



element

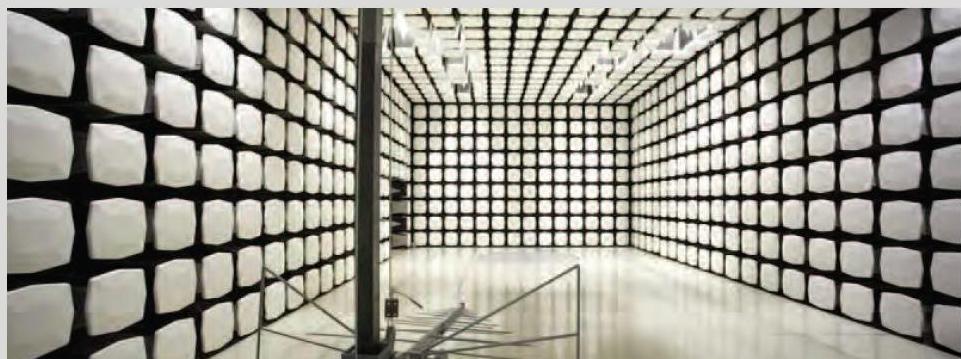
WatchGuard Video

Vista WiFi

SAR Evaluation Report # **WTVD0001.5**

Evaluated to the following SAR specification:

FCC 2.1093:2018



NVLAP Lab Code: 200630-0

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More: <https://www.bis.doc.gov/index.php/forms-documents/regulations-docs/14-commerce-country-chart/fileT>



CERTIFICATE OF TEST

Last Date of Test: October 26, 2018
WatchGuard Video
Model: Vista WiFi

Applicable Standard

Test Description	Specification	Test Method	Pass/Fail
SAR Evaluation	FCC 2.1093:2018	FCC KDB 865664 D01 v01r04 FCC KDB 865664 D02 v01r02 FCC KDB 447498 D01 v06 IEEE Std 1528:2013	Pass

Highest SAR Values:

Frequency Bands (GHz)	Body (W/kg) 1g	Limit (W/kg) 1g	Exposure Environment
			General Population
2.4	0.1	1.6	

Deviations From Test Standards

None

Approved By:

Don Facteau, Process Architect

REVISION HISTORY



Revision Number	Description	Date (yyyy-mm-dd)	Page Number
00	None		

ACCREDITATIONS AND AUTHORIZATIONS



United States

FCC - Designated by the FCC as a Telecommunications Certification Body (TCB). Certification chambers, Open Area Test Sites, and conducted measurement facilities are listed with the FCC.

A2LA - Accredited by A2LA to ISO / IEC 17065 as a product certifier. This allows Element to certify transmitters to FCC and IC specifications.

NVLAP - Each laboratory is accredited by NVLAP to ISO 17025

Canada

ISED - Recognized by Innovation, Science and Economic Development Canada as a Certification Body (CB). Certification chambers and Open Area Test Sites are filed with ISED.

European Union

European Commission – Within Element, we have a EU Notified Body validated for the EMCD and RED Directives.

Australia/New Zealand

ACMA - Recognized by ACMA as a CAB for the acceptance of test data.

Korea

MSIT / RRA - Recognized by KCC's RRA as a CAB for the acceptance of test data.

Japan

VCCI - Associate Member of the VCCI. Conducted and radiated measurement facilities are registered.

Taiwan

BSMI – Recognized by BSMI as a CAB for the acceptance of test data.

NCC - Recognized by NCC as a CAB for the acceptance of test data.

Singapore

IDA – Recognized by IDA as a CAB for the acceptance of test data.

Israel

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Hong Kong

OFCA – Recognized by OFCA as a CAB for the acceptance of test data.

Vietnam

MIC – Recognized by MIC as a CAB for the acceptance of test data.

