



Product Service

**Choose certainty.
Add value.**

Report On

Specific Absorption Rate Testing of the
DAQRI Smart Helmet

FCC ID: 2AEWMDQR001001

COMMERCIAL-IN-CONFIDENCE

Document 75937080 Report 05 Issue 1

March 2017



Product Service

TÜV SÜD Product Service, Octagon House, Concorde Way, Segensworth North,
Fareham, Hampshire, United Kingdom, PO15 5RL
Tel: +44 (0) 1489 558100. Website: www.tuv-sud.co.uk

COMMERCIAL-IN-CONFIDENCE

REPORT ON

Specific Absorption Rate Testing of the
DAQRI Smart Helmet

Document 75937080 Report 05 Issue 1

March 2017

PREPARED FOR

DAQRI LLC
1201 W. 5th St. Suite T-800
Los Angeles
California
90017
United States

A handwritten signature in black ink, appearing to read "Stephen Dodd".

Stephen Dodd
SAR Engineer

APPROVED BY

A handwritten signature in black ink, appearing to read "Nigel Grigsby".

Nigel Grigsby
Authorised Signatory

DATED

31 March 2017



CONTENTS

Section	Page No
1 REPORT SUMMARY	3
1.1 Introduction	4
1.2 Brief Summary of Results	5
1.3 Test Results Summary	6
1.4 FCC Power Measurements	17
2 TEST DETAILS	20
2.1 DASY5 Measurement System	21
2.2 WLAN 2450 MHz Head SAR Test Results	25
2.3 WLAN 2450 MHz Body-Extremity SAR Test Results	26
2.4 WLAN U-NII-2A Head SAR Test Results	27
2.5 WLAN U-NII-2A Body-Extremity SAR Test Results	28
2.6 WLAN U-NII-2C Head SAR Test Results	29
2.7 WLAN U-NII-2C Body-Extremity SAR Test Results	30
2.8 WLAN U-NII-3 Head SAR Test Results	31
2.9 WLAN U-NII-3 Body-Extremity SAR Test Results	32
3 TEST EQUIPMENT USED	33
3.1 Test Equipment Used	34
3.2 Test Software	35
3.3 Dielectric Properties of Simulant Liquids	36
3.4 Test Conditions	37
3.5 Measurement Uncertainty	38
4 ACCREDITATION, DISCLAIMERS AND COPYRIGHT	42
4.1 Accreditation, Disclaimers and Copyright	43
ANNEX A Probe Calibration Reports	A.2
ANNEX B Dipole Calibration Reports	B.2



Product Service

SECTION 1

REPORT SUMMARY

Specific Absorption Rate Testing of the
DAQRI Smart Helmet



Product Service

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Specific Absorption Rate Testing of the DAQRI Smart Helmet to the requirements of KDB 447498 D01 v06 General RF Exposure Guidance.

Objective	To perform Specific Absorption Rate Testing to determine the Equipment Under Test's (EUT's) compliance with the requirements specified of KDB 447498 D01 v06 General RF Exposure Guidance, for the series of tests carried out.
Applicant	DAQRI LLC
Manufacturer	DAQRI International Ltd
Model Number	DAQRI Smart Helmet
Number of Samples Tested	1
Hardware Version	DAQRI Thor DE
Software Version	V16
Serial Number	Not Serialised - 75937080_TS0061
Battery Cell Manufacturer	GETAC TECHNOLOGY CORP
Battery Model Number	THR-00152
Test Specification/Issue/Date	KDB 447498 D01 v06 General RF Exposure Guidance
Start of Test	20 March 2017
Finish of Test	23 March 2017
Related Document(s)	FCC 47CFR 2.1093: 2015 KDB 865664 – D01 v01r04 KDB 865664 – D02 v01r02 IEEE 1528-2013 KDB 248227 – D01 v02r02
Name of Engineer(s)	Stephen Dodd



Product Service

1.2 BRIEF SUMMARY OF RESULTS

The measurements shown in this report were made in accordance with the procedures specified KDB 447498 D01 v06 General RF Exposure Guidance.

The maximum 1g volume averaged stand -alone SAR found during this Assessment:

Max 1g SAR (W/kg) Head	0.20 (Measured)	0.29 (Scaled)
The maximum 1g volume averaged SAR level measured for all the tests performed did not exceed the limits for General Population/Uncontrolled Exposure (W/kg) Partial Body of 1.6 W/kg.		

The maximum 10g volume averaged stand -alone SAR found during this Assessment:

Max 10g SAR (W/kg) Body-Extremity	0.31 (Measured)	0.45 (Scaled)
The maximum 10g volume averaged SAR level measured for all the tests performed did not exceed the limits for General Population/Uncontrolled Exposure (W/kg) Partial Body of 4.0 W/kg.		

The maximum 1g volume averaged stand -alone Reported SAR found during this Assessment for each supported mode:

Band	Test Configuration	Max Reported SAR (W/kg)
2450 MHz	Head	0.08
U-NII-2A	Head	0.28
U-NII-2C	Head	0.21
U-NII-3	Head	0.29
The maximum 1g volume averaged SAR level measured for all the tests performed (including simultaneous transmission analysis results) did not exceed the limits for General Population/Uncontrolled Exposure (W/kg) Partial Body of 1.6 W/kg.		

The maximum 10g volume averaged stand -alone Reported SAR found during this Assessment for each supported mode:

Band	Test Configuration	Max Reported SAR (W/kg)
2450 MHz	Body-Extremity	0.26
U-NII-2A	Body-Extremity	0.29
U-NII-2C	Body-Extremity	0.33
U-NII-3	Body-Extremity	0.45
The maximum 10g volume averaged SAR level measured for all the tests performed (including simultaneous transmission analysis results) did not exceed the limits for General Population/Uncontrolled Exposure (W/kg) Partial Body of 4.0 W/kg.		



Product Service

1.3 TEST RESULTS SUMMARY

1.3.1 System Performance / Validation Check Results

Prior to formal testing being performed a System Check was performed in accordance with KDB 865664 and the results were compared against published data in Standard IEEE 1528-2003. The following results were obtained: -

System performance / Validation results

Date	Frequency (MHz)	Max 1g SAR (W/kg)*	Percentage Drift on Reference
20/03/2017	5200 MHz	70.07	-8.41
20/03/2017	5500 MHz	83.20	-0.12
21/03/2017	5800 MHz	74.44	0.46
21/03/2017	5200 MHz	64.89	-9.62
21/03/2017	5500 MHz	71.66	-9.41
21/03/2017	5500 MHz	71.66	-9.41
22/03/2017	5500 MHz	72.06	-8.90
22/03/2017	5800 MHz	67.28	-9.20
22/03/2017	2450 MHz	48.17	-5.92
23/03/2017	2450 MHz	53.74	2.56

*Normalised to a forward power of 1W



1.3.2 Results Summary Tables

2.4 GHz DSSS Helmet Internal - Antenna A Power Setting 16: WLAN 2450 MHz 802.11b
20MHz 1Mbps Head Specific Absorbtion Rate (Maximum SAR) 1g Results

Test Position	Channel Number	Frequency (MHz)	Measured Average Power (dBm)	Tune Up (dBm)	Measured 1g SAR (W/kg)	Scaled 1g SAR (W/kg)	Scan Figure Number
0mm Internal	1	2412	15.19	16.50	0.06	0.08	Figure 2
Limit for General Population (Uncontrolled Exposure) 1.6 W/kg (1g)							
KDB 447498 D01 - Testing of other required channels within the operation mode of a frequency band is not required when the reported 1g SAR for mid-band or highest output power channel is:							
≤ 0.8W/kg when the transmission band is ≤ 100MHz							
≤ 0.6W/kg when the transmission band is between 100MHz and 200MHz							
≤ 0.4W/kg when the transmission band is ≥ 200MHz							
KDB248227 D01 v02 - Testing was not required for OFDM as per Section 5.2.2							

2.4 GHz DSSS Helmet Internal - Antenna B Power Setting 16: WLAN 2450 MHz 802.11b
20MHz 1Mbps Head Specific Absorbtion Rate (Maximum SAR) 1g Results

Test Position	Channel Number	Frequency (MHz)	Measured Average Power (dBm)	Tune Up (dBm)	Measured 1g SAR (W/kg)	Scaled 1g SAR (W/kg)	Scan Figure Number
0mm Internal	1	2412	15.19	16.50	0.02	0.03	Figure 3
Limit for General Population (Uncontrolled Exposure) 1.6 W/kg (1g)							
KDB 447498 D01 - Testing of other required channels within the operation mode of a frequency band is not required when the reported 1g SAR for mid-band or highest output power channel is:							
≤ 0.8W/kg when the transmission band is ≤ 100MHz							
≤ 0.6W/kg when the transmission band is between 100MHz and 200MHz							
≤ 0.4W/kg when the transmission band is ≥ 200MHz							
KDB248227 D01 v02 - Testing was not required for OFDM as per Section 5.2.2							

2.4 GHz DSSS Helmet External - Antenna A Power Setting 16: WLAN 2450 MHz 802.11b
20MHz 1Mbps Extremity-Specific Absorbtion Rate (Maximum SAR) 10g Results

Test Position	Channel Number	Frequency (MHz)	Measured Average Power (dBm)	Tune Up (dBm)	Measured 10g SAR (W/kg)	Scaled 10g SAR (W/kg)	Scan Figure Number
1mm External	1	2412	15.19	16.50	0.19	0.26	Figure 4
Limit for General Population (Uncontrolled Exposure) 4 W/kg (10g)							
KDB 447498 D01 - Testing of other required channels within the operation mode of a frequency band is not required when the reported 1g SAR for mid-band or highest output power channel is:							
≤ 2.0W/kg when the transmission band is ≤ 100MHz							
≤ 1.5W/kg when the transmission band is between 100MHz and 200MHz							
≤ 0.1W/kg when the transmission band is ≥ 200MHz							
KDB248227 D01 v02 - Testing was not required for OFDM as per Section 5.2.2							



Product Service

2.4 GHz DSSS Helmet External - Antenna B Power Setting 16: 802.11b 20MHz 1Mbps Extremity Specific Absorbtion Rate (Maximum SAR) 10g Results

Test Position	Channel Number	Frequency (MHz)	Measured Average Power (dBm)	Tune Up (dBm)	Measured 10g SAR (W/kg)	Scaled 10g SAR (W/kg)	Scan Figure Number
1mm External	1	2412	15.19	16.50	0.18	0.25	Figure 5
Limit for General Population (Uncontrolled Exposure) 4 W/kg (10g)							
KDB 447498 D01 - Testing of other required channels within the operation mode of a frequency band is not required when the reported 1g SAR for mid-band or highest output power channel is:							
≤ 2.0W/kg when the transmission band is ≤ 100MHz							
≤ 1.5W/kg when the transmission band is between 100MHz and 200MHz							
≤ 0.1W/kg when the transmission band is ≥ 200MHz							
KDB248227 D01 v02 - Testing was not required for OFDM as per Section 5.2.2							

5 GHz Helmet Internal - Antenna A U-NII 2A Power Setting 16: 802.11n 40MHz HT0 Head Specific Absorbtion Rate (Maximum SAR) 1g Results

Test Position	Channel Number	Frequency (MHz)	Measured Average Power (dBm)	Tune Up (dBm)	Measured 1g SAR (W/kg)	Scaled 1g SAR (W/kg)	Scan Figure Number
0mm Internal	54	5270	15.12	17.00	0.07	0.11	Figure 6
Limit for General Population (Uncontrolled Exposure) 1.6 W/kg (1g)							
KDB 447498 D01 - Testing of other required channels within the operation mode of a frequency band is not required when the reported 1g SAR for mid-band or highest output power channel is:							
≤ 0.8W/kg when the transmission band is ≤ 100MHz							
≤ 0.6W/kg when the transmission band is between 100MHz and 200MHz							
≤ 0.4W/kg when the transmission band is ≥ 200MHz							

5 GHz Helmet Internal - Antenna B U-NII 2A Power Setting 16: 802.11n 40MHz HT0 Head Specific Absorbtion Rate (Maximum SAR) 1g Results

Test Position	Channel Number	Frequency (MHz)	Measured Average Power (dBm)	Tune Up (dBm)	Measured 1g SAR (W/kg)	Scaled 1g SAR (W/kg)	Scan Figure Number
0mm Internal	54	5270	15.12	17.00	0.19	0.28	Figure 7
Limit for General Population (Uncontrolled Exposure) 1.6 W/kg (1g)							
KDB 447498 D01 - Testing of other required channels within the operation mode of a frequency band is not required when the reported 1g SAR for mid-band or highest output power channel is:							
≤ 0.8W/kg when the transmission band is ≤ 100MHz							
≤ 0.6W/kg when the transmission band is between 100MHz and 200MHz							
≤ 0.4W/kg when the transmission band is ≥ 200MHz							



Product Service

5 GHz Helmet External - Antenna A U-NII 2A Power Setting 16: 802.11n 40MHz HT0 Extremity Specific Absorbtion Rate (Maximum SAR) 10g Results

Test Position	Channel Number	Frequency (MHz)	Measured Average Power (dBm)	Tune Up (dBm)	Measured 10g SAR (W/kg)	Scaled 10g SAR (W/kg)	Scan Figure Number
1mm External	54	5270	15.12	17.00	0.19	0.29	Figure 8
Limit for General Population (Uncontrolled Exposure) 4 W/kg (10g)							
KDB 447498 D01 - Testing of other required channels within the operation mode of a frequency band is not required when the reported 1g SAR for mid-band or highest output power channel is:							
≤ 2.0W/kg when the transmission band is ≤ 100MHz							
≤ 1.5W/kg when the transmission band is between 100MHz and 200MHz							
≤ 01.0W/kg when the transmission band is ≥ 200MHz							

5 GHz Helmet External - Antenna B U-NII 2A Power Setting 16: 802.11n 40MHz HT0 Extremity Specific Absorbtion Rate (Maximum SAR) 10g Results

Test Position	Channel Number	Frequency (MHz)	Measured Average Power (dBm)	Tune Up (dBm)	Measured 10g SAR (W/kg)	Scaled 10g SAR (W/kg)	Scan Figure Number
1mm External	54	5270	15.12	17.00	0.18	0.27	Figure 9
Limit for General Population (Uncontrolled Exposure) 4 W/kg (10g)							
KDB 447498 D01 - Testing of other required channels within the operation mode of a frequency band is not required when the reported 1g SAR for mid-band or highest output power channel is:							
≤ 2.0W/kg when the transmission band is ≤ 100MHz							
≤ 1.5W/kg when the transmission band is between 100MHz and 200MHz							
≤ 01.0W/kg when the transmission band is ≥ 200MHz							

5 GHz Helmet Internal - Antenna A U-NII 2C Power Setting 16: 802.11n 40MHz HT0 Head Specific Absorbtion Rate (Maximum SAR) 1g Results

Test Position	Channel Number	Frequency (MHz)	Measured Average Power (dBm)	Tune Up (dBm)	Measured 1g SAR (W/kg)	Scaled 1g SAR (W/kg)	Scan Figure Number
0mm Internal	118	5590	16.08	17.50	0.07	0.10	Figure 10
Limit for General Population (Uncontrolled Exposure) 1.6 W/kg (1g)							
KDB 447498 D01 - Testing of other required channels within the operation mode of a frequency band is not required when the reported 1g SAR for mid-band or highest output power channel is:							
≤ 0.8W/kg when the transmission band is ≤ 100MHz							
≤ 0.6W/kg when the transmission band is between 100MHz and 200MHz							
≤ 0.4W/kg when the transmission band is ≥ 200MHz							



Product Service

5 GHz Helmet Internal - Antenna B U-NII 2C Power Setting 16: 802.11n 40MHz HT0 Head Specific Absorbtion Rate (Maximum SAR) 1g Results

Test Position	Channel Number	Frequency (MHz)	Measured Average Power (dBm)	Tune Up (dBm)	Measured 1g SAR (W/kg)	Scaled 1g SAR (W/kg)	Scan Figure Number
0mm Internal	118	5590	16.08	17.50	0.15	0.21	Figure 11
Limit for General Population (Uncontrolled Exposure) 1.6 W/kg (1g)							
KDB 447498 D01 - Testing of other required channels within the operation mode of a frequency band is not required when the reported 1g SAR for mid-band or highest output power channel is:							
≤ 0.8W/kg when the transmission band is ≤ 100MHz							
≤ 0.6W/kg when the transmission band is between 100MHz and 200MHz							
≤ 0.4W/kg when the transmission band is ≥ 200MHz							

5 GHz Helmet External - Antenna A U-NII 2C Power Setting 16: 802.11n 40MHz HT0 Extremity Specific Absorbtion Rate (Maximum SAR) 10g Results

Test Position	Channel Number	Frequency (MHz)	Measured Average Power (dBm)	Tune Up (dBm)	Measured 10g SAR (W/kg)	Scaled 10g SAR (W/kg)	Scan Figure Number
1mm External	118	5590	16.08	17.50	0.15	0.21	Figure 12
Limit for General Population (Uncontrolled Exposure) 4 W/kg (10g)							
KDB 447498 D01 - Testing of other required channels within the operation mode of a frequency band is not required when the reported 1g SAR for mid-band or highest output power channel is:							
≤ 2.0W/kg when the transmission band is ≤ 100MHz							
≤ 1.5W/kg when the transmission band is between 100MHz and 200MHz							
≤ 0.10W/kg when the transmission band is ≥ 200MHz							

5 GHz Helmet External - Antenna B U-NII 2C Power Setting 16: MHz 802.11n 40MHz HT0 Extremity Specific Absorbtion Rate (Maximum SAR) 10g Results

Test Position	Channel Number	Frequency (MHz)	Measured Average Power (dBm)	Tune Up (dBm)	Measured 10g SAR (W/kg)	Scaled 10g SAR (W/kg)	Scan Figure Number
1mm External	118	5590	16.08	17.50	0.23	0.33	Figure 13
Limit for General Population (Uncontrolled Exposure) 4 W/kg (10g)							
KDB 447498 D01 - Testing of other required channels within the operation mode of a frequency band is not required when the reported 1g SAR for mid-band or highest output power channel is:							
≤ 2.0W/kg when the transmission band is ≤ 100MHz							
≤ 1.5W/kg when the transmission band is between 100MHz and 200MHz							
≤ 0.10W/kg when the transmission band is ≥ 200MHz							



Product Service

5 GHz Helmet Internal - Antenna A U-NII 3 Power Setting 17: 802.11ac 80MHz VHT0 Head Specific Absorbtion Rate (Maximum SAR) 1g Results

Test Position	Channel Number	Frequency (MHz)	Measured Average Power (dBm)	Tune Up (dBm)	Measured 1g SAR (W/kg)	Scaled 1g SAR (W/kg)	Scan Figure Number
0mm Internal	138	5690	16.34	18.00	0.20	0.29	Figure 14
Limit for General Population (Uncontrolled Exposure) 1.6 W/kg (1g)							
KDB 447498 D01 - Testing of other required channels within the operation mode of a frequency band is not required when the reported 1g SAR for mid-band or highest output power channel is:							
≤ 0.8W/kg when the transmission band is ≤ 100MHz							
≤ 0.6W/kg when the transmission band is between 100MHz and 200MHz							
≤ 0.4W/kg when the transmission band is ≥ 200MHz							

