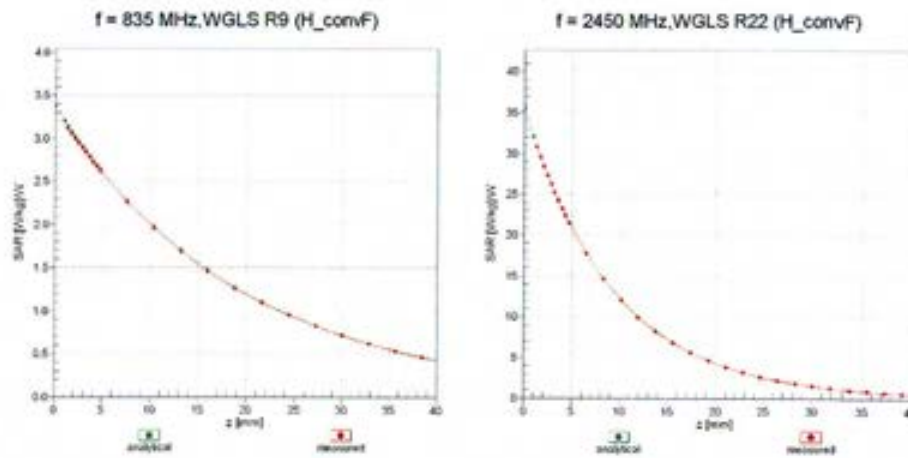


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

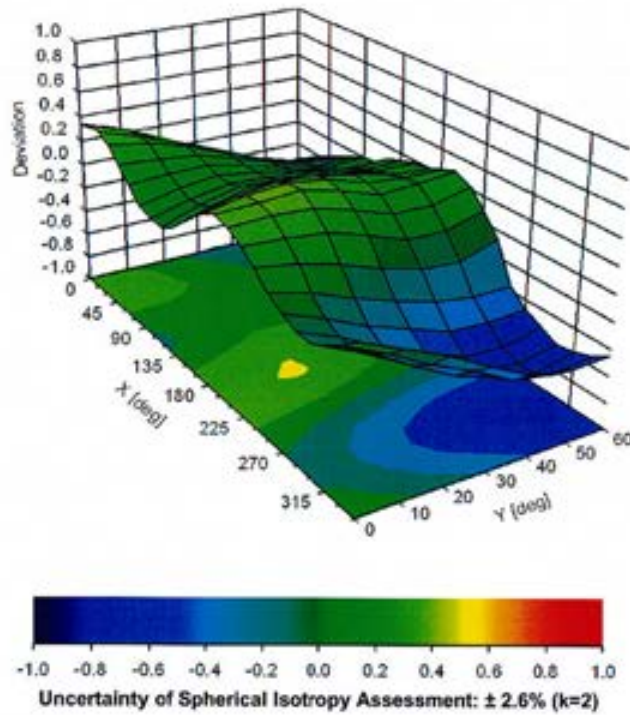
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### Conversion Factor Assessment



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



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**Appendix: Modulation Calibration Parameters**