SCOPE

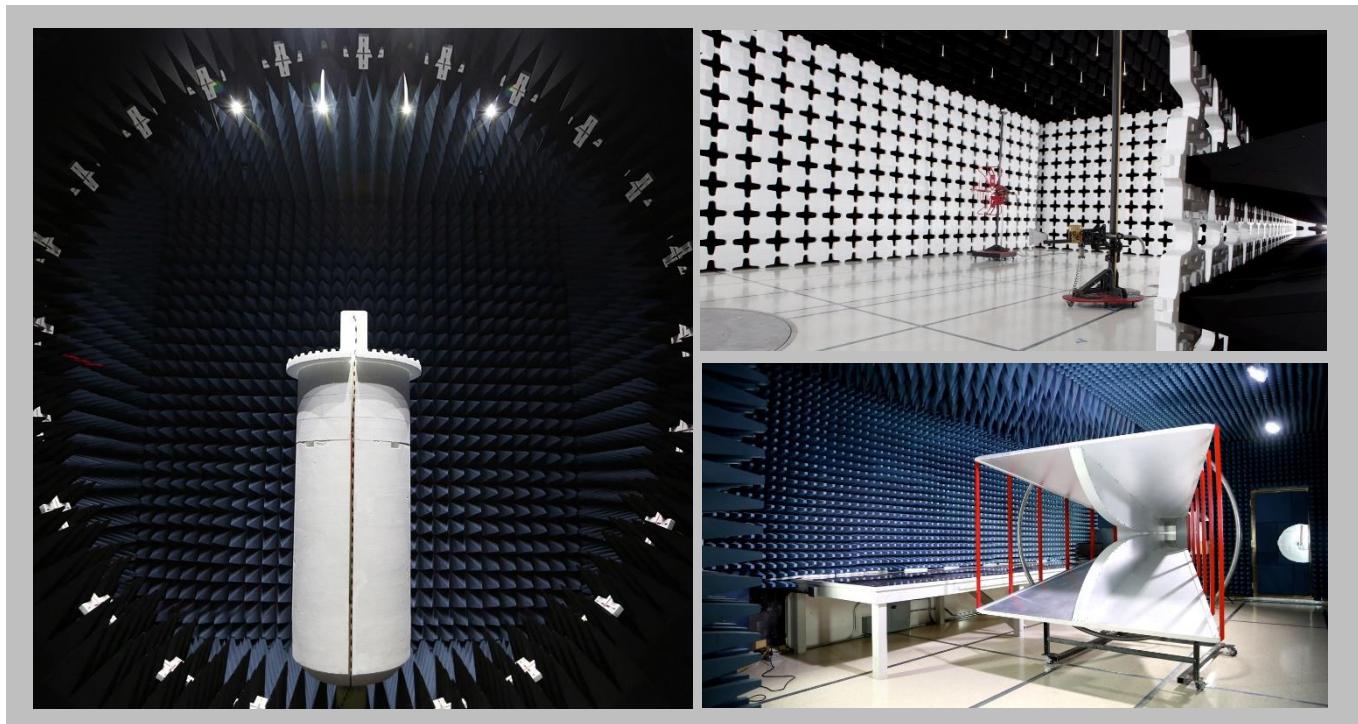
For details on the Scopes of our Accreditations, please visit:

<https://www.nwemc.com/emc-testing-accreditations>

FACILITIES



California	Minnesota	New York	Oregon	Texas	Washington
Labs OC01-17 41 Tesla Irvine, CA 92618 (949) 861-8918	Labs MN01-10 9349 W Broadway Ave. Brooklyn Park, MN 55445 (612)-638-5136	Labs NY01-04 4939 Jordan Rd. Elbridge, NY 13060 (315) 554-8214	Labs EV01-12 6775 NE Evergreen Pkwy #400 Hillsboro, OR 97124 (503) 844-4066	Labs TX01-09 3801 E Plano Pkwy Plano, TX 75074 (469) 304-5255	Labs NC01-05 19201 120 th Ave NE Bothell, WA 98011 (425)984-6600
NVLAP					
NVLAP Lab Code: 200676-0	NVLAP Lab Code: 200881-0	NVLAP Lab Code: 200761-0	NVLAP Lab Code: 200630-0	NVLAP Lab Code: 201049-0	NVLAP Lab Code: 200629-0
Innovation, Science and Economic Development Canada					
2834B-1, 2834B-3	2834E-1, 2834E-3	N/A	2834D-1, 2834D-2	2834G-1	2834F-1
BSMI					
SL2-IN-E-1154R	SL2-IN-E-1152R	N/A	SL2-IN-E-1017	SL2-IN-E-1158R	SL2-IN-E-1153R
VCCI					
A-0029	A-0109	N/A	A-0108	A-0201	A-0110
Recognized Phase I CAB for ACMA, BSMI, IDA, KCC/RRA, MIC, MOC, NCC, OFCA					
US0158	US0175	N/A	US0017	US0191	US0157



PRODUCT DESCRIPTION



Client and Equipment Under Test (EUT) Information

Company Name:	WatchGuard Video
Address:	415 East Exchange Parkway
City, State, Zip:	Allen, TX 75002
Test Requested By:	Navaid Karimi
Model:	Vista WiFi
First Date of Test:	October 25, 2018
Last Date of Test:	October 26, 2018
Receipt Date of Samples:	October 26, 2018
Equipment Design Stage:	Prototype
Equipment Condition:	No Damage
Purchase Authorization:	Verified

Information Provided by the Party Requesting the Test

Functional Description of the EUT:

The EUT is a body camera for law enforcement with WiFi link. This test report contains measured SAR data for the WiFi radio which is a 2450MHz 802.11 gn radio and has one antenna. The WiFi Module operates as a SISO in the 2.4 GHz ISM band only, utilizing only Channel 6 (2.437 GHz center frequency) with 20 MHz channel width. No external devices will be used with the EUT.

Location of transmit antenna(s):



PRODUCT DESCRIPTION



Testing Objective:

To demonstrate compliance of the radio with the SAR requirements of FCC 2.1093:2018.