5 GHz Helmet Internal - Antenna B U-NII 3 Power Setting 17: MHz 802.11ac 80MHz VHT0 Head Specific Absorbtion Rate (Maximum SAR) 1g Results

Test Position	Channel Number	Frequency (MHz)	Measured Average Power (dBm)	Tune Up (dBm)	Measured 1g SAR (W/kg)	Scaled 1g SAR (W/kg)	Scan Figure Number
0mm Internal	138	5690	16.34	18.00	0.19	0.26	Figure 15
Limit for General Population (Uncontrolled Exposure) 1.6 W/kg (1g)							
KDB 447498 D01 - Testing of other required channels within the operation mode of a frequency band is not required when the reported 1g SAR for mid-band or highest output power channel is:							
≤ 0.8W/kg when the transmission band is ≤ 100MHz							
≤ 0.6W/kg when the transmission band is between 100MHz and 200MHz							
≤ 0.4W/kg when the transmission band is ≥ 200MHz							

5 GHz Helmet External - Antenna A U-NII 3 Power Setting 17: 802.11ac 80MHz VHT0 Extremity Specific Absorbtion Rate (Maximum SAR) 10g Results

Test Position	Channel Number	Frequency (MHz)	Measured Average Power (dBm)	Tune Up (dBm)	Measured 10g SAR (W/kg)	Scaled 10g SAR (W/kg)	Scan Figure Number
1mm External	138	5690	16.34	18.00	0.21	0.31	Figure 16
Limit for General Population (Uncontrolled Exposure) 4 W/kg (10g)							
KDB 447498 D01 - Testing of other required channels within the operation mode of a frequency band is not required when the reported 1g SAR for mid-band or highest output power channel is:							
≤ 2.0W/kg when the transmission band is ≤ 100MHz							
≤ 1.5W/kg when the transmission band is between 100MHz and 200MHz							
≤ 0.10W/kg when the transmission band is ≥ 200MHz							



Product Service

5 GHz Helmet External - Antenna B U-NII 3 Power Setting 17: 802.11ac 80MHz VHT0 Extremity Specific Absorbtion Rate (Maximum SAR) 10g Results

Test Position	Channel Number	Frequency (MHz)	Measured Average Power (dBm)	Tune Up (dBm)	Measured 10g SAR (W/kg)	Scaled 10g SAR (W/kg)	Scan Figure Number
1mm External	138	5690	16.34	18.00	0.31	0.45	Figure 17
Limit for General Population (Uncontrolled Exposure) 4 W/kg (10g)							
KDB 447498 D01 - Testing of other required channels within the operation mode of a frequency band is not required when the reported 1g SAR for mid-band or highest output power channel is:							
≤ 2.0W/kg when the transmission band is ≤ 100MHz							
≤ 1.5W/kg when the transmission band is between 100MHz and 200MHz							
≤ 01.0W/kg when the transmission band is ≥ 200MHz							

1.3.3 Simultaneous Transmission

Position	802.11b 20MHz 1Mbps 1g SAR (W/kg) SISO A CH 1 (Scaled SAR values)	802.11b 20MHz 1Mbps 1g SAR (W/kg) SISO B CH 1 (Scaled SAR values))	Σ 1g SAR (W/kg)
Head			
Internal	0.08	0.03	0.11
The antennas were spatially separated to the extent that the SAR distributions did not overlap, therefore were treated independently as per KDB 248227 D01 Section 6.5. The highest reported SAR for the 802.11 transmission modes in the frequency band was used for simultaneous transmission SAR test exclusion.			

Simultaneous SAR measurements were not required as the sum of the 1g SAR measurements did not exceed 1.6 W/kg.

Position	802.11b 20MHz 1Mbps 10g SAR (W/kg) SISO A CH 1 (Scaled SAR values)	802.11b 20MHz 1Mbps Head 10g SAR (W/kg) SISO B CH 1 (Scaled SAR values))	Σ 10g SAR (W/kg)
Extremity			
External	0.26	0.25	0.51
The antennas were spatially separated to the extent that the SAR distributions did not overlap, therefore were treated independently as per KDB 248227 D01 Section 6.5. The highest reported SAR for the 802.11 transmission modes in the frequency band was used for simultaneous transmission SAR test exclusion.			

Simultaneous SAR measurements were not required as the sum of the 1g SAR measurements did not exceed 1.6 W/kg.



Position	802.11n 40MHz HT0 1g SAR (W/kg) SISO A CH 54 (Scaled SAR values)	802.11n 40MHz HT0 1g SAR (W/kg) SISO B CH 54 (Scaled SAR values)	Σ 1g SAR (W/kg)
Head			
Internal	0.11	0.28	0.39

The antennas were spatially separated to the extent that the SAR distributions did not overlap, therefore were treated independently as per KDB 248227 D01 Section 6.5. The highest reported SAR for the 802.11 transmission modes in the frequency band was used for simultaneous transmission SAR test exclusion.

Simultaneous SAR measurements were not required as the sum of the 1g SAR measurements did not exceed 1.6 W/kg.

Position	802.11n 40MHz HT0 10g SAR (W/kg) SISO A CH 54 (Scaled SAR values)	802.11n 40MHz HT0 10g SAR (W/kg) SISO B CH 54 (Scaled SAR values)	Σ 10g SAR (W/kg)
Extremity			
External	0.29	0.27	0.56

The antennas were spatially separated to the extent that the SAR distributions did not overlap, therefore were treated independently as per KDB 248227 D01 Section 6.5. The highest reported SAR for the 802.11 transmission modes in the frequency band was used for simultaneous transmission SAR test exclusion.

Simultaneous SAR measurements were not required as the sum of the 10g SAR measurements did not exceed 4.0 W/kg.

Position	802.11n 40MHz HT0 1g SAR (W/kg) SISO A CH 118 (Scaled SAR values)	802.11n 40MHz HT0 1g SAR (W/kg) SISO B CH 118 (Scaled SAR values)	Σ 1g SAR (W/kg)
Head			
Internal	0.10	0.21	0.31

The antennas were spatially separated to the extent that the SAR distributions did not overlap, therefore were treated independently as per KDB 248227 D01 Section 6.5. The highest reported SAR for the 802.11 transmission modes in the frequency band was used for simultaneous transmission SAR test exclusion..

Simultaneous SAR measurements were not required as the sum of the 1g SAR measurements did not exceed 1.6 W/kg.

Position	802.11n 40MHz HT0 10g SAR (W/kg) SISO A CH 118 (Scaled SAR values)	802.11n 40MHz HT0 10g SAR (W/kg) SISO B CH 118 (Scaled SAR values)	Σ 10g SAR (W/kg)
Extremity			
External	0.21	0.33	0.54

The antennas were spatially separated to the extent that the SAR distributions did not overlap, therefore were treated independently as per KDB 248227 D01 Section 6.5. The highest reported SAR for the 802.11 transmission modes in the frequency band was used for simultaneous transmission SAR test exclusion.



Product Service

Simultaneous SAR measurements were not required as the sum of the 1g SAR measurements did not exceed 1.6 W/kg.

Position	802.11ac 80MHz VHT0 1g SAR (W/kg) SISO A CH 138 (Scaled SAR values)	802.11ac 80MHz VHT0 1g SAR (W/kg) SISO B CH 138 (Scaled SAR values)	Σ 1g SAR (W/kg)
Head			
Internal	0.29	0.26	0.55

The antennas were spatially separated to the extent that the SAR distributions did not overlap, therefore were treated independently as per KDB 248227 D01 Section 6.5. The highest reported SAR for the 802.11 transmission modes in the frequency band was used for simultaneous transmission SAR test exclusion.

Simultaneous SAR measurements were not required as the sum of the 1g SAR measurements did not exceed 1.6 W/kg.

Position	802.11ac 80MHz VHT0 10g SAR (W/kg) SISO A CH 138 (Scaled SAR values)	802.11ac 80MHz VHT0 10g SAR (W/kg) SISO B CH 138 (Scaled SAR values)	Σ 10g SAR (W/kg)
Extremity			
External	0.31	0.45	0.76

The antennas were spatially separated to the extent that the SAR distributions did not overlap, therefore were treated independently as per KDB 248227 D01 Section 6.5. The highest reported SAR for the 802.11 transmission modes in the frequency band was used for simultaneous transmission SAR test exclusion.

Simultaneous SAR measurements were not required as the sum of the 10g SAR measurements did not exceed 4.0 W/kg.

The antennas were spatially separated to the extent that the SAR distributions did not overlap, therefore were treated independently



1.3.4 Standalone SAR Test Exclusion Considerations (KDB 447498 D01)

The 1g SAR Test exclusion thresholds for 100 MHz to 6 GHz *test separation distances* \leq 50 mm are determined by:

$[(\text{max power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] / \sqrt{f(\text{GHz})} \leq 3.0$, where

- $f(\text{GHz})$ is the RF channel transmit frequency in GHz.
- Power and distance are rounded to the nearest mW and mm before calculation.
- The result is rounded to one decimal place for comparison.
- When the maximum test separation distance is < 5 mm, a distance of 5 mm is applied.

Band	Frequency (MHz)	Power (dBm)	Power (mW)	Test Position	Distance (mm)	Threshold	Test Exclusion
2450 MHz	2412	16.5	44.7	Head	<5	13.9	No
2450 MHz	2412	16.5	44.7	Body	<5	13.9	No
U-NII-1	5270	17.0	50.1	Head	<5	23.0	No
U-NII-1	5270	17.0	50.1	Body	<5	23.0	No
U-NII-2a	5590	17.5	56.2	Head	<5	26.6	No
U-NII-2a	5590	17.5	56.2	Body	<5	26.6	No
U-NII-3	5690	18.0	63.1	Head	<5	30.1	No
U-NII-3	5690	18.0	63.1	Body	<5	30.1	No

1.3.5 Technical Description

The equipment under test (EUT) was a DAQRI Smart Helmet. A full technical description can be found in the manufacturer's documentation.

1.3.6 Test Configuration and Modes of Operation

To enable accurate SAR assessment of the device, the internal electronics (PCB and battery) were removed from the inside of the helmet. This was due the measurement system not being able to measure inside the helmet and the form-factor and the curved edges of the DUT.

The testing was performed with an integral battery supplied and manufactured by DAQRI.

WLAN testing was achieved using the devices internal software, customer supplied software and settings supplied by the customer. For each scan the device was configured into a continuous transmission test mode.

Worst case data rates used were 2.4 GHz DSSS -802.11.b 20 MHz 1Mbps, U-NIII-2A 802.11n 40 MHz MCS0, U-NIII-2C 802.11n 40 MHz MCS0, U-NIII-3 802.11ac 80 MHz MCS0.

For head SAR assessment the internal electronics / PCB and battery of the device were placed against an Elliptical phantom with a 0mm separation distance. The separation distance from the antenna to the phantom shell was 32mm. The phantom was filled with broad band simulant liquid. The dielectric properties were measured and found to be in accordance with the requirements for the dielectric properties specified in KDB 865665.

For body/extremity SAR assessment the internal electronics / PCB and battery of the device were placed against an Elliptical phantom with a 1mm separation distance to simulate the outer shell of the helmet. The separation distance from the antenna to the phantom shell was 5mm. The phantom was filled with broad band simulant liquid. The dielectric properties were



Product Service

measured and found to be in accordance with the requirements for the dielectric properties specified in KDB 865665

The Elliptical Phantom dimensions are 600 mm major axis and 400mm minor axis with a shell thickness of 2.00mm. The phantom was filled to a minimum depth of 150mm with the appropriate simulant liquid. The dielectric properties were in accordance with the requirements specified in KDB 865665.

Included in this report are descriptions of the test method; the equipment used and an analysis of the test uncertainties applicable and diagrams indicating the locations of maximum SAR for each test position along with photographs indicating the positioning of the handset against the body as appropriate.

1.3.7 Deviations From Standard

Power measurements on several channels were more than 2dB lower than the maximum tune-up limit, specified in KDB 447498 D01 General RF Exposure Guidance v06.

Although the power output of the DUT could not be permanently adjusted by the customer, for testing purposes the output power could be temporarily adjusted using the customer supplied software. The DUT power levels were increased to be within the tune-up limit tolerance for testing, hence giving an over-estimation of the SAR values which would be lower in real time use.



Product Service

1.4 FCC POWER MEASUREMENTS

1.4.1 Method

Conducted power measurements were made using a power meter.

1.4.2 Conducted Power Measurements

WLAN 2450 MHz

Mode	Frequency (MHz)	Duty Cycle (%)	Burst Average Power (dBm) SISO A	Burst Average Power (dBm) SISO B
802.11b - 20 MHz - 1 Mbps DSSS	2412	100	15.19	15.14
802.11b - 20 MHz - 1 Mbps DSSS	2437	100	14.67	14.63
802.11b - 20 MHz - 1 Mbps DSSS	2462	100	15.03	15.02
802.11b - 20 MHz - 6 Mbps OFDM	2412	100	15.98	15.97
802.11b - 20 MHz - 6 Mbps OFDM	2437	100	15.48	15.43
802.11b - 20 MHz - 6 Mbps OFDM	2462	100	15.82	15.79

WLAN 5000 MHz

Mode	Frequency (MHz)	Duty Cycle (%)	Burst Average Power (dBm) SISO A	Burst Average Power (dBm) SISO B
802.11a - 20 MHz - 6 Mbps	5180	100	14.76	14.37
802.11a - 20 MHz - 6 Mbps	5200	100	14.53	14.27
802.11a - 20 MHz - 6 Mbps	5220	100	14.50	14.08
802.11a - 20 MHz - 6 Mbps	5240	100	14.09	14.23
802.11a - 20 MHz - 6 Mbps	5260	100	14.52	14.71
802.11a - 20 MHz - 6 Mbps	5280	100	14.56	14.67
802.11a - 20 MHz - 6 Mbps	5300	100	14.72	14.69
802.11a - 20 MHz - 6 Mbps	5320	100	14.86	14.72
802.11a - 20 MHz - 6 Mbps	5500	100	15.71	15.62
802.11a - 20 MHz - 6 Mbps	5560	100	15.96	16.02
802.11a - 20 MHz - 6 Mbps	5580	100	15.98	15.91
802.11a - 20 MHz - 6 Mbps	5640	100	15.67	15.48
802.11a - 20 MHz - 6 Mbps	5660	100	15.49	15.44
802.11a - 20 MHz - 6 Mbps	5745	100	15.13	15.42



Product Service

802.11a - 20 MHz - 6 Mbps	5825	100	15.30	15.43
802.11a- 20 MHz- HT0	5180	100	14.76	14.37
802.11a- 20 MHz- HT0	5200	100	14.49	14.27
802.11a- 20 MHz- HT0	5220	100	14.53	14.08
802.11a- 20 MHz- HT0	5240	100	14.09	14.23
802.11a- 20 MHz- HT0	5260	100	14.41	14.69
802.11a- 20 MHz- HT0	5280	100	14.45	14.60
802.11a- 20 MHz- HT0	5300	100	14.55	14.57
802.11a- 20 MHz- HT0	5320	100	14.76	14.61
802.11a- 20 MHz- HT0	5500	100	15.43	15.52
802.11a- 20 MHz- HT0	5560	100	15.63	15.93
802.11a- 20 MHz- HT0	5580	100	15.63	15.76
802.11a- 20 MHz- HT0	5640	100	14.86	15.34
802.11a- 20 MHz- HT0	5660	100	15.46	15.04
802.11a- 20 MHz- HT0	5745	100	13.18	13.38
802.11a- 20 MHz- HT0	5825	100	13.33	13.39
802.11n- 40MHz- HT0	5190	100	14.75	15.08
802.11n- 40MHz- HT0	5230	100	14.47	14.73
802.11n- 40MHz- HT0	5270	100	15.12	15.27
802.11n- 40MHz- HT0	5310	100	12.94	13.72
802.11n- 40MHz- HT0	5510	100	12.69	14.19
802.11n- 40MHz- HT0	5550	100	15.93	15.95
802.11n- 40MHz- HT0	5590	100	16.08	15.98
802.11n- 40MHz- HT0	5630	100	15.62	15.74
802.11n- 40MHz- HT0	5670	100	15.42	15.81
802.11n- 40MHz- HT0	5710	100	15.28	15.65
802.11n- 40MHz- HT0	5755	100	13.27	13.30
802.11n- 40MHz- HT0	5795	100	13.02	12.78
802.11n-20MHz- VHT0	5180	100	14.93	14.38
802.11n-20MHz- VHT0	5200	100	14.61	14.33
802.11n-20MHz- VHT0	5220	100	14.63	14.03



Product Service

802.11n-20MHz-VHT0	5240	100	14.27	14.12
802.11n-20MHz-VHT0	5260	100	14.48	14.15
802.11n-20MHz-VHT0	5680	100	14.46	14.06
802.11n-20MHz-VHT0	5300	100	14.63	14.10
802.11n-20MHz-VHT0	5320	100	14.79	14.13
802.11n-20MHz-VHT0	5500	100	15.31	15.03
802.11n-20MHz-VHT0	5560	100	15.47	15.06
802.11n-20MHz-VHT0	5580	100	15.48	14.84
802.11n-20MHz-VHT0	5640	100	15.13	15.38
802.11ac-40MHz-VHT0	5190	100	15.1	15.09
802.11ac-40MHz-VHT0	5230	100	14.8	14.70
802.11ac-40MHz-VHT0	5270	100	15.22	15.36
802.11ac-40MHz-VHT0	5310	100	12.57	13.85
802.11ac-40MHz-VHT0	5510	100	12.98	14.03
802.11ac-40MHz-VHT0	5550	100	14.68	16.02
802.11ac-40MHz-VHT0	5590	100	12.16	15.71
802.11ac-40MHz-VHT0	5630	100	15.23	15.60
802.11ac-40MHz-VHT0	5670	100	14.74	15.75
802.11ac-40MHz-VHT0	5710	100	15.51	15.65
802.11ac-40MHz-VHT0	5755	100	13.36	13.27
802.11ac-40MHz-VHT0	5795	100	13.08	13.07
802.11ac-80MHz-VHT0	5210	100	12.77	12.88
802.11ac-80MHz-VHT0	5290	100	10.62	11.75
802.11ac-80MHz-VHT0	5530	100	12.17	12.24
802.11ac-80MHz-VHT0	5610	100	15.64	15.56
802.11ac-80MHz-VHT0	5690	100	16.34	16.61
802.11ac-80MHz-VHT0	5775	100	12.99	12.95



Product Service

SECTION 2

TEST DETAILS

Specific Absorption Rate Testing of the
DAQRI Smart Helmet



2.1 DASY5 MEASUREMENT SYSTEM

2.1.1 System Description

The DASY5 system for performing compliance tests consists of the following items:

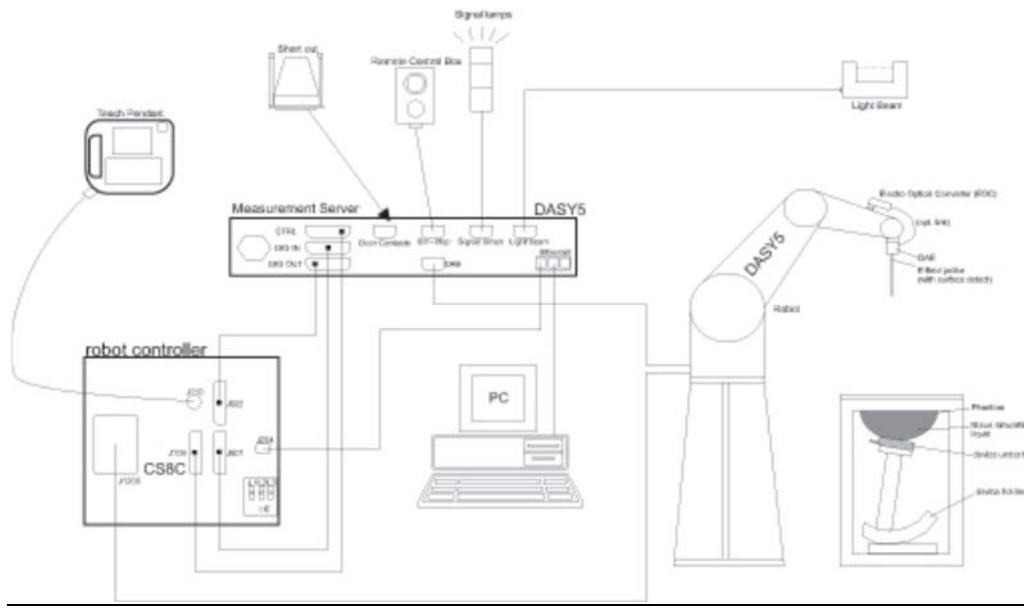


Figure 1 System Description Diagram

A standard high precision 6-axis robot (Stäubli TX=RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).