UID	Communication System Name		A dB	B dBV $\mu$ V	C	D dB	VR mV	Max dev.	Unc <sup>k</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	145.2	$\pm 3.8\%$	$\pm 4.7\%$
		Y	0.0	0.0	1.0		159.8		
		Z	0.0	0.0	1.0		148.5		
10117- CAC	IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK)	X	9.83	67.8	20.7	8.07	135.6	$\pm 3.0\%$	$\pm 4.7\%$
		Y	9.76	68.0	20.8		149.2		
		Z	9.86	68.3	21.0		139.0		
10196- CAC	IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK)	X	9.44	67.6	20.6	8.10	129.3	$\pm 2.7\%$	$\pm 4.7\%$
		Y	9.40	67.9	20.8		141.8		
		Z	9.49	68.2	21.0		132.6		
10415- AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle)	X	2.53	65.8	16.9	1.54	136.9	$\pm 0.5\%$	$\pm 4.7\%$
		Y	2.47	66.8	17.8		149.8		
		Z	3.39	72.8	20.7		140.5		
10417- AAB	IEEE 802.11a/n WiFi 5 GHz (OFDM, 6 Mbps, 99pc duty cycle)	X	9.51	67.6	20.7	8.23	127.8	$\pm 2.5\%$	$\pm 4.7\%$
		Y	9.49	67.9	20.9		141.8		
		Z	9.56	68.1	21.0		131.6		
10525- AAB	IEEE 802.11ac WiFi (20MHz, MCS0, 99pc duty cycle)	X	9.74	67.8	20.9	8.36	130.1	$\pm 2.7\%$	$\pm 4.7\%$
		Y	9.69	68.1	21.1		143.5		
		Z	9.78	68.3	21.2		133.9		
10534- AAB	IEEE 802.11ac WiFi (40MHz, MCS0, 99pc duty cycle)	X	10.28	68.3	21.1	8.45	137.0	$\pm 3.0\%$	$\pm 4.7\%$
		Y	9.85	67.6	20.7		124.3		
		Z	10.31	68.7	21.4		140.8		
10544- AAB	IEEE 802.11ac WiFi (80MHz, MCS0, 99pc duty cycle)	X	10.60	68.5	21.1	8.47	142.9	$\pm 3.3\%$	$\pm 4.7\%$
		Y	10.09	67.7	20.7		128.7		
		Z	10.63	69.0	21.4		147.0		
10571- AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 90pc duty cycle)	X	2.60	65.8	17.0	1.99	132.6	$\pm 0.7\%$	$\pm 4.7\%$
		Y	2.58	67.1	18.2		144.9		
		Z	3.64	73.7	21.4		136.4		
10583- AAB	IEEE 802.11a/n WiFi 5 GHz (OFDM, 6 Mbps, 90pc duty cycle)	X	9.64	67.7	21.0	8.59	125.3	$\pm 2.5\%$	$\pm 4.7\%$
		Y	9.55	67.8	21.1		136.8		
		Z	9.65	68.1	21.3		128.7		
10591- AAB	IEEE 802.11n (HT Mixed, 20MHz, MCS0, 90pc duty cycle)	X	9.75	67.7	21.0	8.63	126.7	$\pm 2.7\%$	$\pm 4.7\%$
		Y	9.69	67.9	21.2		139.7		
		Z	9.82	68.3	21.4		131.0		
10599- AAB	IEEE 802.11n (HT Mixed, 40MHz, MCS0, 90pc duty cycle)	X	10.38	68.3	21.4	8.79	134.2	$\pm 3.3\%$	$\pm 4.7\%$
		Y	10.24	68.4	21.4		146.7		
		Z	10.37	68.6	21.6		137.3		

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10607-AAB	IEEE 802.11ac WiFi (20MHz, MCS0, 90pc duty cycle)	X	9.78	67.8	21.1	8.64	126.9	±3.3 %	±4.7 %
		Y	9.69	67.9	21.2		138.6		
		Z	9.83	68.3	21.4		131.1		
10616-AAB	IEEE 802.11ac WiFi (40MHz, MCS0, 90pc duty cycle)	X	10.41	68.3	21.4	8.82	134.4	±3.3 %	±4.7 %
		Y	10.26	68.4	21.4		146.8		
		Z	10.43	68.8	21.6		138.7		
10626-AAB	IEEE 802.11ac WiFi (80MHz, MCS0, 90pc duty cycle)	X	10.71	68.5	21.4	8.83	138.9	±3.5 %	±4.7 %
		Y	10.17	67.6	20.8		125.5		
		Z	10.74	69.0	21.6		143.7		

<sup>4</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

## Appendix C 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 0108**

Client **Motorola Solutions MY**

Certificate No: **D450V3-1053\_Oct18**

**CALIBRATION CERTIFICATE**

Object: **D450V3 - SN:1053**

Calibration procedure(s): **QA CAL-15.v8  
Calibration procedure for dipole validation kits below 700 MHz**