CONFIGURATIONS



Configuration WTVD0001- 6

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
Body Camera with WiFi Link	Watchguard Video	Vista WiFi	WFC1-039084

Configuration WTVD0001- 2

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
Body Camera with Wifi Link (Direct Connect)	Watchguard Video	VISTA WiFi	WFC1-009113

Peripherals in test setup boundary			
Description	Manufacturer	Model/Part Number	Serial Number
Command Console Board	Watchguard Video	WGA00341	0615413600
Charging Base	Watchguard Video	WGA00537	VHB1-05863

Remote Equipment Outside of Test Setup Boundary			
Description	Manufacturer	Model/Part Number	Serial Number
Laptop Computer	Dell	Latitude 7480	27904748150
AC/DC Power Supply (Base)	Unknown	M120100A0	None

Cables					
Cable Type	Shield	Length (m)	Ferrite	Connection 1	Connection 2
DC Power (Base)	No	1.5m	No	AC/DC Power Supply (Base)	Charging Base
USB to RS-232	Yes	0.5m	No	Laptop Computer	Command Console Board

CONFIGURATIONS



Configuration WTVD0018- 2

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
Body Camera with WiFi Link (Direct Connect)	WatchGuard Video	VISTA WiFi	WFC1-009113

Remote Equipment Outside of Test Setup Boundary			
Description	Manufacturer	Model/Part Number	Serial Number
Laptop Computer	Dell	Latitude 7480	27904748150
Command Console Board	WatchGuard Video	WGA00341	0615413600
Charging Base	WatchGuard Video	WGA00537	VHB1-05863
AC/DC Power Supply (Base)	Unknown	M120100A0	None

Cables					
Cable Type	Shield	Length (m)	Ferrite	Connection 1	Connection 2
DC Power (Base)	No	1.5m	No	AC/DC Power Supply (Base)	Charging Base
USB to RS-232	Yes	0.5m	No	Laptop Computer	Command Console Board

MODIFICATIONS



Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2018-10-25	SAR Evaluation	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
2	2018-10-26	SAR Evaluation	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

TISSUE – EQUIVALENT LIQUID DESCRIPTION



Characterization of tissue-equivalent liquid dielectric properties

Per IEEE 1528: 2013, Section 5.3.2, the permittivity and conductivity of the tissue material should be measured at least within 24 hours of any full-compliance test. The measured values must be within +/- 5% of the target values. The temperature variation in the liquid during SAR measurements must be within +/- 2 degrees C of that recorded when the dielectric properties were measured.

The dielectric parameters of the tissue-equivalent liquids were measured within 24 hours of the start of testing using the SPEAG DAKS:200 dielectric assessment kit. The dielectric measurements were made across the frequency range of the liquid. The attached data sheets show that the dielectric parameters of the liquid were within the required 5% tolerances.

Target values of dielectric parameters

Per KDB 865664 D01 v01r04, Appendix A:

"The head tissue dielectric parameters recommended by IEEE Std 1528-2013 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in IEEE Std 1528 are derived from tissue dielectric parameters computed from the 4-Cole-Cole equations described above and extrapolated according to the head parameters specified in IEEE Std 1528."

Target Frequency (MHz)	Head		Body	
	ϵ_r	σ (S/m)	ϵ_r	σ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800 – 2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5800	35.3	5.27	48.2	6.00

(ϵ_r = relative permittivity, σ = conductivity and $\rho = 1000 \text{ kg/m}^3$)

TISSUE – EQUIVALENT LIQUID DESCRIPTION



Composition of Ingredients for Liquid Tissue Phantoms

Element uses tissue-equivalent liquids prepared by SPEAG and confirmed by them to be within +/- 5% from the target values. Their recipes are based upon the following formulations as found in IEEE 1528:2013 Annex C (head) and IEC 62209-2:2010 Annex E (body):

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation:

HEAD

**Table C.1—Suggested recipes for achieving target dielectric parameters:
300 MHz to 900 MHz**

Frequency (MHz)	300	450	450	450	835	835	900	900	900	900
Reference	[B118]	[B118]	[B172]	[B74]	[B118]	[B74]	[B118]	[B196]	[B172]	[B74]
Ingredients (% by weight)										
1,2-Propanediol	—	—	—	—	—	—	—	64.81	—	—
Bactericide	0.19	0.19	0.50	—	0.10	—	0.10	—	0.50	—
Diacetin	—	—	48.90	—	—	—	—	—	49.20	—
DGBE	—	—	—	—	—	—	—	—	—	—
HEC	0.98	0.98	—	—	1.00	—	1.00	—	—	—
NaCl	5.95	3.95	1.70	1.96	1.45	1.25	1.48	0.79	1.10	1.35
Sucrose	55.32	56.32	—	—	57.00	—	56.50	—	—	—
Triton X-100	—	—	—	—	—	—	—	—	—	—
Tween 20	—	—	—	49.51	—	48.39	—	—	—	48.34
Water	37.56	38.56	48.90	48.53	40.45	50.36	40.92	34.40	49.20	50.31