An isotropic field probe optimized and calibrated for the targeted measurement.

A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.

The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.

The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.

The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.

A computer running Win7 professional operating system and the DASY5 software.

Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.

The phantom, the device holder and other accessories according to the targeted measurement.



2.1.2 Probe Specification

The probes used by the DASY system are isotropic E-field probes, constructed with a symmetric design and a triangular core. The probes have built-in shielding against static charges and are contained within a PEEK enclosure material. These probes are specially designed and calibrated for use in liquids with high permittivities. The frequency range of the probes are from 6 MHz to 6 GHz.

2.1.3 Data Acquisition Electronics

The data acquisition electronics (DAE4 or DAE3) consist of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder with a control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information, as well as an optical uplink for commands and the clock.

The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection. The input impedance of both the DAE4 as well as of the DAE3 box is 200MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

2.1.4 SAR Evaluation Description

The DASY5 software includes all numerical procedures necessary to evaluate the spatial peak SAR values.

Based on the IEEE 1528 standard, a new algorithm has been implemented. The spatial-peak SAR can be computed over any required mass.

The base for the evaluation is a "cube" measurement in a volume of 30mm³ (7x7x7 points). The measured volume must include the 1 g and 10 g cubes with the highest averaged SAR values. For that purpose, the centre of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan. If the 10g cube or both cubes are not entirely inside the measured volumes, the system issues a warning regarding the evaluated spatial peak values within the Post processing engine (SEMCAD X). This means that if the measured volume is shifted, higher values might be possible. To get the correct values you can use a finer measurement grid for the area scan. In complicated field distributions, a large grid spacing for the area scan might miss some details and give an incorrectly interpolated peak location.

The entire evaluation of the spatial peak values is performed within the Post-processing engine (SEMCAD X). The system always gives the maximum values for the 1 g and 10 g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

1. extraction of the measured data (grid and values) from the Zoom Scan
2. calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
3. generation of a high-resolution mesh within the measured volume
4. interpolation of all measured values from the measurement grid to the high-resolution grid
5. extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
6. calculation of the averaged SAR within masses of 1 g and 10 g



2.1.5 Interpolation, Extrapolation and Detection of Maxima

The probe is calibrated at the centre of the dipole sensors which is located 1 to 2.7mm away from the probe tip. During measurements, the probe stops shortly above the phantom surface, depending on the probe and the surface detecting system. Both distances are included as parameters in the probe configuration file. The software always knows exactly how far away the measured point is from the surface. As the probe cannot directly measure at the surface, the values between the deepest measured point and the surface must be extrapolated.

In DASY5, the choice of the coordinate system defining the location of the measurement points has no influence on the uncertainty of the interpolation, Maxima Search and extrapolation routines. The interpolation, extrapolation and maximum search routines are all based on the modified Quadratic Shepard's method [1]. Thereby, the interpolation scheme combines a least-square fitted function method and a weighted average method which are the two basic types of computational interpolation and approximation. The DASY5 routines construct a once-continuously differentiable function that interpolates the measurement values as follows:

For each measurement point a trivariate (3-D) / bivariate (2-D) quadratic is computed. It interpolates the measurement values at the data point and forms a least-square fit to neighbouring measurement values. The spatial location of the quadratic with respect to the measurement values is attenuated by an inverse distance weighting. This is performed since the calculated quadratic will fit measurement values at nearby points more accurate than at points located further away.

After the quadratics are calculated for all measurement points, the interpolating function is calculated as a weighted average of the quadratics.

There are two control parameters that govern the behaviour of the interpolation method. One specifies the number of measurement points to be used in computing the least-square fits for the local quadratics. These measurement points are the ones nearest the input point for which the quadratic is being computed. The second parameter specifies the number of measurement points that will be used in calculating the weights for the quadratics to produce the final function. The input data points used there are the ones nearest the point at which the interpolation is desired. Appropriate defaults are chosen for each of the control parameters

The trivariate quadratics that have been previously computed for the 3-D interpolation and whose input data are at the closest distance from the phantom surface, are used in order to extrapolate the fields to the surface of the phantom.

In order to determine all the field maxima in 2-D (Area Scan) and 3-D (Zoom Scan), the measurement grid is refined by a default factor of 10 and the interpolation function is used to evaluate all field values between corresponding measurement points. Subsequently, a linear search is applied to find all the candidate maxima. In a last step, non physical maxima are removed and only those maxima which are within 2 dB of the global maximum value are retained.

In the Area Scan, the gradient of the interpolation function is evaluated to find all the extrema of the SAR distribution. The uncertainty on the locations of the extrema is less than 1/20 of the grid size. Only local maxima within 2 dB of the global maximum are searched and passed for the Zoom Scan measurement.

In the Zoom Scan, the interpolation function is used to extrapolate the Peak SAR from the lowest measurement points to the inner phantom surface (the extrapolation distance). The



Product Service

uncertainty increases with the extrapolation distance. To keep the uncertainty within 1% for the 1 g and 10 g cubes, the extrapolation distance should not be larger than 5mm.

2.1.6 Averaging and Determination of Spacial Peak SAR

The interpolated data is used to average the SAR over the 1g and 10g cubes by spatially discretising the entire measured volume. The resolution of this spatial grid used to calculate the averaged SAR is 1mm or about 42875 interpolated points. The resulting volumes are defined as cubical volumes containing the appropriate tissue parameters that are centred at the location. The location is defined as the centre of the incremental volume (voxel).

The spatial-peak SAR must be evaluated in cubical volumes containing a mass that is within 5% of the required mass. The cubical volume centred at each location, as defined above, should be expanded in all directions until the desired value for the mass is reached, with no surface boundaries of the averaging volume extending beyond the outermost surface of the considered region. In addition, the cubical volume should not consist of more than 10% of air. If these conditions are not satisfied then the centre of the averaging volume is moved to the next location. Otherwise, the exact size of the final sampling cube is found using an inverse polynomial approximation algorithm, leading to results with improved accuracy. If one boundary of the averaging volume reaches the boundary of the measured volume during its expansion, it will not be evaluated at all. Reference is kept of all locations used and those not used for averaging the SAR. All average SAR values are finally assigned to the centred location in each valid averaging volume.

All locations included in an averaging volume are marked to indicate that they have been used at least once. If a location has been marked as used, but has never been assigned to the centre of a cube, the highest averaged SAR value of all other cubical volumes which have used this location for averaging is assigned to this location. Only those locations that are not part of any valid averaging volume should be marked as unused. For the case of an unused location, a new averaging volume must be constructed which will have the unused location centred at one surface of the cube. The remaining five surfaces are expanded evenly in all directions until the required mass is enclosed, regardless of the amount of included air. Of the six possible cubes with one surface centred on the unused location, the smallest cube is used, which still contains the required mass.

If the final cube containing the highest averaged SAR touches the surface of the measured volume, an appropriate warning is issued within the Post-processing engine.



2.2 WLAN 2450 MHz HEAD SAR TEST RESULTS

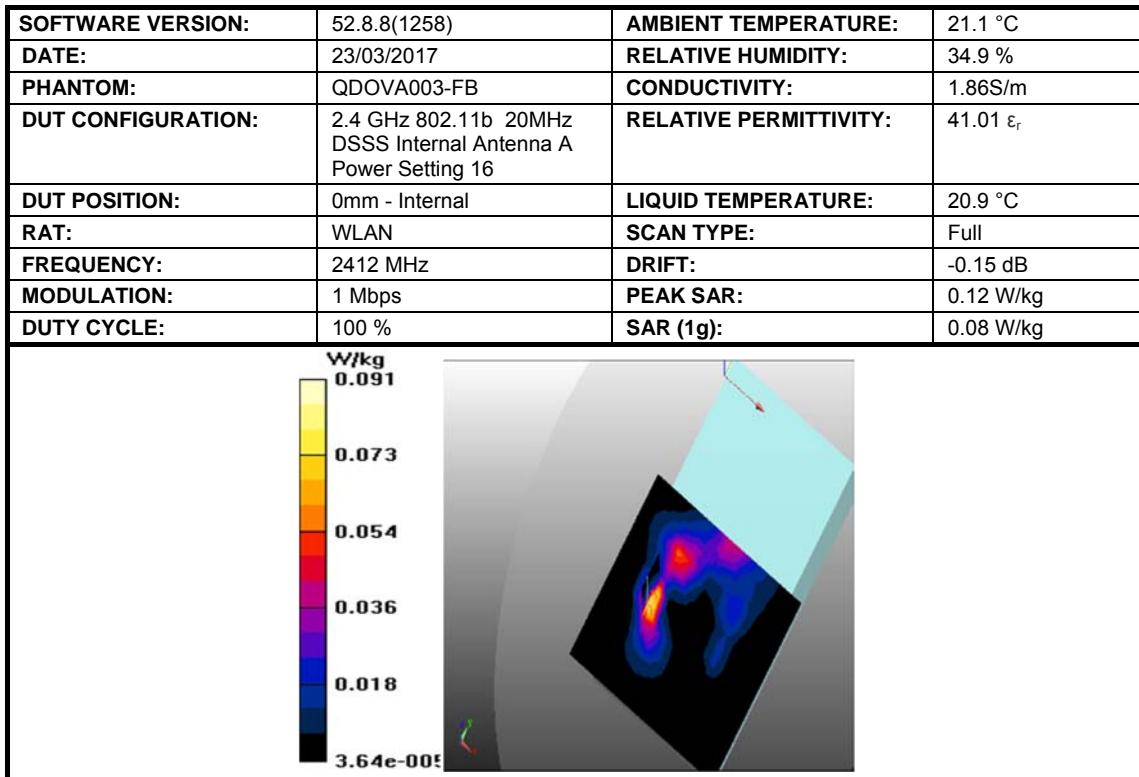


Figure 2: SAR Head Testing Results for the DAQRI Smart Helmet at 2412 MHz.

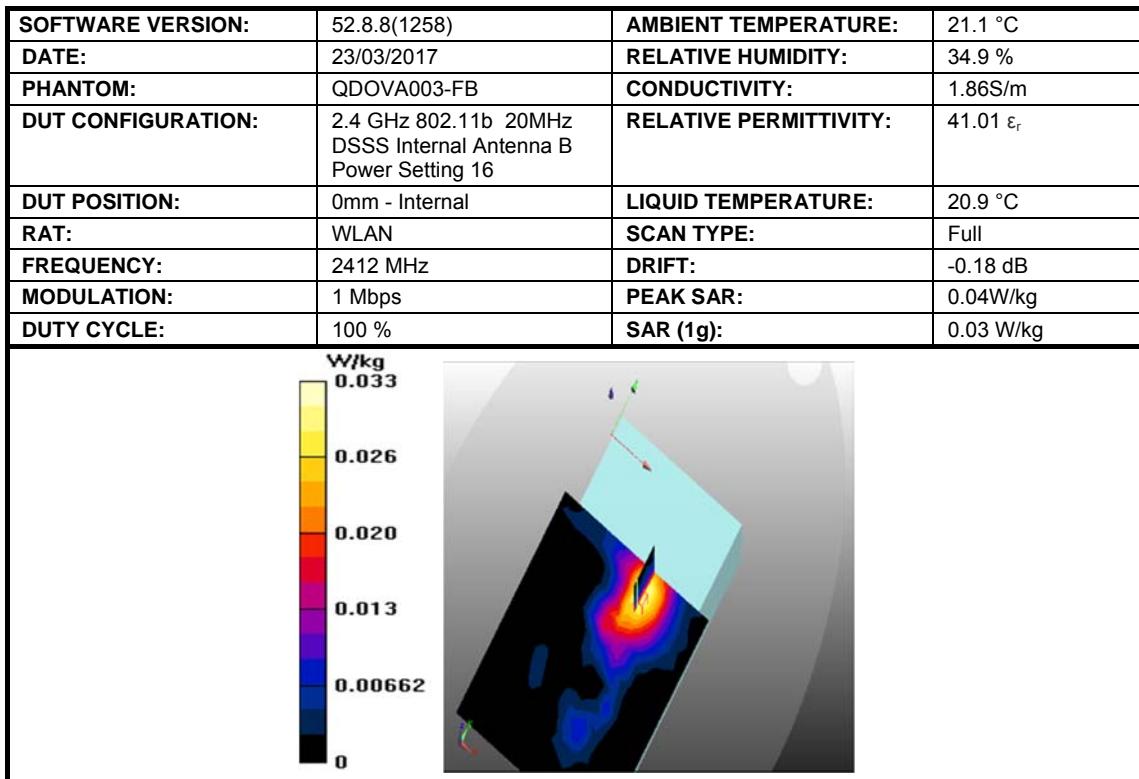


Figure 3: SAR Head Testing Results for the DAQRI Smart Helmet at 2412 MHz.



2.3 WLAN 2450 MHz BODY-EXTREMITY SAR TEST RESULTS

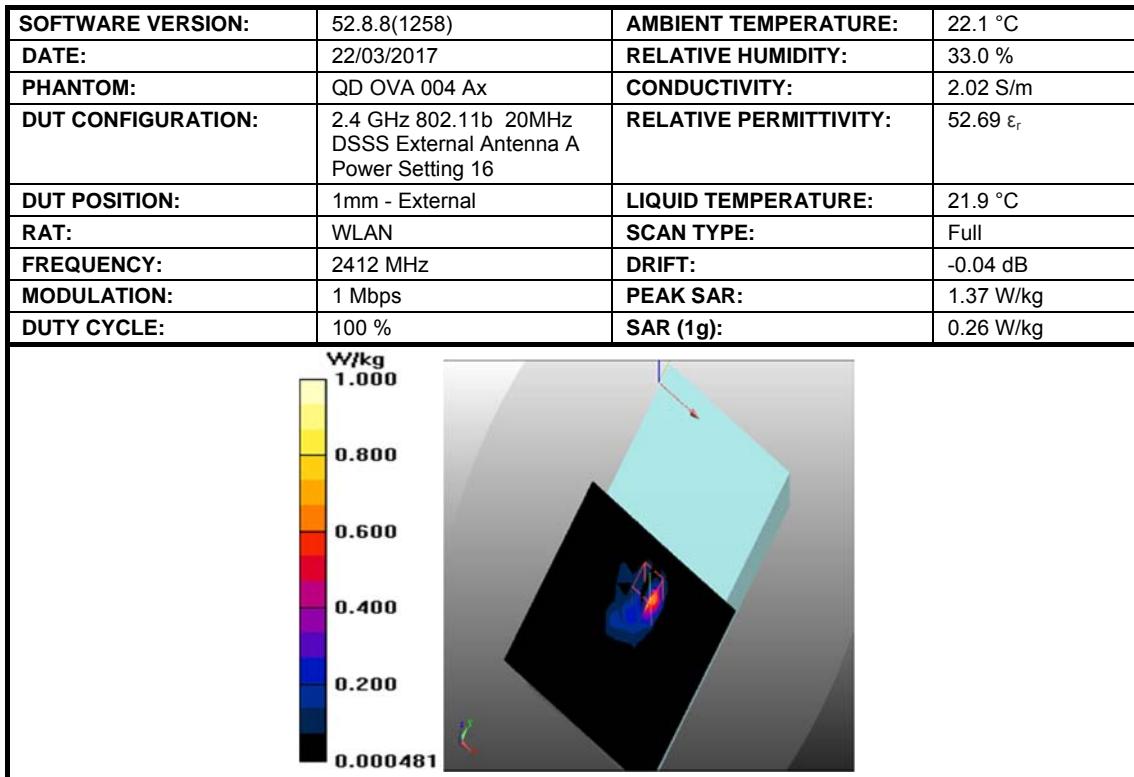


Figure 4: SAR Body-Extremity Testing Results for the DAQRI Smart Helmet at 2412 MHz.