Calibration date: **October 19, 2018**

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 NRP	SN: 104778	04-Apr-18 (No. 217-02672/02673)	Apr-19
Power sensor NRP-Z91	SN: 103244	04-Apr-18 (No. 217-02672)	Apr-19
Power sensor NRP-Z91	SN: 103245	04-Apr-18 (No. 217-02673)	Apr-19
Reference 20 dB Attenuator	SN: 5277 (20x)	04-Apr-18 (No. 217-02682)	Apr-19
Type-N mismatch combination	SN: 5047.2 / 06327	04-Apr-18 (No. 217-02683)	Apr-19
Reference Probe EX3DV4	SN: 3877	30-Dec-17 (No. EX3-3877_Dec17)	Dec-18
DAE4	SN: 654	05-Jul-18 (No. DAE4-654_Jul18)	Jul-19

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	12-Jun-18 (No. 217-02285/02284)	In house check: Jun-20
Power sensor E4412A	SN: MY41498087	12-Jun-18 (No. 217-02285)	In house check: Jun-20
Power sensor E4412A	SN: 000110210	12-Jun-18 (No. 217-02284)	In house check: Jun-20
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-18)	In house check: Jun-20
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-18)	In house check: Oct-19

Calibrated by:	Name	Function	Signature
	Claudio Leubler	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: October 19, 2018

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  
**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 0108**

**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 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- c) IEC 62209-2, "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)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

**Additional Documentation:**

- e) 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.

DASY Version	DASY5	V52.10.2
Extrapolation	Advanced Extrapolation	
Phantom	ELI4 Flat Phantom	Shell thickness: 2 ± 0.2 mm
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	450 MHz ± 1 MHz	

**Head TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	43.5	0.87 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	44.1 ± 6 %	0.87 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

**SAR result with Head TSL**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	1.14 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>4.57 W/kg ± 18.1 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	0.762 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	<b>3.05 W/kg ± 17.6 % (k=2)</b>

**Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	56.7	0.94 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	55.5 ± 6 %	0.92 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

**SAR result with Body TSL**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	1.12 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>4.53 W/kg ± 18.1 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	0.753 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	<b>3.05 W/kg ± 17.6 % (k=2)</b>



**Appendix (Additional assessments outside the scope of SCS 0108)**

**Antenna Parameters with Head TSL**

Impedance, transformed to feed point	57.6 Ω - 4.4 jΩ
Return Loss	- 21.7 dB

**Antenna Parameters with Body TSL**

Impedance, transformed to feed point	55.1 Ω - 7.0 jΩ
Return Loss	- 21.7 dB

**General Antenna Parameters and Design**

Electrical Delay (one direction)	1.351 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	December 16, 2005

**DASY5 Validation Report for Head TSL**

Date: 19.10.2018

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 450 MHz; Type: D450V3; Serial: D450V3 - SN:1053**

Communication System: UID 0 - CW; Frequency: 450 MHz

Medium parameters used:  $f = 450 \text{ MHz}$ ;  $\sigma = 0.87 \text{ S/m}$ ;  $\epsilon_r = 44.1$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(10.5, 10.5, 10.5) @ 450 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 05.07.2018
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

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

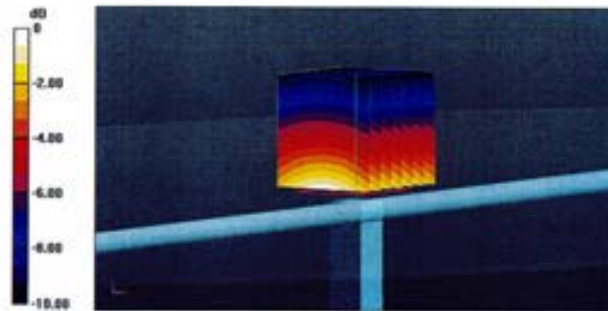
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 38.89 V/m; Power Drift = -0.00 dB