**Table C.2—Suggested recipes for achieving target dielectric parameters:
1450 MHz to 2000 MHz**

Frequency (MHz)	1450	1800	1800	1800	1800	1800	1900	1900	1950	2000
Reference	[B118]	[B118]	[B196]	[B196]	[B172]	[B74]	[B118]	[B196]	[B74]	[B118]
Ingredients (% by weight)										
1,2-Propanediol	—	—	—	—	—	—	—	—	—	—
Bactericide	—	—	—	—	0.50	—	—	—	—	—
Diacetin	—	—	—	—	49.43	—	—	—	—	—
DGBE	45.51	47.00	13.84	44.92	—	—	44.92	13.84	45.00	50.00
HEC	—	—	—	—	—	—	—	—	—	—
NaCl	0.67	0.36	0.35	0.18	0.64	0.50	0.18	0.35	—	—
Sucrose	—	—	—	—	—	—	—	—	—	—
Triton X-100	—	—	30.45	—	—	—	—	30.45	—	—
Tween 20	—	—	—	—	—	45.27	—	—	—	—
Water	53.82	52.64	55.36	54.90	49.43	54.23	54.90	55.36	55.00	50.00

TISSUE – EQUIVALENT LIQUID DESCRIPTION



**Table C.3—Suggested recipes for achieving target dielectric parameters:
2100 MHz to 5800 MHz**

Frequency (MHz)	2100	2100	2450	2450	3000	5200	5800
Reference	[B118]	[B196]	[B196]	[B172]	[B196]		
Ingredients (% by weight)							
1,2-Propanediol	—	—	—	—	—	—	—
Bactericide	—	—	—	0.50	—	—	—
Diacetin	—	—	—	49.75	—	—	—
DGBE	50.00	7.99	7.99	—	7.99	—	—
HEC	—	—	—	—	—	—	—
NaCl	—	0.16	0.16	—	0.16	—	—
Sucrose	—	—	—	—	—	—	—
Triton X-100	—	19.97	19.97	—	19.97	17.24	17.24
Diethylenglycol monohexylether	—	—	—	—	—	17.24	17.24
Water	50.00	71.88	71.88	49.75	71.88	65.52	65.52

BODY

Frequency (MHz)	30	50		144		450		835		900	
Recipe source number	3	3	2	2	3	2	4	2	2	2	4
Ingredients (% by weight)											
Deionised water	48,30	48,30	53,53	55,12	48,30	48,53	56	50,36	50,31	56	
Tween			44,70	43,31		49,51		48,39	48,34		
Oxidised mineral oil							44				44
Diethylenglycol monohexylether											
Triton X-100											
Diacetin	50,00	50,00			50,00						
DGBE											
NaCl	1,60	1,60	1,77	1,57	1,60	1,96		1,25	1,35		
Additives and salt	0,10	0,10			0,10						

Frequency (MHz)	1 800		2 450	4 000	5 000	5 200	5 800	6 000
Recipe source number	2	4	4	4	4	1	1	4
Ingredients (% by weight)								
Deionised water	54,23	56	56	56	56	65,53	65,53	56
Tween	45,27							
Oxidised mineral oil		44	44	44	44			44
Diethylenglycol monohexylether						17,24	17,24	
Triton X-100						17,24	17,24	
Diacetin								
DGBE								
NaCl	0,50							
Additives and salt								

TISSUE – EQUIVALENT LIQUID



Date:	10/25/2018	Temperature:	22.1°C
Tissue:	Body, MSL2450, 2450MHz	Liquid Temperature:	21.4°C
Tested By:	Ethan Schoonover	Relative Humidity:	52%
Job Site:	EV08	Bar. Pressure:	1014 mb

TEST SPECIFICATIONS

Specification:	Method:
FCC 2.1093:2018	FCC KDB 865664 D01 v01r04 FCC KDB 865664 D02 v01r02 IEEE Std 1528:2013

RESULTS

Frequency (MHz)	Actual Values		Target Values		Deviation (%)	
	Relative Permittivity	Conductivity	Relative Permittivity	Conductivity	Relative Permittivity	Conductivity
2450	50.54	1.913	52.7	1.95	4.1	1.9

Frequency (MHz)	Relative Permittivity	Conductivity
2000	52.13	1.361
2050	51.96	1.419
2100	51.76	1.478
2150	51.57	1.538
2200	51.39	1.599
2250	51.23	1.661
2300	51.06	1.723
2350	50.89	1.785
2400	50.72	1.848
2450	50.54	1.913
2500	50.36	1.978
2550	50.18	2.045
2600	50.00	2.112
2650	49.82	2.180
2700	49.64	2.249
2750	49.45	2.317
2800	49.28	2.387
2850	49.1	2.458
2900	48.92	2.527
2950	48.72	2.594

SAR SYSTEM VERIFICATION DESCRIPTION



REQUIREMENT

Per IEEE 1528, Section 8.2.1, "System checks are performed prior to compliance tests and the results must always be within $\pm 10\%$ of the target value corresponding to the test frequency, liquid, and the source used. The target values are 1 g or 10 g averaged SAR values measured on systems having current system validation and calibration status, and using the system check setup as shown in Figure 14. These target values should be determined using a standard source."