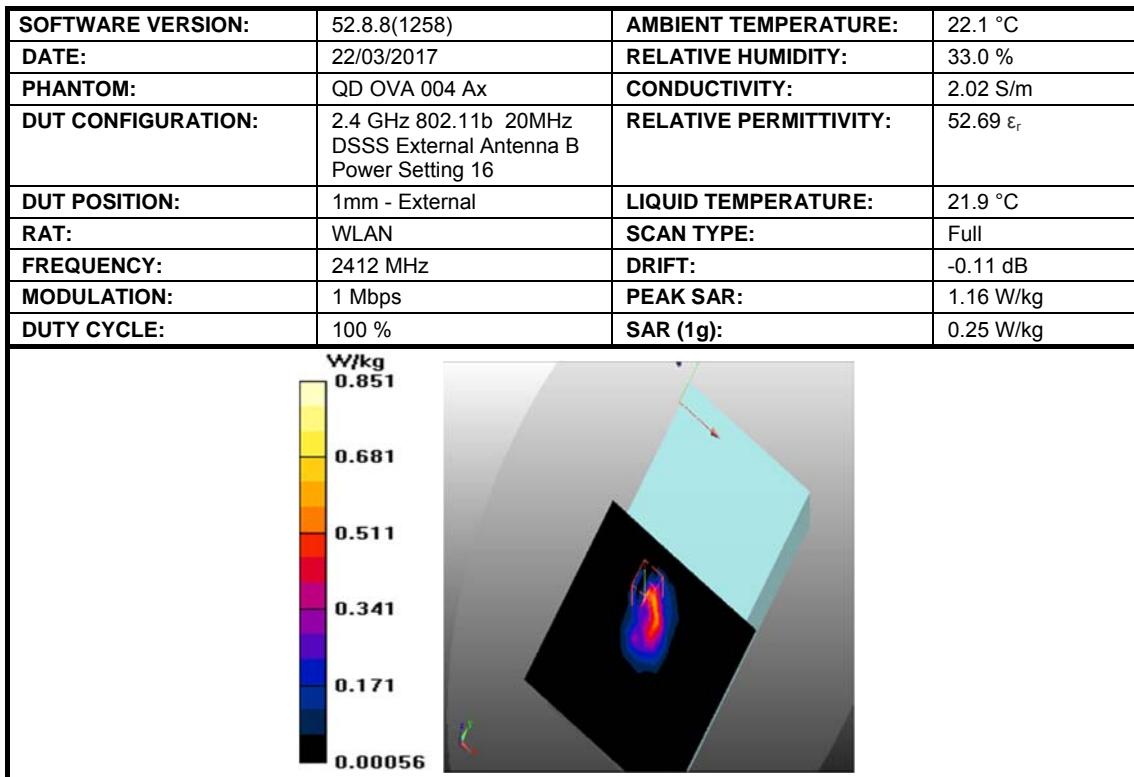


Figure 5: SAR Body-Extremity Testing Results for the DAQRI Smart Helmet at 2412 MHz.



2.4 WLAN U-NII-2A HEAD SAR TEST RESULTS

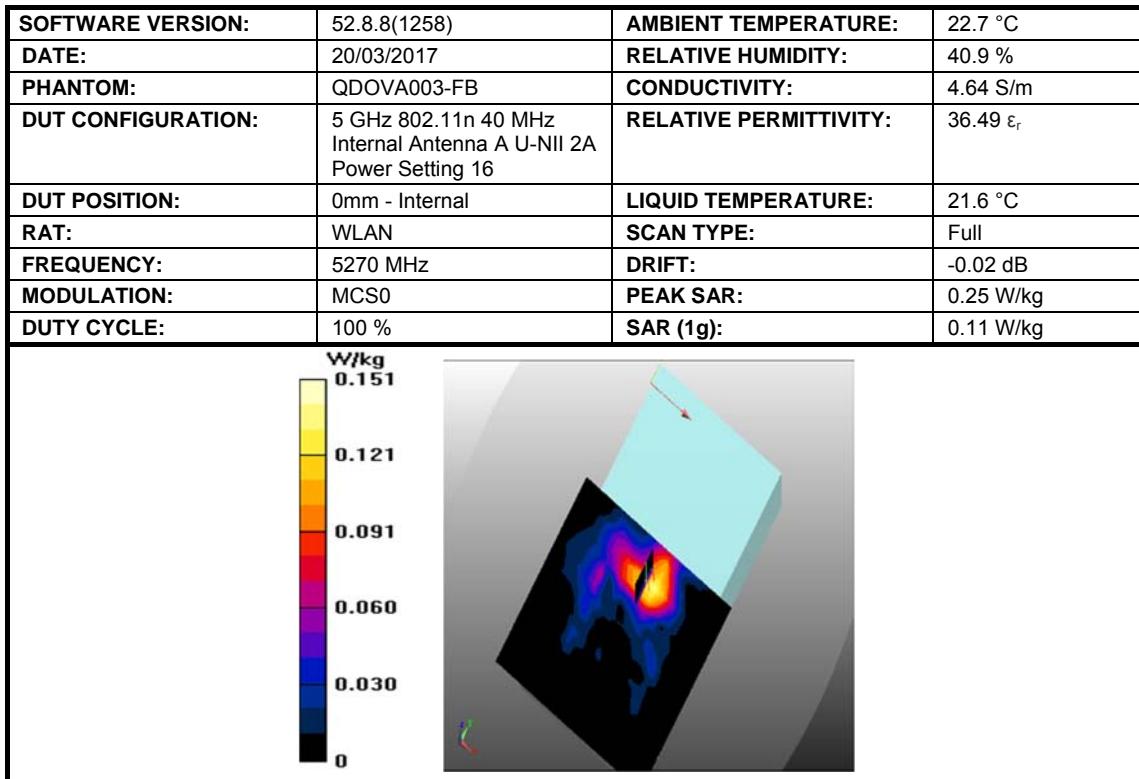


Figure 6: SAR Head Testing Results for the DAQRI Smart Helmet at 5270 MHz.

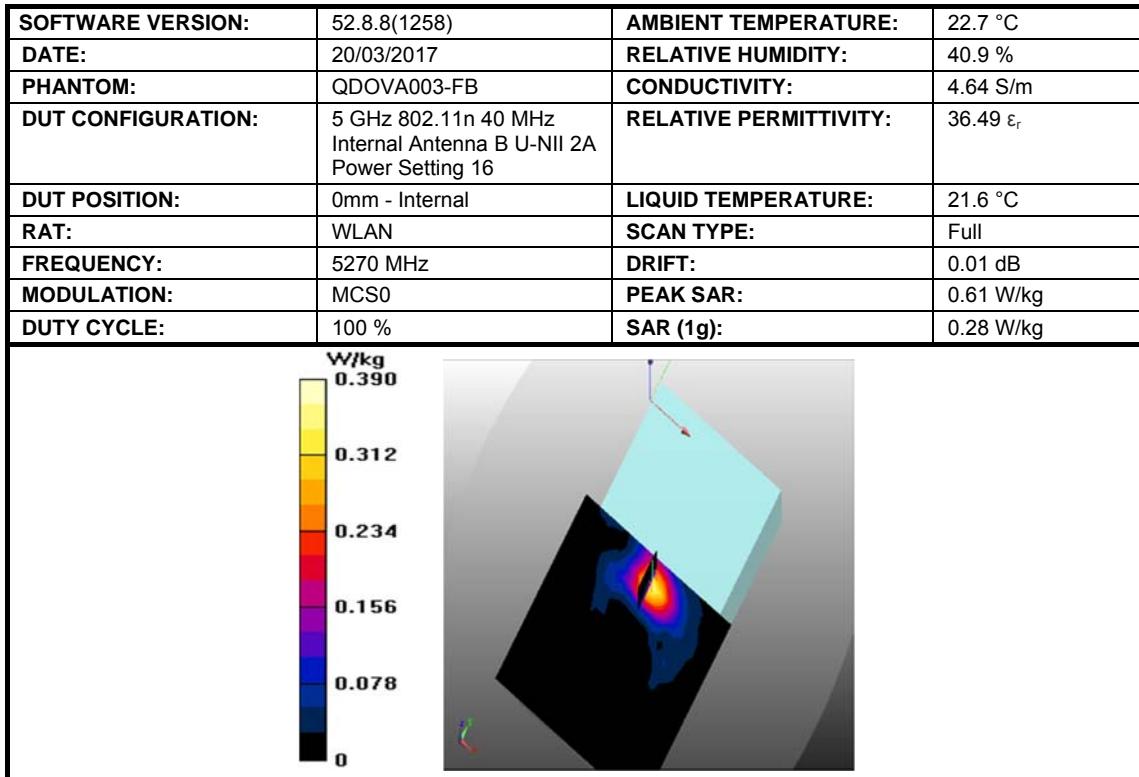


Figure 7: SAR Head Testing Results for the DAQRI Smart Helmet at 5270 MHz.



2.5 WLAN U-NII-2A BODY-EXTREMITY SAR TEST RESULTS

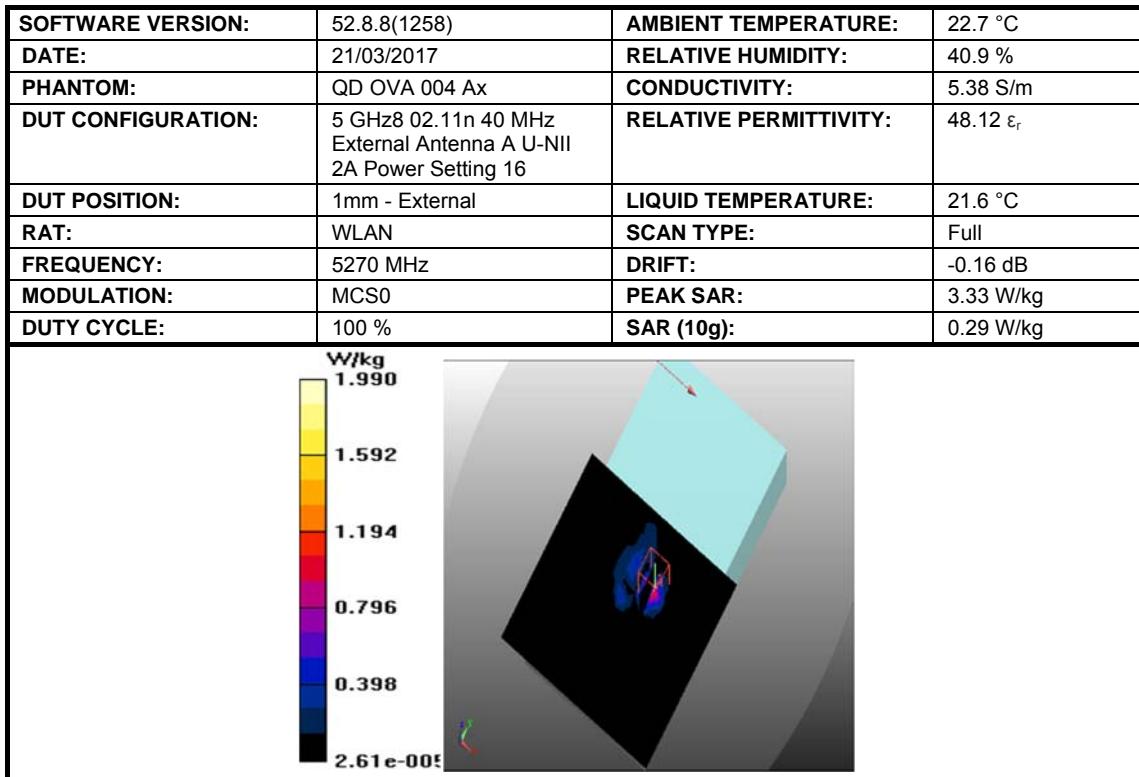


Figure 8: SAR Body-Extremity Testing Results for the DAQRI Smart Helmet at 5270 MHz.

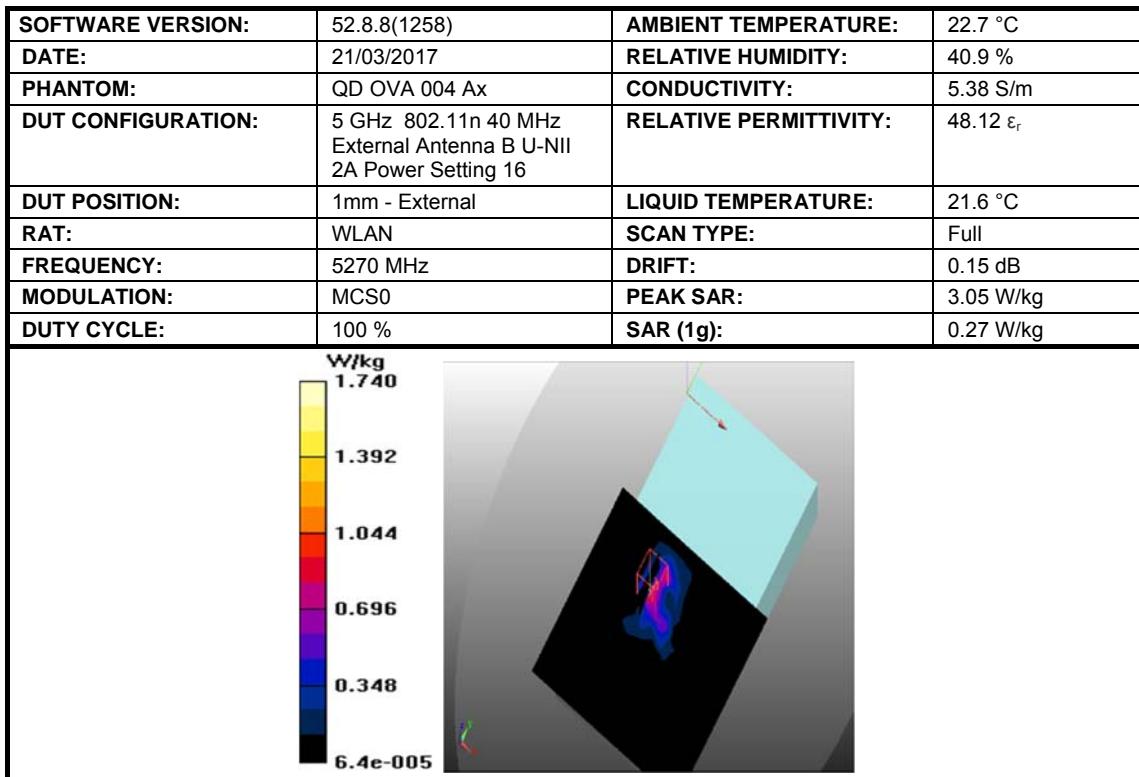


Figure 9: SAR Body-Extremity Testing Results for the DAQRI Smart Helmet at 5270 MHz.



2.6 WLAN U-NII-2C HEAD SAR TEST RESULTS

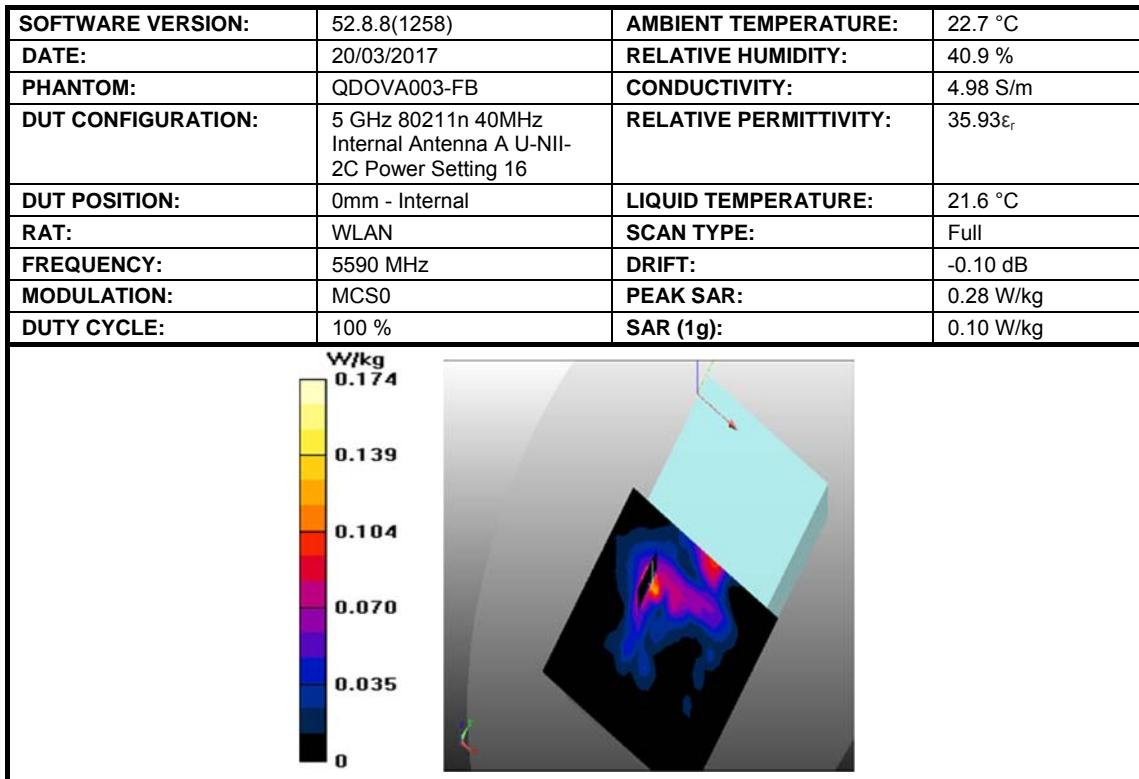


Figure 10: SAR Head Testing Results for the DAQRI Smart Helmet at 5590 MHz.

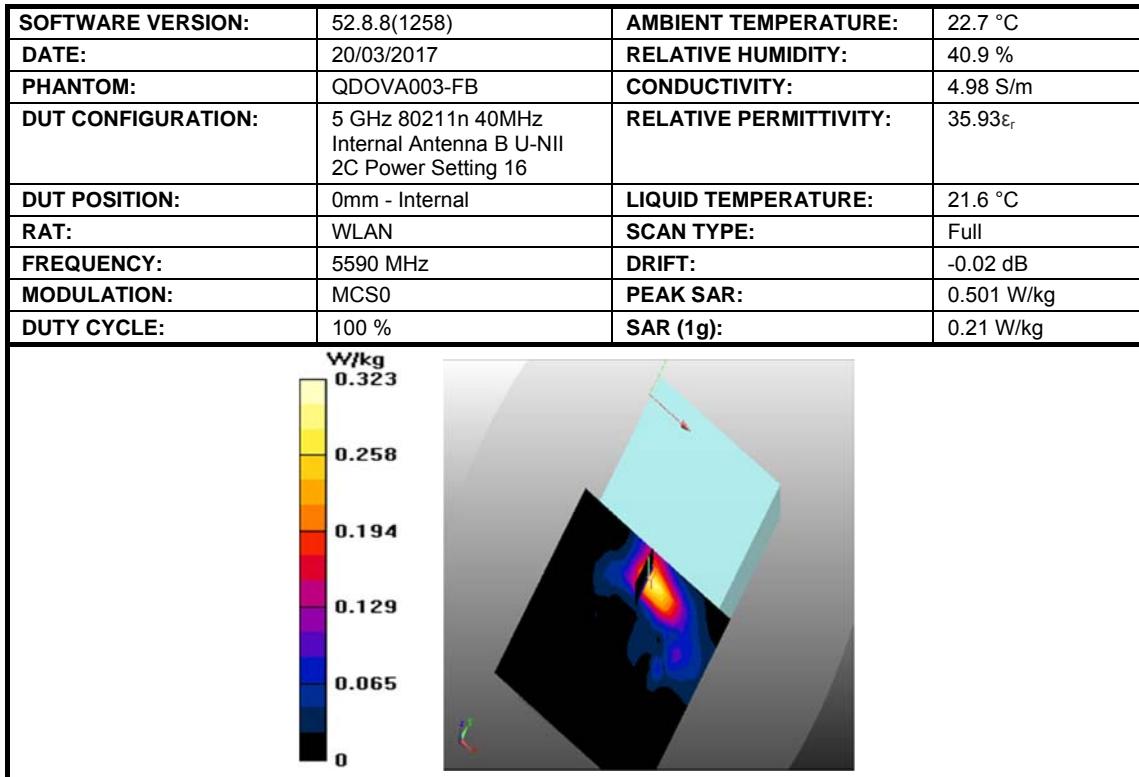


Figure 11: SAR Head Testing Results for the DAQRI Smart Helmet at 5590 MHz.