Peak SAR (extrapolated) = 1.74 W/kg

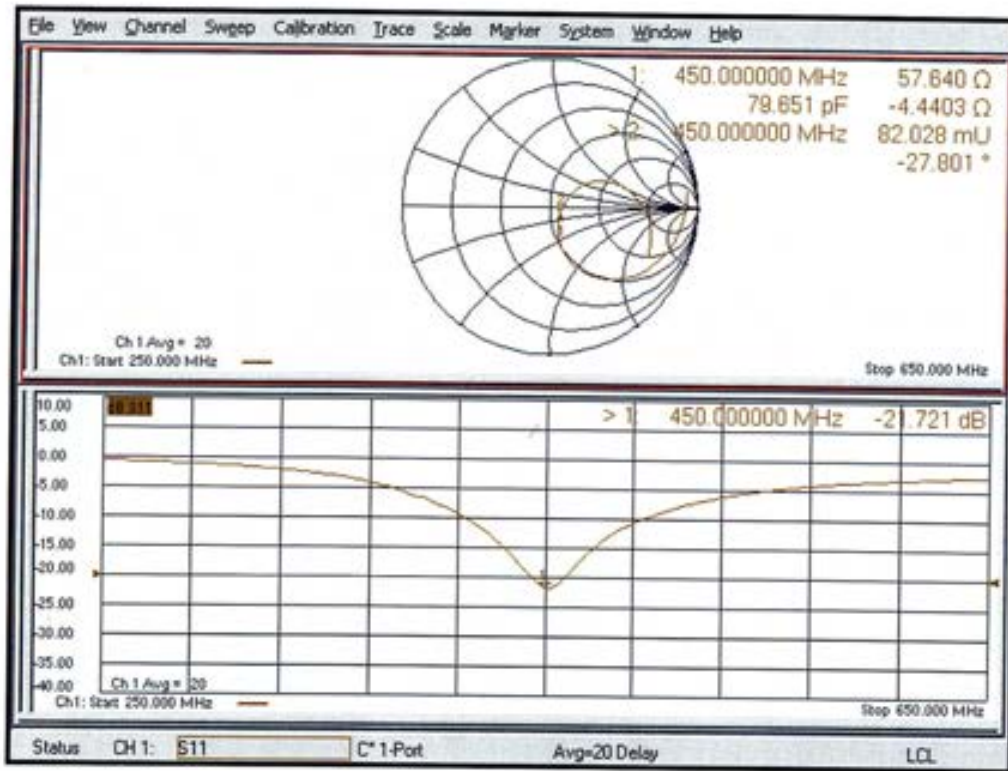
**SAR(1 g) = 1.14 W/kg; SAR(10 g) = 0.762 W/kg**

Maximum value of SAR (measured) = 1.52 W/kg



0 dB = 1.52 W/kg = 1.82 dBW/kg

### Impedance Measurement Plot for Head TSL



**DASY5 Validation Report for Body TSL**

Date: 19.10.2018

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 450 MHz; Type: D450V3; Serial: D450V3 - SN:1053**

Communication System: UID 0 - CW; Frequency: 450 MHz

Medium parameters used:  $f = 450 \text{ MHz}$ ;  $\sigma = 0.92 \text{ S/m}$ ;  $\epsilon_r = 55.5$ ;  $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(10.8, 10.8, 10.8) @ 450 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 05.07.2018
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

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

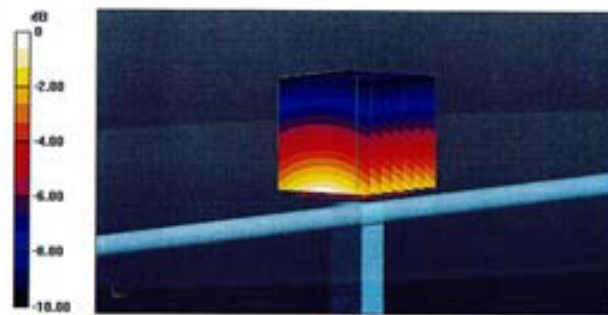
Measurement grid:  $dx=5\text{mm}$ ,  $dy=5\text{mm}$ ,  $dz=5\text{mm}$