TEST DESCRIPTION

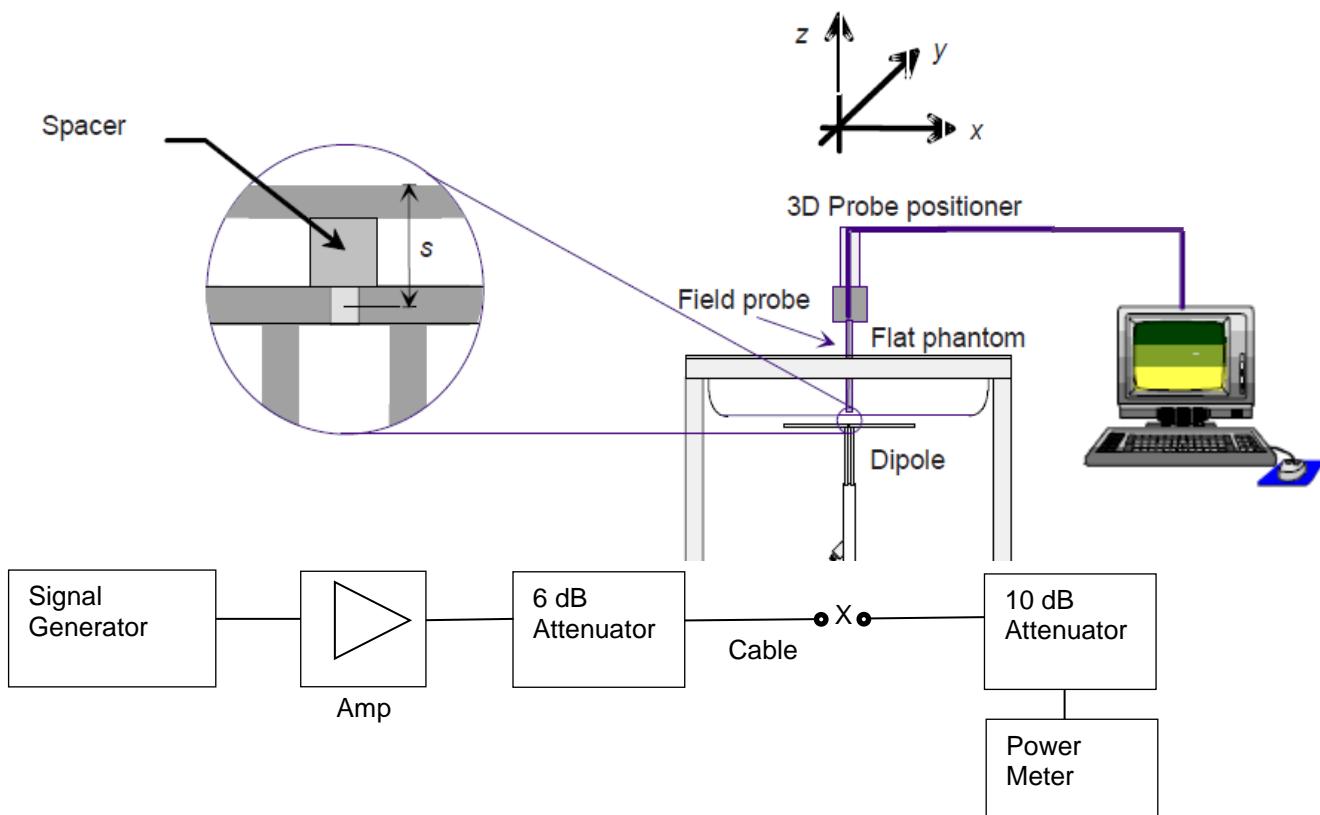
Within 24 hours of a measurement, then every 72 hours thereafter, Element used the system validation kit (calibrated reference dipole) to test whether the system was operating within its specifications. The validation was performed in the indicated bands by making SAR measurements of the reference dipole with the phantom filled with the tissue-equivalent liquid. First, a signal generator and power amplifier were used to produce a 100mW level as measured with a power meter at the antenna terminals of the dipole (X). Then, the reference dipole was positioned below the bottom of the phantom and centered with its axis parallel to the longest side of the phantom. A low loss and low relative permittivity spacer was used to establish the correct distance between the center axis of the reference dipole and the liquid.

For the reference dipoles, the spacing distance s is given by:

$$s = 15\text{mm}, +/- 0.2\text{mm} \text{ for } 300\text{MHz} \leq f \geq 1000 \text{ MHz}$$

$$s = 10\text{mm}, +/- 0.2\text{mm} \text{ for } 1000\text{MHz} \leq f \geq 6000\text{MHz}$$

The measured 1 g and 10 g spatial average SAR values were normalized to a 1W dipole input power for comparison to the calibration data. The results are summarized in the attached table. The deviation is less than 10% in all cases, indicating that the system performance check was within tolerance.