2.7 WLAN U-NII-2C BODY-EXTREMITY SAR TEST RESULTS

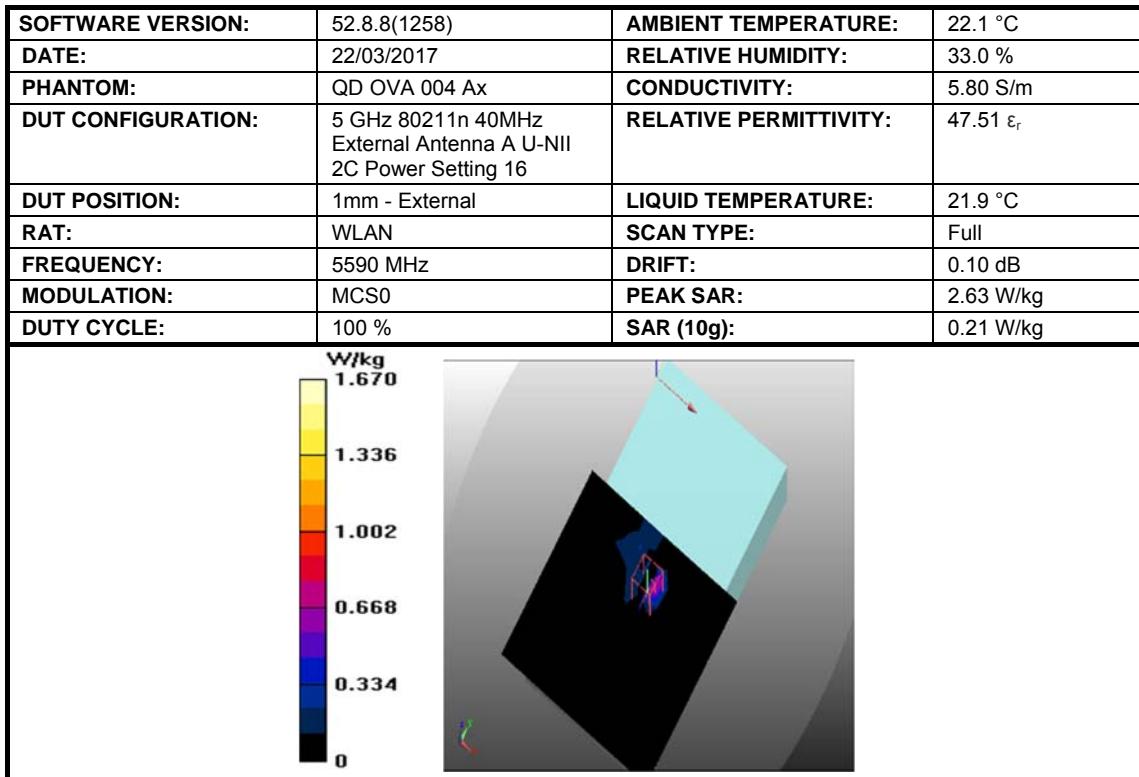


Figure 12: SAR Body-Extremity Testing Results for the DAQRI Smart Helmet at 5590 MHz.

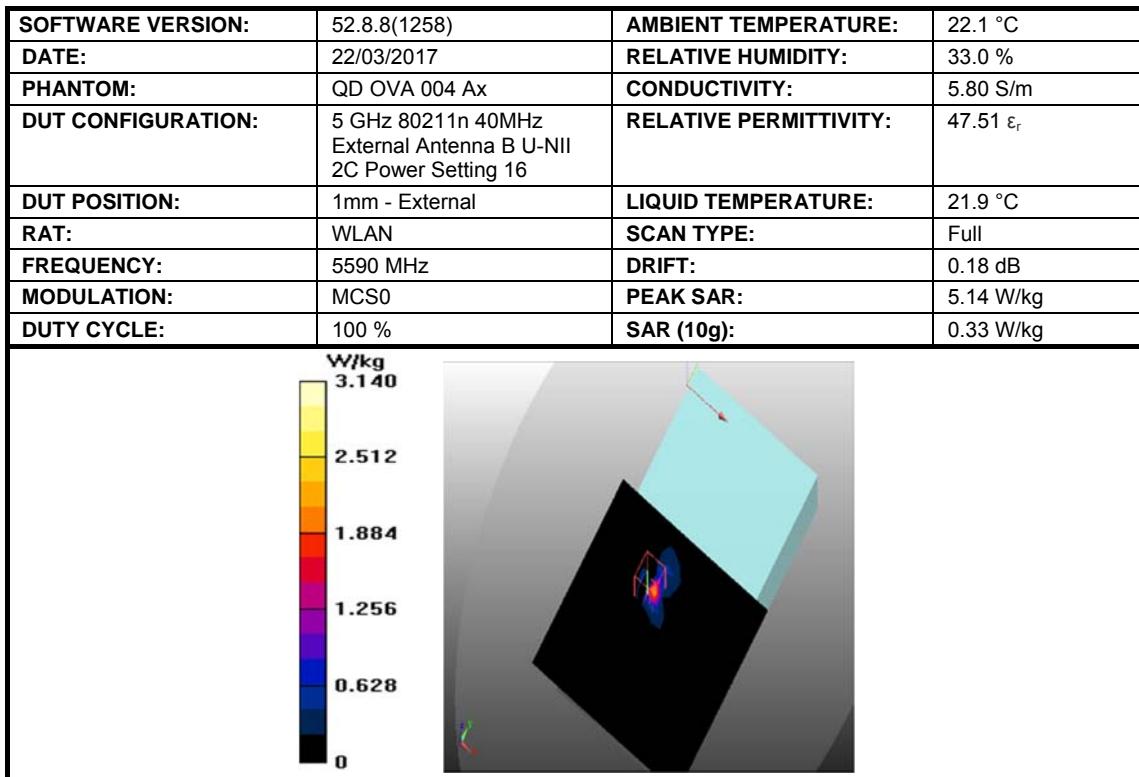


Figure 13: SAR Body-Extremity Testing Results for the DAQRI Smart Helmet at 5590 MHz.



2.8 WLAN U-NII-3 HEAD SAR TEST RESULTS

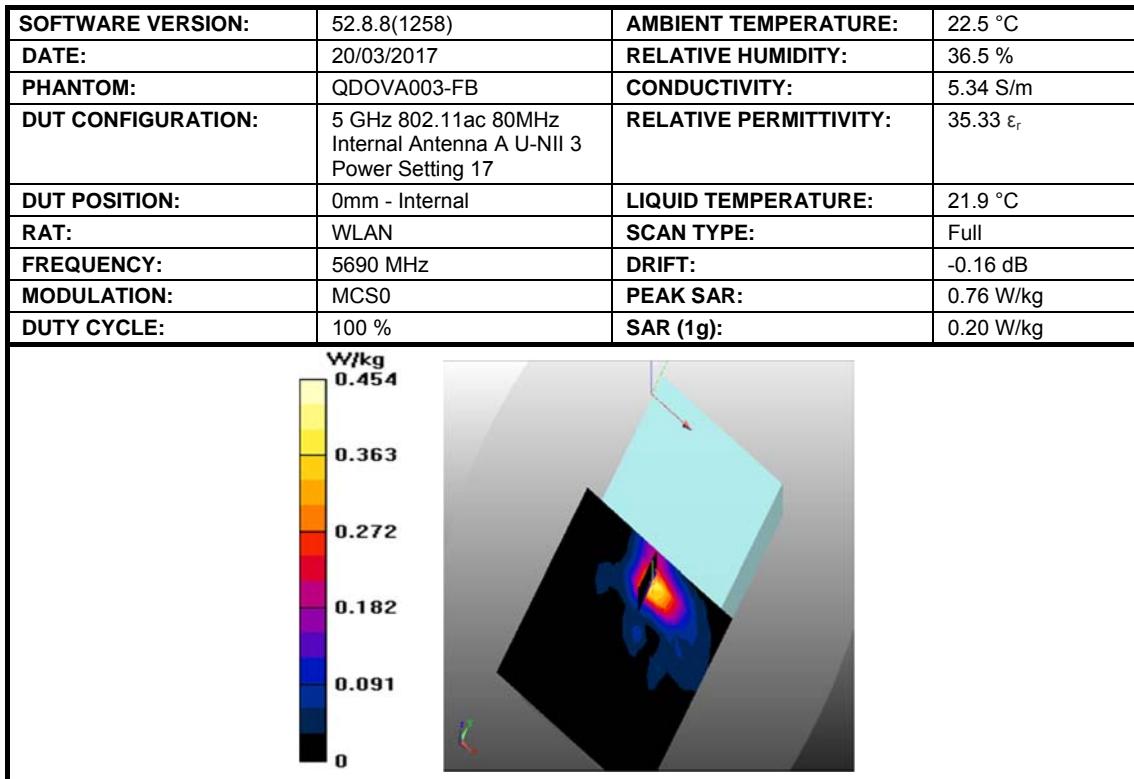


Figure 14: SAR Head Testing Results for the DAQRI Smart Helmet at 5690 MHz.

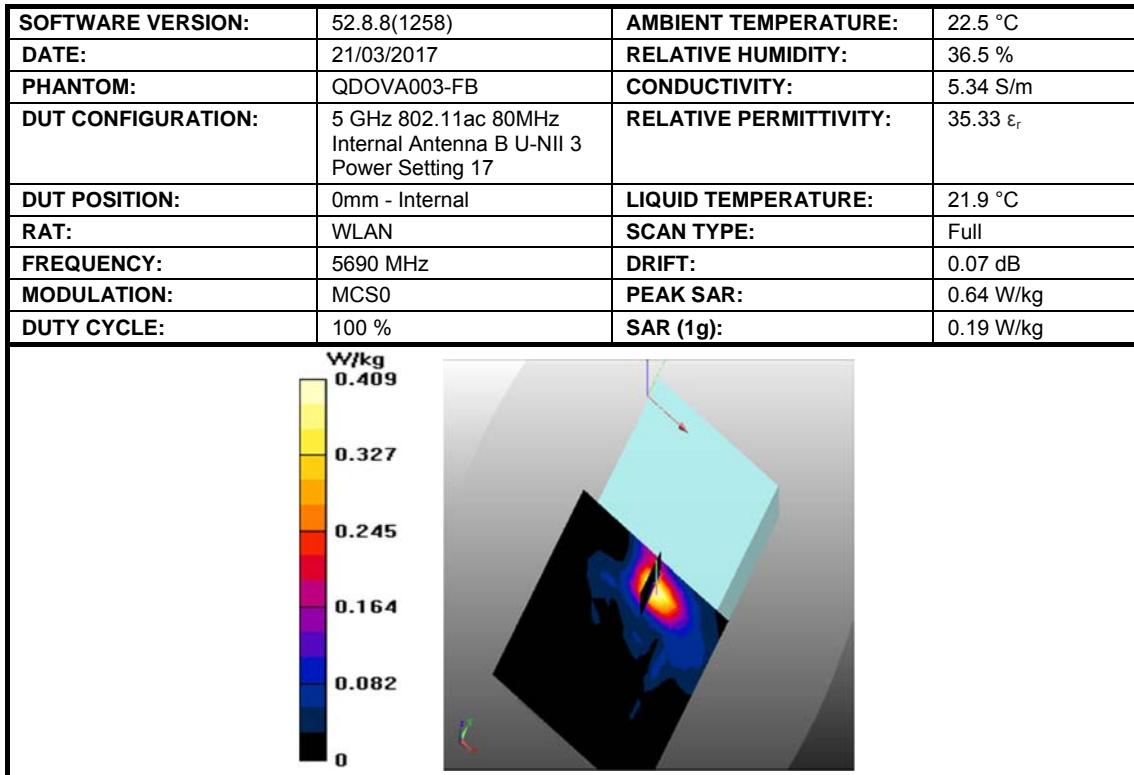


Figure 15: SAR Head Testing Results for the DAQRI Smart Helmet at 5690 MHz.



Product Service

2.9 WLAN U-NII-3 BODY-EXTREMITY SAR TEST RESULTS

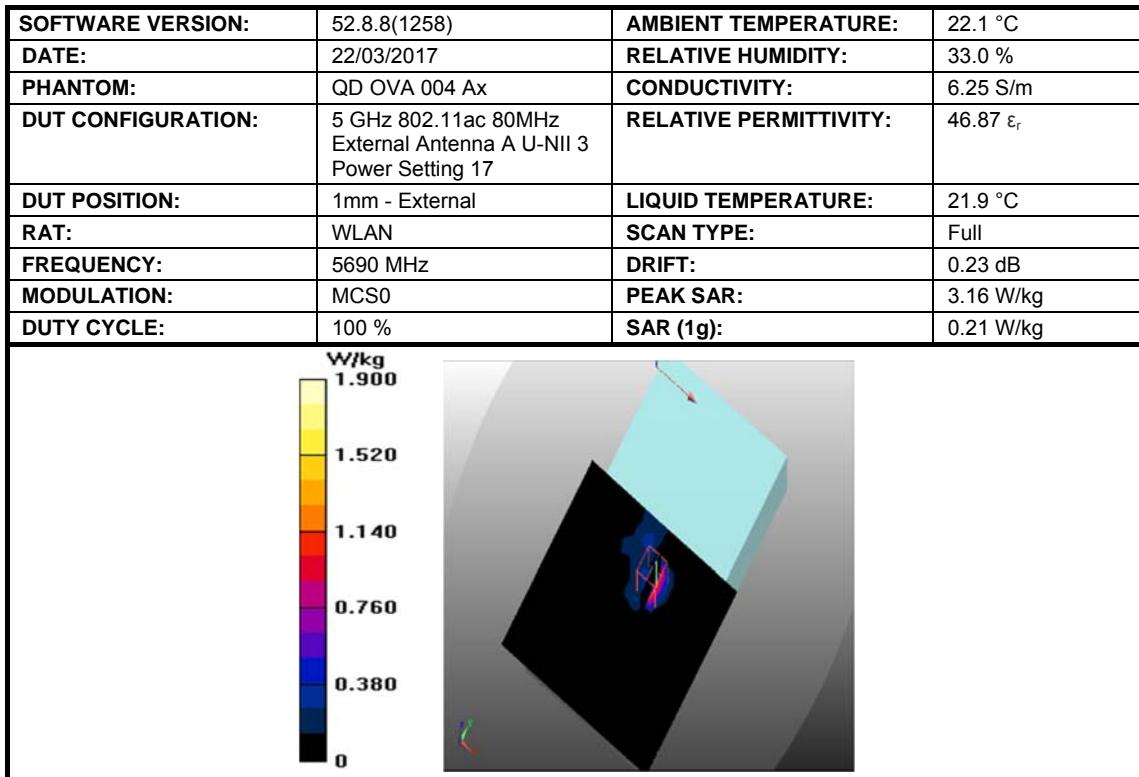


Figure 16: SAR Body-Extremity Testing Results for the DAQRI Smart Helmet at 5690 MHz.

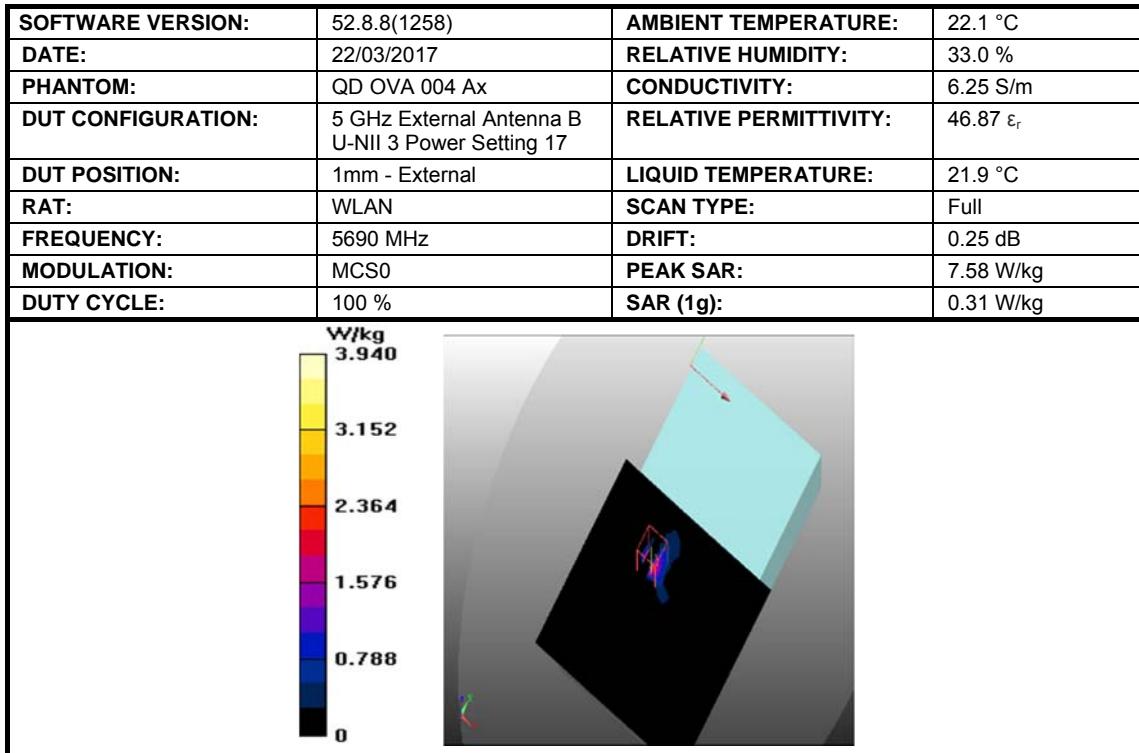


Figure 16: SAR Body-Extremity Testing Results for the DAQRI Smart Helmet at 5690 MHz.