Reference Value = 41.78 V/m; Power Drift = -0.04 dB

Peak SAR (extrapolated) = 1.72 W/kg

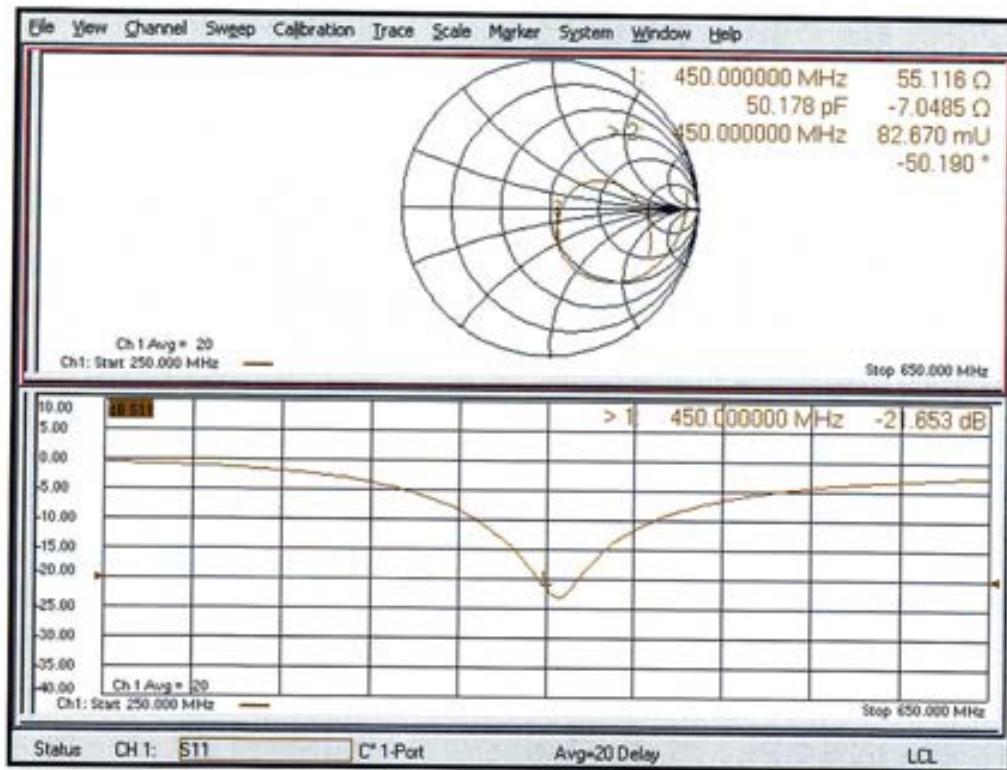
**SAR(1 g) = 1.12 W/kg; SAR(10 g) = 0.753 W/kg**

Maximum value of SAR (measured) = 1.50 W/kg



0 dB = 1.50 W/kg = 1.76 dBW/kg

### Impedance Measurement Plot for Body TSL



## Dipole Data

As stated in KDB 865664, only dipoles used for longer calibration intervals required to provide supporting information and measurement to qualify for extended calibration interval.

The table below includes dipole impedance and return loss measurement data measured by Motorola Solutions' EME lab. The results meet requirements stated in KDB 865664.

<b>Dipole D450V3 (SN 1053)</b>	<b>Head</b>			<b>Body</b>		
<b>Date Measured</b>	<b>Impedance</b>		<b>Return Loss</b>	<b>Impedance</b>		<b>Return Loss</b>
	<b>real <math>\Omega</math></b>	<b>imag <math>j\Omega</math></b>	<b>dB</b>	<b>real <math>\Omega</math></b>	<b>imag <math>j\Omega</math></b>	<b>dB</b>
11/08/2018	53.78	-7.39	-21.97	49.27	-7.93	-21.94
11/10/2019	53.95	-6.72	-22.49	49.84	-7.37	-22.74