SAR SYSTEM VERIFICATION



TEST SPECIFICATIONS

Specification:	Method:
FCC 2.1093:2018	FCC KDB 865664 D01 v01r04 FCC KDB 865664 D02 v01r02 IEEE Std 1528:2013

RESULTS

Date	Liquid part number and frequency	Conducted Power into the Dipole (dBm)	Correction Factor	Measured		Normalized to 1W		Target (Normalized to 1W) Get from Dipole Calibration Certificate		% Difference	
				1g	10g	1g	10g	1g	10g	1g	10g
10/25/2018	MSL 2450 (2450 MHz)	20.00	10.00	5.20	2.46	52.00	24.60	50.90	24.00	2.16	2.50

SAR SYSTEM VERIFICATION



Tested By:	Ethan Schoonover	Room Temperature (°C):	22.3°C
Date:	10/25/2018	Liquid Temperature (°C):	21.3°C
Configuration:	NA	Humidity (%RH):	54%
		Bar. Pressure (mb):	1014 mb

MSL2450 System Check 10-25-18

DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2

Communication System: UID 10000, CW; Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz; Communication System PAR: 0 dB; PMF: 1

Medium parameters used: $f = 2450 \text{ MHz}$; $\sigma = 1.913 \text{ S/m}$; $\epsilon_r = 50.542$; $\rho = 1000 \text{ kg/m}^3$, Medium parameters used: $\sigma = 0 \text{ S/m}$, $\epsilon_r = 1$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: EX3DV4 - SN3746; ConvF(7.02, 7.02, 7.02); Calibrated: 11/15/2017;
 - Modulation Compensation:
- Sensor-Surface: 5mm (Mechanical Surface Detection), Sensor-Surface: 0mm (Fix Surface), $z = 1.0, 101.0, 31.0$
- Electronics: DAE4 Sn1237; Calibrated: 11/7/2017
- Phantom: ELI v5.0; Type: QDOVA002AA;
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

System Check/System Check/Area Scan (51x61x1): Interpolated grid: $dx=1.000 \text{ mm}$, $dy=1.000 \text{ mm}$

Maximum value of SAR (interpolated) = 5.43 W/kg

System Check/System Check/Z Scan (1x1x21): Measurement grid: $dx=20\text{mm}$, $dy=20\text{mm}$, $dz=5\text{mm}$

Maximum value of Total (measured) = 63.70 V/m

System Check/System Check/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 50.83 V/m; Power Drift = 0.12 dB

Peak SAR (extrapolated) = 10.2 W/kg

SAR(1 g) = 5.2 W/kg; SAR(10 g) = 2.46 W/kg

Maximum value of SAR (measured) = 5.21 W/kg

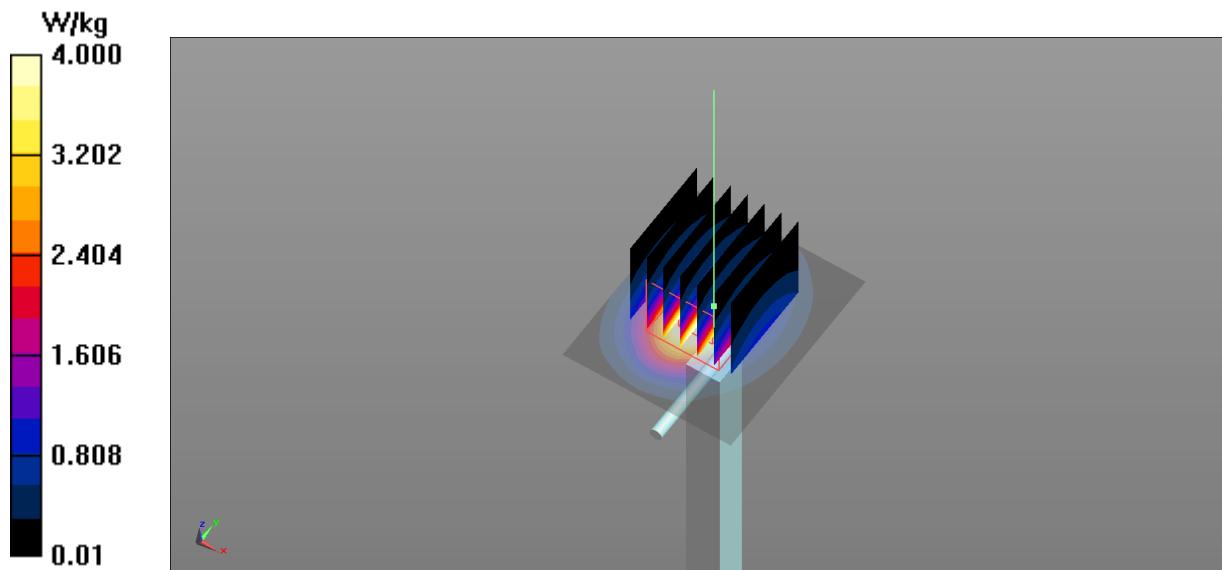
Maximum value of SAR (measured) = 7.76 W/kg

 
Approved By



SAR SYSTEM VERIFICATION

MSL2450 System Check 10-25-18



OUTPUT POWER



XMit 2017.12.13

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Block - DC	Fairview Microwave	SD3379	AMT	10-Oct-18	10-Oct-19
Attenuator	Fairview Microwave	SA4018-20	TYE	10-Oct-18	10-Oct-19
Cable	Micro-Coax	UFD150A-1-0720-200200	TXG	10-Oct-18	10-Oct-19
Generator - Signal	Agilent	N5173B	TIW	5-Jul-17	5-Jul-20
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFM	19-Mar-18	19-Mar-19

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer. The fundamental emission output power (maximum average conducted output power) was measured using the channels and modes as called out on the following data sheets. The transmit power was set to its default maximum.