Product Service

SECTION 3

TEST EQUIPMENT USED



Product Service

3.1 TEST EQUIPMENT USED

The following test equipment was used at TÜV SÜD Product Service:

Instrument Description	Manufacturer	Model Type	TE Number	Cal Period (months)	Calibration Due Date
10MHz - 2.5GHz, 3W, Amplifier	Vectawave Technology	VTL5400	51	-	TU
Power Sensor	Rohde & Schwarz	NRV-Z1	60	12	16-Jun-2017
Signal Generator	Hewlett Packard	ESG4000A	61	12	12-Jul-2017
Attenuator (20dB, 10W)	Weinschel	37-20-34	482	12	26-Oct-2017
Bi-directional Coupler	IndexSar Ltd	7401 (VDC0830-20)	2414	-	TU
Thermometer	Digitron	T208	64	12	13-May-2017
Hygrometer	Rotronic	I-1000	2784	12	26-Apr-2017
Power Sensor	Rohde & Schwarz	NRV-Z5	2878	12	16-Jun-2017
Dual Channel Power Meter	Rohde & Schwarz	NRVD	3259	12	16-Jun-2017
Data Acquisition Electronics	Speag	DAE 4 - SD 000 D04 BM	4689	12	12-Dec-2017
Measurement Server	Speag	DASY 5 Measurement Server	4692	-	TU
Body Phantom	Speag	ELI Phantom	4699	-	TU
Body Phantom	Speag	ELI Phantom	4833	-	TU
Dosimetric SAR Probe	Speag	EX3DV4	4700	12	16-Dec-2017
Mounting Platform for TX90XL Robot and Phantoms	Speag	MP6C-TX90XL Mounting Platform Extended	4702	-	TU
Robot	Speag	TX90 XLSpeag Robot	4704	-	TU
2450MHz Dipole	Speag	D2450V2	3875	12	14-Dec-2017
5000 MHz Dipole	Speag	D5000V2	4796	12	14-Dec-2017
HBBL Fluid	Speag	Batch 2	N/A	Weekly	06-Mar-2017
MBBL Fluid	Speag	Batch 1	N/A	Weekly	06-Mar-2017

TU = Traceability Unscheduled



Product Service

3.2 TEST SOFTWARE

The following software was used to control the TÜV SÜD Product Service DASY System.

Instrument	Version Number
DASY system	52.8.8(1258)



Product Service

3.3 DIELECTRIC PROPERTIES OF SIMULANT LIQUIDS

The fluid properties of the simulant fluids used during routine SAR evaluation meet the dielectric properties required KDB 865665.

The dielectric properties of the tissue simulant liquids used for the SAR testing at TÜV SÜD Product Service are as follows:-

Fluid Type and Frequency	Relative Permittivity Target	Relative Permittivity Measured	Conductivity Target	Conductivity Measured
2450 MHz HBBL	39.20	41.01	1.80	1.86
2450 MHz MBBL	52.70	52.69	1.95	2.02
5200 MHz HBBL	35.99	36.49	4.66	4.64
5200 MHz MBBL	49.01	48.12	5.30	5.38
5500 MHz HBBL	35.64	35.93	4.96	4.98
5500 MHz MBBL	48.61	47.51	5.65	5.80
5800 MHz HBBL	35.30	35.33	5.27	5.34
5800 MHz MBBL	48.20	46.87	6.00	6.25



Product Service

3.4 TEST CONDITIONS

3.4.1 Test Laboratory Conditions

Ambient temperature: Within +15°C to +35°C.

The actual temperature during the testing ranged from 21.1°C to 22.7°C.

The actual humidity during the testing ranged from 33.0% to 40.9% RH.

3.4.2 Test Fluid Temperature Range

Frequency	Fluid	Min Temperature °C	Max Temperature °C
2450 MHz	HBBL	20.9	20.9
2450 MHz	MBBL	21.9	21.9
5200 MHz	HBBL	21.6	21.6
5200 MHz	MBBL	21.6	21.6
5500 MHz	HBBL	21.6	21.6
5500 MHz	MBBL	21.9	21.9
5800 MHz	HBBL	21.9	21.9
5800 MHz	MBBL	21.9	21.9

3.4.3 SAR Drift

The maximum SAR Drift was recorded as 0.18 dB for head and 0.25 dB for body.



Product Service

3.5 MEASUREMENT UNCERTAINTY

Head, Full SAR Measurements, 3 GHz to 6 GHz Using Probe EX3DV4 - SN3759

Source of Uncertainty	Uncertainty \pm %	Probability distribution	Div	c_i (1g)	Standard Uncertainty \pm % (1g)	$V_i (V_{eff})$
Measurement System						
Probe calibration	6.6	N	1.00	1.00	6.6	Infinity
Axial Isotropy	4.7	R	1.73	0.70	1.9	Infinity
Hemispherical Isotropy	9.6	R	1.73	0.70	3.9	Infinity
Boundary effect	2.0	R	1.73	1.00	1.2	Infinity
Linearity	4.7	R	1.73	1.00	2.7	Infinity
System Detection limits	1.0	R	1.73	1.00	0.6	Infinity
Modulation response	2.4	R	1.73	1.00	1.4	Infinity
Readout electronics	0.3	N	1.00	1.00	0.3	Infinity
Response time	0.8	R	1.73	1.00	0.5	Infinity
Integration time	2.6	R	1.73	1.00	1.5	Infinity
RF ambient noise	3.0	R	1.73	1.00	1.7	Infinity
RF ambient reflections	3.0	R	1.73	1.00	1.7	Infinity
Probe positioner	0.8	R	1.73	1.00	0.5	Infinity
Probe positioning	6.7	R	1.73	1.00	3.9	Infinity
Max SAR Evaluation	4.0	R	1.73	1.00	2.3	Infinity
Test sample related						
Device Positioning	2.9	N	1.00	1.00	2.9	145
Device Holder	3.6	N	1.00	1.00	3.6	5
Input Power and SAR Drift	5.0	R	1.73	1.00	0.1	Infinity
Phantom and Setup						
Phantom uncertainty	6.6	R	1.73	1.00	3.8	Infinity
SAR Correction	1.9	R	1.73	1.00	1.1	Infinity
Liquid conductivity Meas.	2.5	R	1.73	0.78	1.1	Infinity
Liquid Permittivity Meas.	2.5	R	1.73	0.23	0.3	Infinity
Temp. Unc. Conductivity	3.4	R	1.73	0.78	1.5	Infinity
Temp. Unc. Permittivity	0.4	R	1.73	0.23	0.1	Infinity
Combined Standard Uncertainty		RSS			11.9	748
Expanded Standard Uncertainty		K=2			23.9	



Product Service

Head, Full SAR Measurements, 300 MHz to 3 GHz Using Probe EX3DV4 - SN3759

Source of Uncertainty	Uncertainty ± %	Probability distribution	Div	c _i (1g)	Standard Uncertainty ± % (1g)	v _i (v _{eff})
Measurement System						
Probe calibration	6.0	N	1.00	1.00	6.0	Infinity
Axial Isotropy	4.7	R	1.73	0.70	1.9	Infinity
Hemispherical Isotropy	9.6	R	1.73	0.70	3.9	Infinity
Boundary effect	1.0	R	1.73	1.00	0.6	Infinity
Linearity	4.7	R	1.73	1.00	2.7	Infinity
System Detection limits	1.0	R	1.73	1.00	0.6	Infinity
Modulation response	2.4	R	1.73	1.00	1.4	Infinity
Readout electronics	0.3	N	1.00	1.00	0.3	Infinity
Response time	0.8	R	1.73	1.00	0.5	Infinity
Integration time	2.6	R	1.73	1.00	1.5	Infinity
RF ambient noise	3.0	R	1.73	1.00	1.7	Infinity
RF ambient reflections	3.0	R	1.73	1.00	1.7	Infinity
Probe positioner	0.4	R	1.73	1.00	0.2	Infinity
Probe positioning	2.9	R	1.73	1.00	1.7	Infinity
Max SAR Evaluation	2.0	R	1.73	1.00	1.2	Infinity
Test sample related						
Device Positioning	2.9	N	1.00	1.00	2.9	145
Device Holder	3.6	N	1.00	1.00	3.6	5
Input Power and SAR Drift	5.0	R	1.73	1.00	0.1	Infinity
Phantom and Setup						
Phantom uncertainty	6.1	R	1.73	1.00	3.5	Infinity
SAR Correction	1.9	R	1.73	1.00	1.1	Infinity
Liquid conductivity Meas.	2.5	R	1.73	0.78	1.1	Infinity
Liquid Permittivity Meas.	2.5	R	1.73	0.23	0.3	Infinity
Temp. Unc. Conductivity	3.4	R	1.73	0.78	1.5	Infinity
Temp. Unc. Permittivity	0.4	R	1.73	0.23	0.1	Infinity
Combined Standard Uncertainty		RSS			10.8	361
Expanded Standard Uncertainty		K=2			21.5	



Product Service

Body, Full SAR Measurements, 300 MHz to 3 GHz Using Probe EX3DV4 - SN3759

Source of Uncertainty	Uncertainty ± %	Probability distribution	Div	c _i (1g)	Standard Uncertainty ± % (1g)	v _i (v _{eff})
Measurement System						
Probe calibration	6.0	N	1.00	1.00	6.0	Infinity
Axial Isotropy	4.7	R	1.73	0.70	1.9	Infinity
Hemispherical Isotropy	9.6	R	1.73	0.70	3.9	Infinity
Boundary effect	1.0	R	1.73	1.00	0.6	Infinity
Linearity	4.7	R	1.73	1.00	2.7	Infinity
System Detection limits	1.0	R	1.73	1.00	0.6	Infinity
Modulation response	2.4	R	1.73	1.00	1.4	Infinity
Readout electronics	0.3	N	1.00	1.00	0.3	Infinity
Response time	0.8	R	1.73	1.00	0.5	Infinity
Integration time	2.6	R	1.73	1.00	1.5	Infinity
RF ambient noise	3.0	R	1.73	1.00	1.7	Infinity
RF ambient reflections	3.0	R	1.73	1.00	1.7	Infinity
Probe positioner	0.4	R	1.73	1.00	0.2	Infinity
Probe positioning	2.9	R	1.73	1.00	1.7	Infinity
Max SAR Evaluation	5.0	R	1.73	1.00	1.2	Infinity
Test sample related						
Device Positioning	2.9	N	1.00	1.00	2.9	145
Device Holder	3.6	N	1.00	1.00	3.6	5
Input Power and SAR Drift	0.3	R	1.73	1.00	0.1	Infinity
Phantom and Setup						
Phantom uncertainty	6.1	R	1.73	1.00	3.5	Infinity
SAR Correction	1.9	R	1.73	1.00	1.1	Infinity
Liquid conductivity Meas.	2.5	R	1.73	0.78	1.1	Infinity
Liquid Permittivity Meas.	2.5	R	1.73	0.23	0.3	Infinity
Temp. Unc. Conductivity	3.4	R	1.73	0.78	1.5	Infinity
Temp. Unc. Permittivity	0.4	R	1.73	0.23	0.1	Infinity
Combined Standard Uncertainty		RSS			10.8	361
Expanded Standard Uncertainty		K=2			21.5	



Product Service

Body, Full SAR Measurements, 3 GHz to 6 GHz Using Probe EX3DV4 - SN3759

Source of Uncertainty	Uncertainty ± %	Probability distribution	Div	c _i (1g)	Standard Uncertainty ± % (1g)	v _i (v _{eff})
Measurement System						
Probe calibration	6.6	N	1.00	1.00	6.6	Infinity
Axial Isotropy	4.7	R	1.73	0.70	1.9	Infinity
Hemispherical Isotropy	9.6	R	1.73	0.70	3.9	Infinity
Boundary effect	2.0	R	1.73	1.00	1.2	Infinity
Linearity	4.7	R	1.73	1.00	2.7	Infinity
System Detection limits	1.0	R	1.73	1.00	0.6	Infinity
Modulation response	2.4	R	1.73	1.00	1.4	Infinity
Readout electronics	0.3	N	1.00	1.00	0.3	Infinity
Response time	0.8	R	1.73	1.00	0.5	Infinity
Integration time	2.6	R	1.73	1.00	1.5	Infinity
RF ambient noise	3.0	R	1.73	1.00	1.7	Infinity
RF ambient reflections	3.0	R	1.73	1.00	1.7	Infinity
Probe positioner	0.8	R	1.73	1.00	0.5	Infinity
Probe positioning	6.7	R	1.73	1.00	3.9	Infinity
Max SAR Evaluation	5.0	R	1.73	1.00	2.3	Infinity
Test sample related						
Device Positioning	2.9	N	1.00	1.00	2.9	145
Device Holder	3.6	N	1.00	1.00	3.6	5
Input Power and SAR Drift	0.3	R	1.73	1.00	0.1	Infinity
Phantom and Setup						
Phantom uncertainty	6.6	R	1.73	1.00	3.8	Infinity
SAR Correction	1.9	R	1.73	1.00	1.1	Infinity
Liquid conductivity Meas.	2.5	R	1.73	0.78	1.1	Infinity
Liquid Permittivity Meas.	2.5	R	1.73	0.23	0.3	Infinity
Temp. Unc. Conductivity	3.4	R	1.73	0.78	1.5	Infinity
Temp. Unc. Permittivity	0.4	R	1.73	0.23	0.1	Infinity
Combined Standard Uncertainty		RSS			11.9	748
Expanded Standard Uncertainty		K=2			23.9	



Product Service

SECTION 4

ACCREDITATION, DISCLAIMERS AND COPYRIGHT



Product Service

4.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT



This report relates only to the actual item/items tested.

Our UKAS Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our UKAS Accreditation.

Results of tests not covered by our UKAS Accreditation Schedule are marked NUA
(Not UKAS Accredited).

This report must not be reproduced, except in its entirety, without the written permission of
TÜV SÜD Product Service

© 2017 TÜV SÜD Product Service

COMMERCIAL-IN-CONFIDENCE



Product Service

ANNEX A

PROBE CALIBRATION REPORT



Product Service

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



S Schweizerischer Kalibrierdienst
C Service suisse d'étalementage
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**Client **TÜV SÜD UK**Certificate No: **EX3-3759_Dec16**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3759**

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

Calibration date: **December 16, 2016**

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	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: S5277 (20x)	05-Apr-16 (No. 217-02293)	Apr-17
Reference Probe ES3DV2	SN: 3013	31-Dec-15 (No. ES3-3013_Dec15)	Dec-16
DAE4	SN: 660	7-Dec-16 (No. DAE4-660_Dec16)	Dec-17
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-16)	In house check: Jun-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

Calibrated by:	Name Michael Weber	Function Laboratory Technician	Signature
Approved by:	Katja Pokovic	Technical Manager	

Issued: December 19, 2016

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



Product Service

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



S Schweizerischer Kalibrierdienst
C Service suisse d'étalementage
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
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,y,z}
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., $\vartheta = 0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

- IEEE Std 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
- 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
- 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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}:** Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E-field uncertainty inside TSL (see below ConvF).
- NORM(f)x,y,z = NORM_{x,y,z} * frequency_response** (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCPx,y,z:** DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR:** PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z; 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 $f \leq 800$ 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 $NORM_{x,y,z} * ConvF$ whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical isotropy (3D deviation from isotropy):** in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset:** The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle:** The angle is assessed using the information gained by determining the NORMx (no uncertainty required).



Product Service

EX3DV4 – SN:3759

December 16, 2016

Probe EX3DV4

SN:3759

Manufactured: March 16, 2010
Calibrated: December 16, 2016

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



Product Service

EX3DV4- SN:3759

December 16, 2016

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3759

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})$) ^A	0.47	0.42	0.45	$\pm 10.1 \%$
DCP (mV) ^B	101.1	99.1	101.2	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	149.0	$\pm 3.5 \%$
		Y	0.0	0.0	1.0		147.4	
		Z	0.0	0.0	1.0		138.4	

Note: For details on UID parameters see Appendix.

Sensor Model Parameters

	C1 fF	C2 fF	α V^{-1}	T1 ms.V^{-2}	T2 ms.V^{-1}	T3 ms	T4 V^{-2}	T5 V^{-1}	T6
X	45.34	339.8	35.83	13.18	1.015	4.992	0.942	0.363	1.005
Y	51.23	384.3	35.89	14.75	0.946	5.017	1.083	0.33	1.006
Z	48.36	361.1	35.6	14.31	1.297	4.99	0.629	0.453	1.004

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

^A The uncertainties of Norm X,Y,Z do not affect the E²-field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter: uncertainty not required.

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



Product Service

EX3DV4– SN:3759

December 16, 2016

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3759

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^c	Relative Permittivity ^f	Conductivity (S/m) ^f	ConvF X	ConvF Y	ConvF Z	Alpha ^g	Depth ^g (mm)	Unc (k=2)
450	43.5	0.87	10.95	10.95	10.95	0.15	1.30	± 13.3 %
750	41.9	0.89	10.45	10.45	10.45	0.28	1.01	± 12.0 %
835	41.5	0.90	10.04	10.04	10.04	0.16	1.40	± 12.0 %
900	41.5	0.97	9.94	9.94	9.94	0.24	0.97	± 12.0 %
1640	40.3	1.29	8.63	8.63	8.63	0.19	0.80	± 12.0 %
1750	40.1	1.37	8.58	8.58	8.58	0.18	0.96	± 12.0 %
1900	40.0	1.40	8.32	8.32	8.32	0.14	0.86	± 12.0 %
2100	39.8	1.49	8.45	8.45	8.45	0.23	0.84	± 12.0 %
2300	39.5	1.67	7.80	7.80	7.80	0.15	1.07	± 12.0 %
2450	39.2	1.80	7.42	7.42	7.42	0.23	0.86	± 12.0 %
2600	39.0	1.96	7.16	7.16	7.16	0.20	1.08	± 12.0 %
5200	36.0	4.66	5.68	5.68	5.68	0.30	1.80	± 13.1 %
5300	35.9	4.76	5.46	5.46	5.46	0.30	1.80	± 13.1 %
5500	35.6	4.96	5.05	5.05	5.05	0.35	1.80	± 13.1 %
5600	35.5	5.07	4.72	4.72	4.72	0.40	1.80	± 13.1 %
5800	35.3	5.27	5.02	5.02	5.02	0.40	1.80	± 13.1 %

^c 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. Above 5 GHz frequency validity can be extended to ± 110 MHz.

^f 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.

^g 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:3759

December 16, 2016

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3759

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unc (k=2)
450	56.7	0.94	11.67	11.67	11.67	0.05	1.20	± 13.3 %
750	55.5	0.96	10.25	10.25	10.25	0.31	0.85	± 12.0 %
835	55.2	0.97	9.85	9.85	9.85	0.16	1.31	± 12.0 %
900	55.0	1.05	9.83	9.83	9.83	0.29	0.86	± 12.0 %
1640	53.8	1.40	8.63	8.63	8.63	0.26	0.80	± 12.0 %
1750	53.4	1.49	8.16	8.16	8.16	0.27	0.86	± 12.0 %
1900	53.3	1.52	7.87	7.87	7.87	0.21	0.96	± 12.0 %
2100	53.2	1.62	8.26	8.26	8.26	0.16	1.04	± 12.0 %
2300	52.9	1.81	7.56	7.56	7.56	0.29	0.80	± 12.0 %
2450	52.7	1.95	7.49	7.49	7.49	0.11	0.99	± 12.0 %
2600	52.5	2.16	7.31	7.31	7.31	0.14	1.10	± 12.0 %
5200	49.0	5.30	5.00	5.00	5.00	0.35	1.90	± 13.1 %
5300	48.9	5.42	4.78	4.78	4.78	0.35	1.90	± 13.1 %
5500	48.6	5.65	4.27	4.27	4.27	0.40	1.90	± 13.1 %
5600	48.5	5.77	3.98	3.98	3.98	0.50	1.90	± 13.1 %
5800	48.2	6.00	4.20	4.20	4.20	0.50	1.90	± 13.1 %

^C 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. Above 5 GHz frequency validity can be extended to ± 110 MHz.