Prior to measuring output power; the emission bandwidth (B) and the transmission pulse duration (T) were measured. Both are required to determine the method of measuring Maximum Conducted Output Power. The transmission pulse duration (T) was measured using a zero span on the spectrum analyzer to see the pulses in the time domain.

The method AVGSA-2 in section 11.9.2.2.4 of ANSI C63.10:2013 was used to make the measurement. This method uses trace averaging across ON and OFF times of the EUT transmissions in the spectrum analyzer channel power function using an RMS detector. Following the measurement a duty cycle correction was applied by adding $[10 \log (1 / D)]$, where D is the duty cycle, to the measured power to compute the average power during the actual transmission times.

OUTPUT POWER



Tbitx 2018.09.13

XMI 2017.12.13

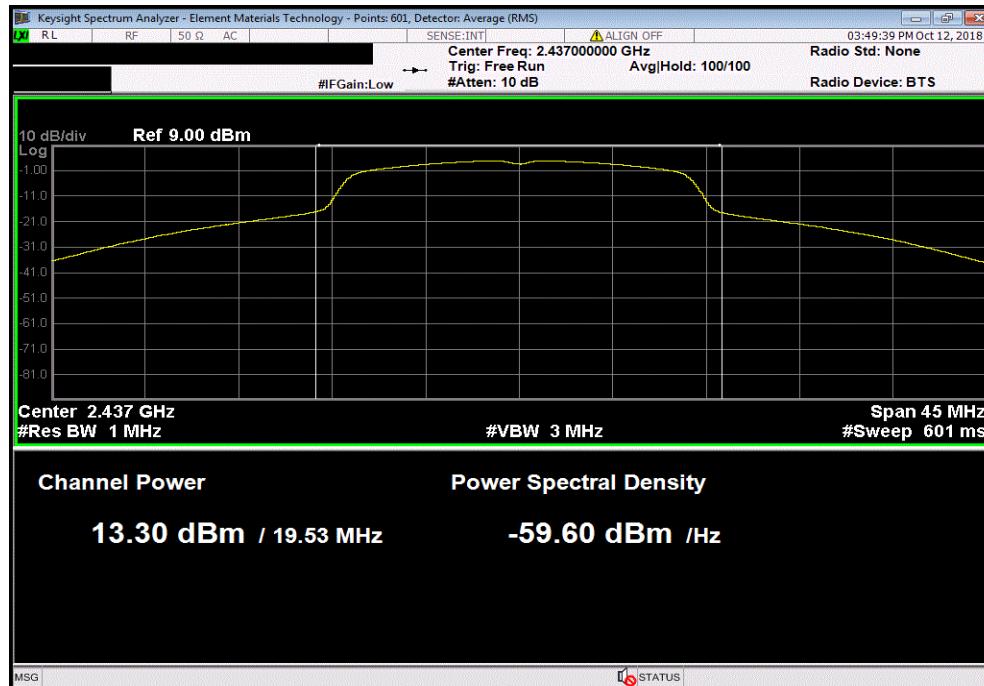
EUT:	Vista WiFi	Work Order:	WTVD0001			
Serial Number:	WFC1-009113	Date:	12-Oct-18			
Customer:	WatchGuard Video	Temperature:	22.2 °C			
Attendees:	Navaid Karimi	HuSingletiy:	50.2% RH			
Project:	None	Barometric Pres.:	1017 mbar			
Tested by:	Jonathan Kiefer	Power:	Battery			
TEST SPECIFICATIONS		Test Method	Job Site: TX09			
FCC 2.1093:2018		FCC KDB 865664 D01 v01r04 FCC KDB 865664 D02 v01r02 IEEE Std 1528:2013				
COMMENTS	None					
DEVIATIONS FROM TEST STANDARD	None					
Configuration #	2	Signature	<i>Jonathan Kiefer</i>			
		Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result
2400 MHz - 2483.5 MHz Band						
802.11(g) 6 Mbps	Single Channel 6, 2437 MHz	13.303	0.8	14.1	30	Pass
802.11(g) 9 Mbps	Single Channel 6, 2437 MHz	13.324	1.2	14.6	30	Pass
802.11(g) 12 Mbps	Single Channel 6, 2437 MHz	12.941	1.5	14.5	30	Pass
802.11(g) 18 Mbps	Single Channel 6, 2437 MHz	12.549	2.1	14.6	30	Pass
802.11(g) 24 Mbps	Single Channel 6, 2437 MHz	10.998	2.6	13.6	30	Pass
802.11(g) 36 Mbps	Single Channel 6, 2437 MHz	9.347	3.4	12.7	30	Pass
802.11(g) 48 Mbps	Single Channel 6, 2437 MHz	8.131	4	12.2	30	Pass
802.11(g) 54 Mbps	Single Channel 6, 2437 MHz	7.135	4.3	11.4	30	Pass