^F 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.

^G 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.

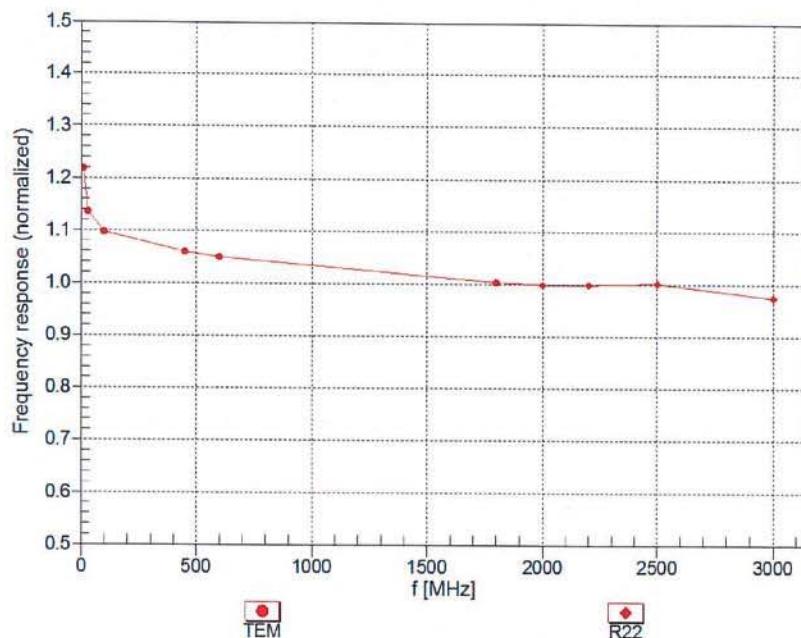


Product Service

EX3DV4- SN:3759

December 16, 2016

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

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



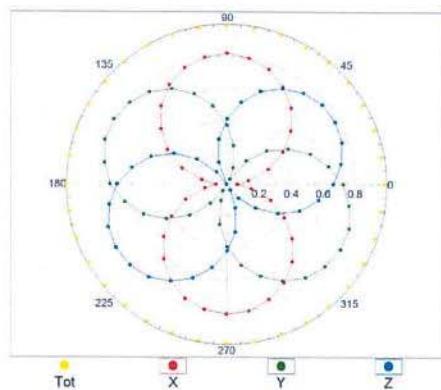
Product Service

EX3DV4- SN:3759

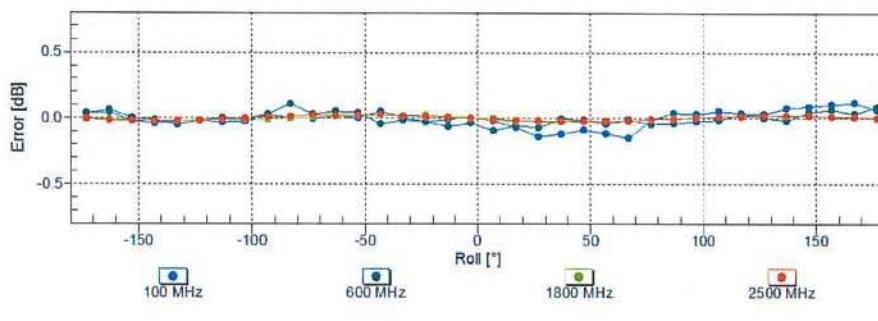
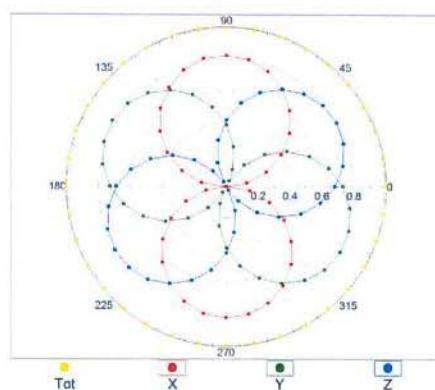
December 16, 2016

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

f=600 MHz, TEM



f=1800 MHz, R22

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

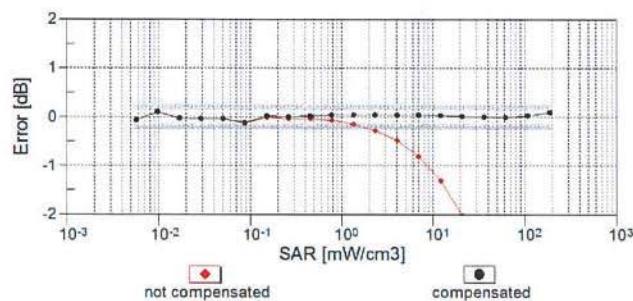
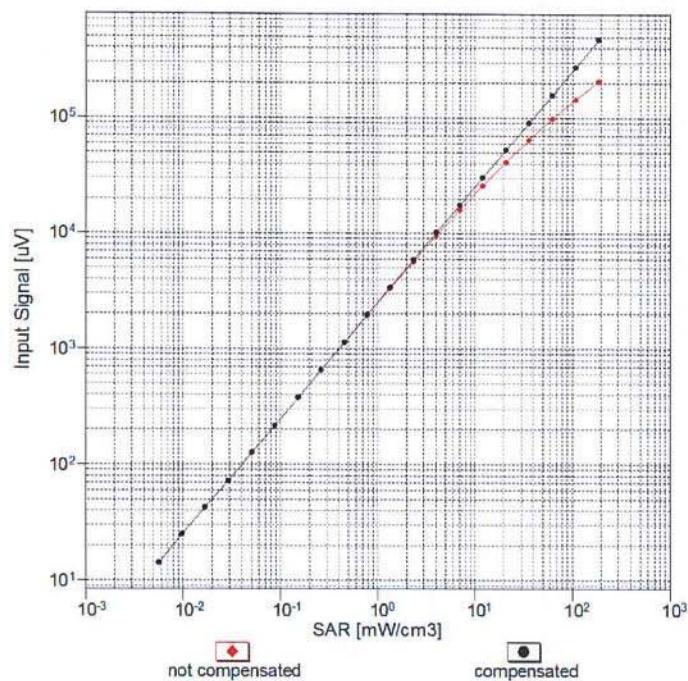


Product Service

EX3DV4- SN:3759

December 16, 2016

Dynamic Range f(SAR_{head})
 (TEM cell , f_{eval}= 1900 MHz)



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

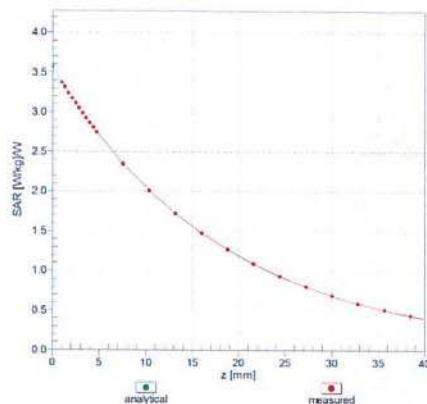
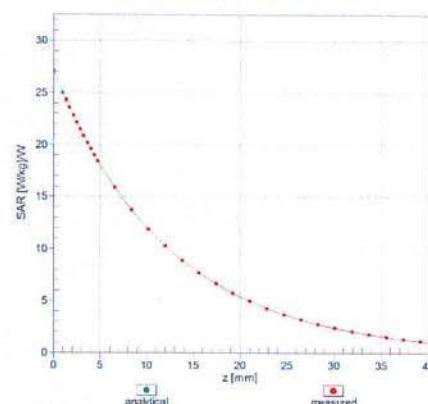


Product Service

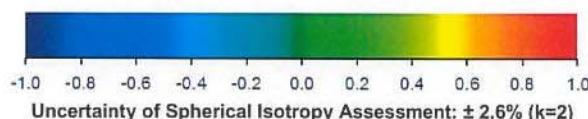
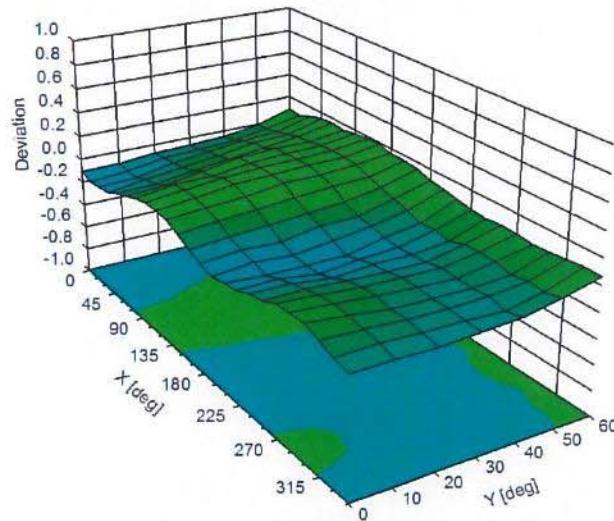
EX3DV4- SN:3759

December 16, 2016

Conversion Factor Assessment

 $f = 900 \text{ MHz}, \text{WGLS R9 (H_convF)}$  $f = 1750 \text{ MHz}, \text{WGLS R22 (H_convF)}$ 

Deviation from Isotropy in Liquid

Error (ϕ, θ), $f = 900 \text{ MHz}$ 



Product Service

EX3DV4- SN:3759

December 16, 2016

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3759

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-3
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



Product Service

EX3DV4– SN:3759

December 16, 2016

Appendix: Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB/ μ V	C	D dB	VR mV	Max Unc ^E (k=2)
0	CW	X	0.00	0.00	1.00	0.00	149.0	$\pm 3.5\%$
		Y	0.00	0.00	1.00		147.4	
		Z	0.00	0.00	1.00		138.4	
10010-CAA	SAR Validation (Square, 100ms, 10ms)	X	3.04	67.74	11.79	10.00	20.0	$\pm 9.6\%$
		Y	3.27	68.79	12.30		20.0	
		Z	3.42	68.76	12.60		20.0	
10011-CAB	UMTS-FDD (WCDMA)	X	0.99	66.30	14.68	0.00	150.0	$\pm 9.6\%$
		Y	1.02	66.67	14.90		150.0	
		Z	0.99	66.23	14.64		150.0	
10012-CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)	X	1.17	63.37	14.79	0.41	150.0	$\pm 9.6\%$
		Y	1.18	63.58	14.98		150.0	
		Z	1.18	63.40	14.78		150.0	
10013-CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps)	X	4.83	66.46	16.84	1.46	150.0	$\pm 9.6\%$
		Y	4.90	66.50	16.94		150.0	
		Z	4.87	66.45	16.82		150.0	
10021-DAC	GSM-FDD (TDMA, GMSK)	X	27.32	96.15	23.00	9.39	50.0	$\pm 9.6\%$
		Y	100.00	113.48	27.55		50.0	
		Z	18.13	91.34	22.13		50.0	
10023-DAC	GPRS-FDD (TDMA, GMSK, TN 0)	X	17.75	90.44	21.39	9.57	50.0	$\pm 9.6\%$
		Y	64.93	107.78	26.22		50.0	
		Z	13.93	87.63	21.03		50.0	
10024-DAC	GPRS-FDD (TDMA, GMSK, TN 0-1)	X	100.00	110.23	24.91	6.56	60.0	$\pm 9.6\%$
		Y	100.00	111.43	25.52		60.0	
		Z	66.71	106.54	24.55		60.0	
10025-DAC	EDGE-FDD (TDMA, 8PSK, TN 0)	X	4.69	70.97	25.39	12.57	50.0	$\pm 9.6\%$
		Y	9.43	92.86	36.24		50.0	
		Z	4.57	69.11	24.07		50.0	
10026-DAC	EDGE-FDD (TDMA, 8PSK, TN 0-1)	X	8.47	87.67	30.15	9.56	60.0	$\pm 9.6\%$
		Y	11.37	95.44	33.46		60.0	
		Z	8.88	87.57	29.82		60.0	
10027-DAC	GPRS-FDD (TDMA, GMSK, TN 0-1-2)	X	100.00	109.77	23.94	4.80	80.0	$\pm 9.6\%$
		Y	100.00	111.14	24.62		80.0	
		Z	100.00	110.40	24.46		80.0	
10028-DAC	GPRS-FDD (TDMA, GMSK, TN 0-1-2-3)	X	100.00	110.50	23.60	3.55	100.0	$\pm 9.6\%$
		Y	100.00	111.94	24.31		100.0	
		Z	100.00	110.79	23.94		100.0	
10029-DAC	EDGE-FDD (TDMA, 8PSK, TN 0-1-2)	X	5.65	79.24	25.77	7.80	80.0	$\pm 9.6\%$
		Y	6.78	83.68	27.89		80.0	
		Z	6.05	79.84	25.79		80.0	
10030-CAA	IEEE 802.15.1 Bluetooth (GFSK, DH1)	X	100.00	108.40	23.61	5.30	70.0	$\pm 9.6\%$
		Y	100.00	109.85	24.34		70.0	
		Z	39.21	99.31	21.96		70.0	
10031-CAA	IEEE 802.15.1 Bluetooth (GFSK, DH3)	X	100.00	109.64	22.00	1.88	100.0	$\pm 9.6\%$
		Y	100.00	111.22	22.73		100.0	
		Z	100.00	109.98	22.33		100.0	



Product Service

EX3DV4- SN:3759

December 16, 2016

10032-CAA	IEEE 802.15.1 Bluetooth (GFSK, DH5)	X	100.00	115.35	23.50	1.17	100.0	$\pm 9.6\%$
		Y	100.00	116.40	23.97		100.0	
		Z	100.00	114.90	23.50		100.0	
10033-CAA	IEEE 802.15.1 Bluetooth (PI/4-DQPSK, DH1)	X	5.50	80.43	20.01	5.30	70.0	$\pm 9.6\%$
		Y	8.78	88.43	23.32		70.0	
		Z	5.52	79.91	19.94		70.0	
10034-CAA	IEEE 802.15.1 Bluetooth (PI/4-DQPSK, DH3)	X	2.26	72.05	15.71	1.88	100.0	$\pm 9.6\%$
		Y	2.75	75.11	17.48		100.0	
		Z	2.35	72.23	15.94		100.0	
10035-CAA	IEEE 802.15.1 Bluetooth (PI/4-DQPSK, DH5)	X	1.71	69.83	14.64	1.17	100.0	$\pm 9.6\%$
		Y	1.95	71.69	15.93		100.0	
		Z	1.77	69.99	14.88		100.0	
10036-CAA	IEEE 802.15.1 Bluetooth (8-DPSK, DH1)	X	6.42	82.93	20.96	5.30	70.0	$\pm 9.6\%$
		Y	11.14	92.31	24.62		70.0	
		Z	6.34	82.16	20.81		70.0	
10037-CAA	IEEE 802.15.1 Bluetooth (8-DPSK, DH3)	X	2.14	71.45	15.43	1.88	100.0	$\pm 9.6\%$
		Y	2.61	74.51	17.21		100.0	
		Z	2.24	71.69	15.69		100.0	
10038-CAA	IEEE 802.15.1 Bluetooth (8-DPSK, DH5)	X	1.72	70.07	14.85	1.17	100.0	$\pm 9.6\%$
		Y	1.96	72.01	16.17		100.0	
		Z	1.78	70.24	15.09		100.0	
10039-CAB	CDMA2000 (1xRTT, RC1)	X	1.67	70.78	15.04	0.00	150.0	$\pm 9.6\%$
		Y	1.78	71.15	15.56		150.0	
		Z	1.72	70.94	15.32		150.0	
10042-CAB	IS-54 / IS-136 FDD (TDMA/FDM, PI/4-DQPSK, Halfrate)	X	22.45	92.22	20.50	7.78	50.0	$\pm 9.6\%$
		Y	100.00	109.74	25.02		50.0	
		Z	17.06	89.50	20.18		50.0	
10044-CAA	IS-91/EIA/TIA-553 FDD (FDMA, FM)	X	0.00	92.98	2.04	0.00	150.0	$\pm 9.6\%$
		Y	0.00	94.50	2.19		150.0	
		Z	0.00	94.03	3.01		150.0	
10048-CAA	DECT (TDD, TDMA/FDM, GFSK, Full Slot, 24)	X	8.86	78.37	18.88	13.80	25.0	$\pm 9.6\%$
		Y	12.87	84.32	21.06		25.0	
		Z	8.56	78.04	19.28		25.0	
10049-CAA	DECT (TDD, TDMA/FDM, GFSK, Double Slot, 12)	X	9.63	81.59	18.85	10.79	40.0	$\pm 9.6\%$
		Y	15.92	88.85	21.37		40.0	
		Z	9.22	81.13	19.17		40.0	
10056-CAA	UMTS-TDD (TD-SCDMA, 1.28 Mcps)	X	9.68	84.10	21.63	9.03	50.0	$\pm 9.6\%$
		Y	14.40	91.26	24.48		50.0	
		Z	8.89	82.35	21.22		50.0	
10058-DAC	EDGE-FDD (TDMA, 8PSK, TN 0-1-2-3)	X	4.44	74.95	23.28	6.55	100.0	$\pm 9.6\%$
		Y	5.07	77.93	24.80		100.0	
		Z	4.74	75.63	23.39		100.0	
10059-CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 2 Mbps)	X	1.20	64.26	15.22	0.61	110.0	$\pm 9.6\%$
		Y	1.22	64.64	15.52		110.0	
		Z	1.22	64.34	15.22		110.0	
10060-CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 5.5 Mbps)	X	3.05	83.81	21.08	1.30	110.0	$\pm 9.6\%$
		Y	6.45	94.80	24.64		110.0	
		Z	3.16	83.51	20.82		110.0	

Certificate No: EX3-3759_Dec16

Page 13 of 38



Product Service

EX3DV4— SN:3759

December 16, 2016

10061-CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps)	X	2.26	74.64	19.29	2.04	110.0	± 9.6 %
		Y	2.80	78.34	20.99		110.0	
		Z	2.40	74.91	19.27		110.0	
10062-CAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps)	X	4.64	66.51	16.35	0.49	100.0	± 9.6 %
		Y	4.71	66.52	16.41		100.0	
		Z	4.68	66.50	16.34		100.0	
10063-CAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 9 Mbps)	X	4.65	66.58	16.42	0.72	100.0	± 9.6 %
		Y	4.72	66.60	16.50		100.0	
		Z	4.69	66.57	16.41		100.0	
10064-CAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 12 Mbps)	X	4.93	66.82	16.63	0.86	100.0	± 9.6 %
		Y	5.02	66.89	16.73		100.0	
		Z	4.98	66.83	16.63		100.0	
10065-CAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 18 Mbps)	X	4.80	66.69	16.70	1.21	100.0	± 9.6 %
		Y	4.89	66.77	16.81		100.0	
		Z	4.84	66.71	16.69		100.0	
10066-CAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 24 Mbps)	X	4.81	66.69	16.83	1.46	100.0	± 9.6 %
		Y	4.90	66.80	16.97		100.0	
		Z	4.86	66.71	16.83		100.0	
10067-CAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 36 Mbps)	X	5.10	66.85	17.25	2.04	100.0	± 9.6 %
		Y	5.19	66.91	17.37		100.0	
		Z	5.15	66.85	17.23		100.0	
10068-CAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 48 Mbps)	X	5.14	66.87	17.43	2.55	100.0	± 9.6 %
		Y	5.25	67.04	17.62		100.0	
		Z	5.21	66.92	17.43		100.0	
10069-CAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps)	X	5.22	66.88	17.62	2.67	100.0	± 9.6 %
		Y	5.33	67.01	17.80		100.0	
		Z	5.29	66.91	17.62		100.0	
10071-CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 9 Mbps)	X	4.92	66.52	17.10	1.99	100.0	± 9.6 %
		Y	4.99	66.58	17.23		100.0	
		Z	4.96	66.52	17.09		100.0	
10072-CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 12 Mbps)	X	4.90	66.80	17.28	2.30	100.0	± 9.6 %
		Y	4.98	66.91	17.43		100.0	
		Z	4.95	66.83	17.27		100.0	
10073-CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 18 Mbps)	X	4.96	66.95	17.56	2.83	100.0	± 9.6 %
		Y	5.04	67.07	17.74		100.0	
		Z	5.01	66.98	17.56		100.0	
10074-CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 24 Mbps)	X	4.95	66.85	17.70	3.30	100.0	± 9.6 %
		Y	5.02	66.97	17.89		100.0	
		Z	5.01	66.89	17.70		100.0	
10075-CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 36 Mbps)	X	4.99	66.96	17.98	3.82	90.0	± 9.6 %
		Y	5.08	67.14	18.22		90.0	
		Z	5.06	67.04	18.00		90.0	
10076-CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 48 Mbps)	X	5.01	66.78	18.11	4.15	90.0	± 9.6 %
		Y	5.08	66.91	18.32		90.0	
		Z	5.08	66.85	18.11		90.0	
10077-CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 54 Mbps)	X	5.04	66.85	18.20	4.30	90.0	± 9.6 %
		Y	5.10	66.97	18.41		90.0	
		Z	5.10	66.92	18.20		90.0	



Product Service

EX3DV4- SN:3759

December 16, 2016

10081-CAB	CDMA2000 (1xRTT, RC3)	X	0.80	65.24	12.08	0.00	150.0	$\pm 9.6\%$
		Y	0.85	65.56	12.59		150.0	
		Z	0.82	65.35	12.34		150.0	
10082-CAB	IS-54 / IS-136 FDD (TDMA/FDM, PI/4-DQPSK, Fullrate)	X	0.68	58.27	3.79	4.77	80.0	$\pm 9.6\%$
		Y	0.86	60.00	4.99		80.0	
		Z	0.80	58.87	4.46		80.0	
10090-DAC	GPRS-FDD (TDMA, GMSK, TN 0-4)	X	100.00	110.24	24.94	6.56	60.0	$\pm 9.6\%$
		Y	100.00	111.45	25.55		60.0	
		Z	61.75	105.66	24.37		60.0	
10097-CAB	UMTS-FDD (HSDPA)	X	1.80	67.24	15.39	0.00	150.0	$\pm 9.6\%$
		Y	1.81	67.18	15.46		150.0	
		Z	1.80	67.11	15.37		150.0	
10098-CAB	UMTS-FDD (HSUPA, Subtest 2)	X	1.76	67.18	15.35	0.00	150.0	$\pm 9.6\%$
		Y	1.78	67.13	15.43		150.0	
		Z	1.76	67.04	15.33		150.0	
10099-DAC	EDGE-FDD (TDMA, 8PSK, TN 0-4)	X	8.51	87.74	30.17	9.56	60.0	$\pm 9.6\%$
		Y	11.43	95.53	33.48		60.0	
		Z	8.91	87.61	29.83		60.0	
10100-CAC	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	3.05	69.78	16.46	0.00	150.0	$\pm 9.6\%$
		Y	3.13	70.04	16.53		150.0	
		Z	3.07	69.82	16.43		150.0	
10101-CAC	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, 16-QAM)	X	3.21	67.25	15.78	0.00	150.0	$\pm 9.6\%$
		Y	3.26	67.38	15.84		150.0	
		Z	3.23	67.28	15.77		150.0	
10102-CAC	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, 64-QAM)	X	3.31	67.26	15.89	0.00	150.0	$\pm 9.6\%$
		Y	3.37	67.35	15.94		150.0	
		Z	3.34	67.28	15.89		150.0	
10103-CAC	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	5.95	73.98	19.42	3.98	65.0	$\pm 9.6\%$
		Y	6.46	75.28	20.05		65.0	
		Z	5.88	73.30	19.04		65.0	
10104-CAC	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, 16-QAM)	X	6.15	72.74	19.68	3.98	65.0	$\pm 9.6\%$
		Y	6.50	73.70	20.23		65.0	
		Z	6.36	72.92	19.68		65.0	
10105-CAC	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, 64-QAM)	X	5.78	71.44	19.39	3.98	65.0	$\pm 9.6\%$
		Y	6.20	72.69	20.09		65.0	
		Z	6.26	72.53	19.82		65.0	
10108-CAD	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	X	2.66	69.02	16.27	0.00	150.0	$\pm 9.6\%$
		Y	2.74	69.24	16.34		150.0	
		Z	2.69	69.04	16.24		150.0	
10109-CAD	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, 16-QAM)	X	2.86	67.09	15.67	0.00	150.0	$\pm 9.6\%$
		Y	2.92	67.19	15.74		150.0	
		Z	2.89	67.10	15.67		150.0	
10110-CAD	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, QPSK)	X	2.15	68.08	15.82	0.00	150.0	$\pm 9.6\%$
		Y	2.23	68.29	15.94		150.0	
		Z	2.18	68.07	15.80		150.0	
10111-CAD	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, 16-QAM)	X	2.58	67.97	15.95	0.00	150.0	$\pm 9.6\%$
		Y	2.63	67.86	15.99		150.0	
		Z	2.60	67.91	15.97		150.0	



Product Service

EX3DV4—SN:3759

December 16, 2016

10112-CAD	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, 64-QAM)	X	2.99	67.13	15.75	0.00	150.0	± 9.6 %
		Y	3.05	67.18	15.80		150.0	
		Z	3.01	67.13	15.74		150.0	
10113-CAD	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, 64-QAM)	X	2.73	68.15	16.11	0.00	150.0	± 9.6 %
		Y	2.78	68.00	16.13		150.0	
		Z	2.76	68.09	16.12		150.0	
10114-CAB	IEEE 802.11n (HT Greenfield, 13.5 Mbps, BPSK)	X	5.12	67.14	16.40	0.00	150.0	± 9.6 %
		Y	5.16	67.11	16.38		150.0	
		Z	5.14	67.13	16.37		150.0	
10115-CAB	IEEE 802.11n (HT Greenfield, 81 Mbps, 16-QAM)	X	5.39	67.23	16.45	0.00	150.0	± 9.6 %
		Y	5.47	67.32	16.49		150.0	
		Z	5.43	67.27	16.45		150.0	
10116-CAB	IEEE 802.11n (HT Greenfield, 135 Mbps, 64-QAM)	X	5.20	67.31	16.41	0.00	150.0	± 9.6 %
		Y	5.26	67.33	16.42		150.0	
		Z	5.23	67.32	16.39		150.0	
10117-CAB	IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK)	X	5.08	66.99	16.34	0.00	150.0	± 9.6 %
		Y	5.13	67.01	16.35		150.0	
		Z	5.10	67.00	16.32		150.0	
10118-CAB	IEEE 802.11n (HT Mixed, 81 Mbps, 16-QAM)	X	5.47	67.43	16.56	0.00	150.0	± 9.6 %
		Y	5.55	67.51	16.60		150.0	
		Z	5.51	67.48	16.56		150.0	
10119-CAB	IEEE 802.11n (HT Mixed, 135 Mbps, 64-QAM)	X	5.19	67.27	16.40	0.00	150.0	± 9.6 %
		Y	5.23	67.26	16.40		150.0	
		Z	5.21	67.26	16.38		150.0	
10140-CAC	LTE-FDD (SC-FDMA, 100% RB, 15 MHz, 16-QAM)	X	3.35	67.26	15.81	0.00	150.0	± 9.6 %
		Y	3.41	67.36	15.86		150.0	
		Z	3.37	67.28	15.80		150.0	
10141-CAC	LTE-FDD (SC-FDMA, 100% RB, 15 MHz, 64-QAM)	X	3.47	67.39	16.00	0.00	150.0	± 9.6 %
		Y	3.53	67.45	16.03		150.0	
		Z	3.50	67.41	15.99		150.0	
10142-CAD	LTE-FDD (SC-FDMA, 100% RB, 3 MHz, QPSK)	X	1.92	68.04	15.43	0.00	150.0	± 9.6 %
		Y	2.00	68.21	15.62		150.0	
		Z	1.95	68.01	15.47		150.0	
10143-CAD	LTE-FDD (SC-FDMA, 100% RB, 3 MHz, 16-QAM)	X	2.43	68.67	15.60	0.00	150.0	± 9.6 %
		Y	2.48	68.53	15.74		150.0	
		Z	2.46	68.63	15.70		150.0	
10144-CAD	LTE-FDD (SC-FDMA, 100% RB, 3 MHz, 64-QAM)	X	2.19	66.27	13.92	0.00	150.0	± 9.6 %
		Y	2.28	66.45	14.25		150.0	
		Z	2.23	66.33	14.07		150.0	
10145-CAD	LTE-FDD (SC-FDMA, 100% RB, 1.4 MHz, QPSK)	X	1.16	64.50	11.31	0.00	150.0	± 9.6 %
		Y	1.29	65.42	12.29		150.0	
		Z	1.24	65.05	11.89		150.0	
10146-CAD	LTE-FDD (SC-FDMA, 100% RB, 1.4 MHz, 16-QAM)	X	1.75	64.91	10.68	0.00	150.0	± 9.6 %
		Y	2.10	66.86	12.19		150.0	
		Z	1.85	65.40	11.22		150.0	
10147-CAD	LTE-FDD (SC-FDMA, 100% RB, 1.4 MHz, 64-QAM)	X	1.99	66.41	11.55	0.00	150.0	± 9.6 %
		Y	2.48	68.95	13.31		150.0	
		Z	2.12	67.01	12.15		150.0	



Product Service

EX3DV4– SN:3759

December 16, 2016

10149-CAC	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, 16-QAM)	X	2.87	67.16	15.72	0.00	150.0	$\pm 9.6\%$
		Y	2.93	67.25	15.78		150.0	
		Z	2.90	67.17	15.71		150.0	
10150-CAC	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, 64-QAM)	X	3.00	67.19	15.79	0.00	150.0	$\pm 9.6\%$
		Y	3.05	67.23	15.84		150.0	
		Z	3.02	67.19	15.79		150.0	
10151-CAC	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	X	6.19	76.09	20.32	3.98	65.0	$\pm 9.6\%$
		Y	6.72	77.39	20.98		65.0	
		Z	6.36	75.98	20.19		65.0	
10152-CAC	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, 16-QAM)	X	5.64	72.49	19.24	3.98	65.0	$\pm 9.6\%$
		Y	6.02	73.58	19.91		65.0	
		Z	5.85	72.65	19.26		65.0	
10153-CAC	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, 64-QAM)	X	6.03	73.53	20.06	3.98	65.0	$\pm 9.6\%$
		Y	6.38	74.47	20.65		65.0	
		Z	6.24	73.66	20.07		65.0	
10154-CAD	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	X	2.20	68.51	16.09	0.00	150.0	$\pm 9.6\%$
		Y	2.28	68.70	16.20		150.0	
		Z	2.23	68.51	16.09		150.0	
10155-CAD	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, 16-QAM)	X	2.58	67.98	15.97	0.00	150.0	$\pm 9.6\%$
		Y	2.63	67.87	16.01		150.0	
		Z	2.61	67.92	15.98		150.0	
10156-CAD	LTE-FDD (SC-FDMA, 50% RB, 5 MHz, QPSK)	X	1.76	68.06	15.17	0.00	150.0	$\pm 9.6\%$
		Y	1.85	68.29	15.45		150.0	
		Z	1.80	68.08	15.26		150.0	
10157-CAD	LTE-FDD (SC-FDMA, 50% RB, 5 MHz, 16-QAM)	X	2.02	66.77	13.91	0.00	150.0	$\pm 9.6\%$
		Y	2.12	66.99	14.30		150.0	
		Z	2.07	66.86	14.11		150.0	
10158-CAD	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, 64-QAM)	X	2.74	68.22	16.16	0.00	150.0	$\pm 9.6\%$
		Y	2.79	68.06	16.17		150.0	
		Z	2.77	68.16	16.17		150.0	
10159-CAD	LTE-FDD (SC-FDMA, 50% RB, 5 MHz, 64-QAM)	X	2.12	67.25	14.20	0.00	150.0	$\pm 9.6\%$
		Y	2.23	67.45	14.59		150.0	
		Z	2.18	67.37	14.42		150.0	
10160-CAC	LTE-FDD (SC-FDMA, 50% RB, 15 MHz, QPSK)	X	2.69	68.25	16.09	0.00	150.0	$\pm 9.6\%$
		Y	2.75	68.31	16.13		150.0	
		Z	2.71	68.19	16.05		150.0	
10161-CAC	LTE-FDD (SC-FDMA, 50% RB, 15 MHz, 16-QAM)	X	2.89	67.14	15.71	0.00	150.0	$\pm 9.6\%$
		Y	2.95	67.16	15.77		150.0	
		Z	2.92	67.13	15.72		150.0	
10162-CAC	LTE-FDD (SC-FDMA, 50% RB, 15 MHz, 64-QAM)	X	3.00	67.31	15.83	0.00	150.0	$\pm 9.6\%$
		Y	3.06	67.29	15.87		150.0	
		Z	3.03	67.28	15.83		150.0	
10166-CAD	LTE-FDD (SC-FDMA, 50% RB, 1.4 MHz, QPSK)	X	3.52	69.26	18.89	3.01	150.0	$\pm 9.6\%$
		Y	3.63	69.41	18.97		150.0	
		Z	3.54	68.96	18.65		150.0	
10167-CAD	LTE-FDD (SC-FDMA, 50% RB, 1.4 MHz, 16-QAM)	X	4.34	72.30	19.40	3.01	150.0	$\pm 9.6\%$
		Y	4.53	72.61	19.56		150.0	
		Z	4.33	71.71	19.05		150.0	



Product Service

EX3DV4- SN:3759

December 16, 2016

10168-CAD	LTE-FDD (SC-FDMA, 50% RB, 1.4 MHz, 64-QAM)	X	4.92	75.00	20.95	3.01	150.0	$\pm 9.6\%$
		Y	5.05	74.92	20.91		150.0	
		Z	4.86	74.20	20.52		150.0	
10169-CAC	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	2.94	68.69	18.63	3.01	150.0	$\pm 9.6\%$
		Y	3.06	69.43	19.00		150.0	
		Z	2.97	68.51	18.42		150.0	
10170-CAC	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM)	X	4.15	75.29	21.28	3.01	150.0	$\pm 9.6\%$
		Y	4.43	76.35	21.68		150.0	
		Z	4.11	74.52	20.83		150.0	
10171-AAC	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, 64-QAM)	X	3.30	70.50	18.18	3.01	150.0	$\pm 9.6\%$
		Y	3.54	71.68	18.72		150.0	
		Z	3.31	70.02	17.86		150.0	
10172-CAC	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	5.72	82.17	24.47	6.02	65.0	$\pm 9.6\%$
		Y	9.41	91.72	28.09		65.0	
		Z	7.05	84.62	25.03		65.0	
10173-CAC	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM)	X	10.09	89.06	25.03	6.02	65.0	$\pm 9.6\%$
		Y	16.80	97.79	27.98		65.0	
		Z	9.48	86.64	24.01		65.0	
10174-CAC	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, 64-QAM)	X	7.37	83.04	22.50	6.02	65.0	$\pm 9.6\%$
		Y	11.94	90.83	25.28		65.0	
		Z	6.31	79.38	21.04		65.0	
10175-CAD	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	2.90	68.35	18.36	3.01	150.0	$\pm 9.6\%$
		Y	3.02	69.11	18.74		150.0	
		Z	2.93	68.17	18.15		150.0	
10176-CAD	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, 16-QAM)	X	4.15	75.31	21.29	3.01	150.0	$\pm 9.6\%$
		Y	4.43	76.38	21.69		150.0	
		Z	4.12	74.55	20.84		150.0	
10177-CAF	LTE-FDD (SC-FDMA, 1 RB, 5 MHz, QPSK)	X	2.92	68.51	18.47	3.01	150.0	$\pm 9.6\%$
		Y	3.05	69.27	18.84		150.0	
		Z	2.95	68.34	18.26		150.0	
10178-CAD	LTE-FDD (SC-FDMA, 1 RB, 5 MHz, 16-QAM)	X	4.11	75.05	21.16	3.01	150.0	$\pm 9.6\%$
		Y	4.38	76.11	21.55		150.0	
		Z	4.07	74.28	20.70		150.0	
10179-CAD	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, 64-QAM)	X	3.67	72.68	19.56	3.01	150.0	$\pm 9.6\%$
		Y	3.93	73.84	20.04		150.0	
		Z	3.66	72.05	19.16		150.0	
10180-CAD	LTE-FDD (SC-FDMA, 1 RB, 5 MHz, 64-QAM)	X	3.29	70.43	18.13	3.01	150.0	$\pm 9.6\%$
		Y	3.53	71.60	18.66		150.0	
		Z	3.30	69.94	17.80		150.0	
10181-CAC	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK)	X	2.92	68.49	18.46	3.01	150.0	$\pm 9.6\%$
		Y	3.04	69.25	18.83		150.0	
		Z	2.95	68.32	18.25		150.0	
10182-CAC	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, 16-QAM)	X	4.10	75.03	21.14	3.01	150.0	$\pm 9.6\%$
		Y	4.37	76.08	21.54		150.0	
		Z	4.06	74.26	20.69		150.0	
10183-AAB	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, 64-QAM)	X	3.29	70.40	18.12	3.01	150.0	$\pm 9.6\%$
		Y	3.52	71.58	18.65		150.0	
		Z	3.30	69.92	17.79		150.0	