OUTPUT POWER

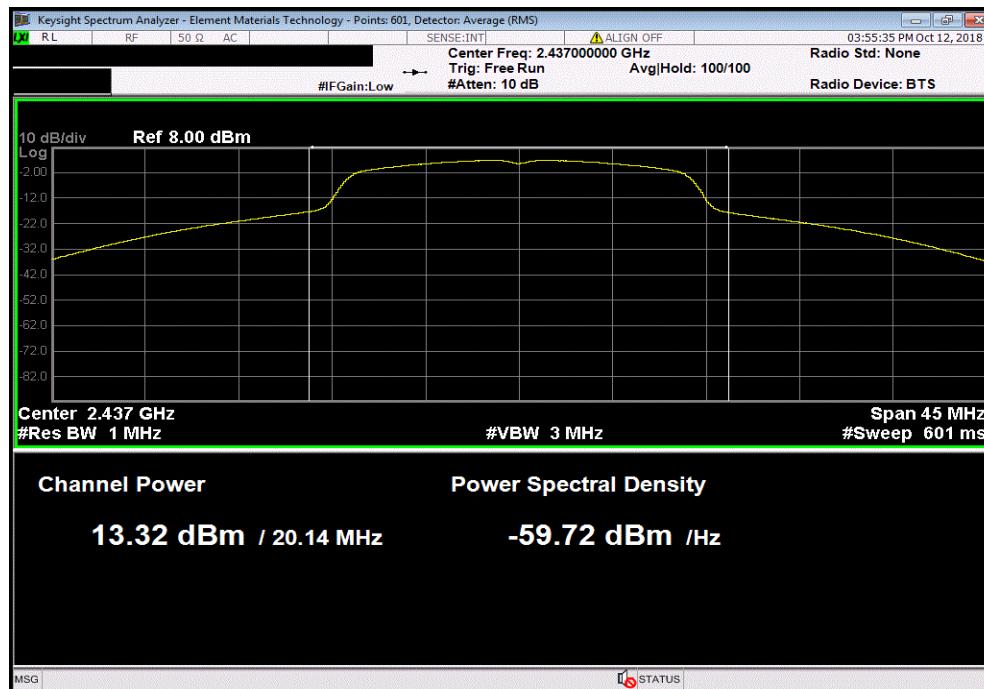


TbTx 2018.09.13 XMI 2017.12.13

2400 MHz - 2483.5 MHz Band, 802.11(g) 6 Mbps, Single Channel 6, 2437 MHz					
Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result	
13.303	0.8	14.1	30	Pass	



2400 MHz - 2483.5 MHz Band, 802.11(g) 9 Mbps, Single Channel 6, 2437 MHz					
Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result	
13.324	1.2	14.6	30	Pass	

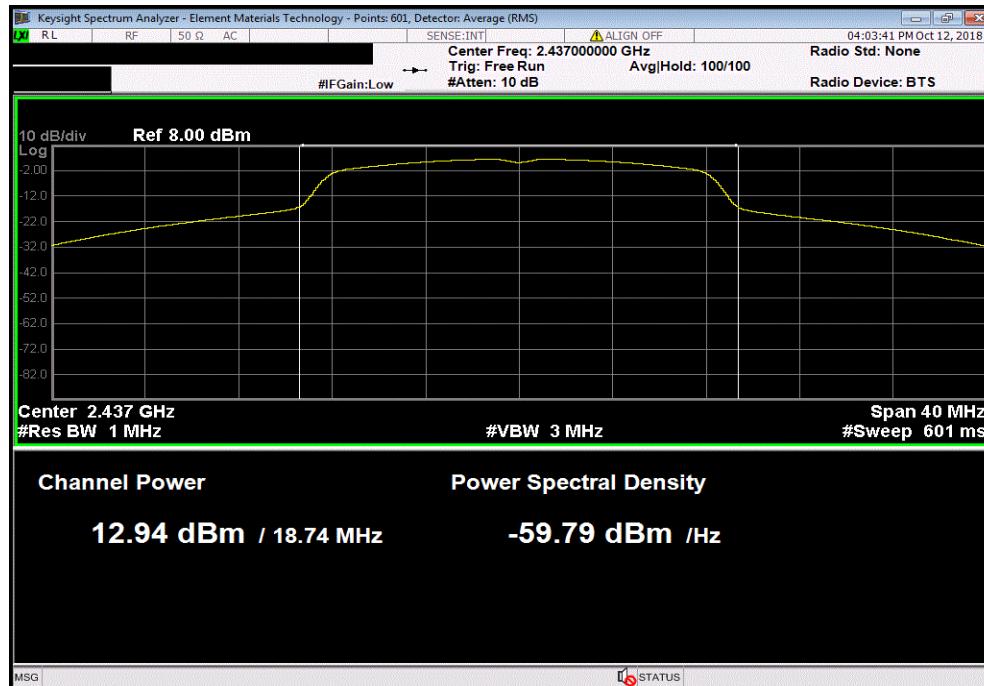


OUTPUT POWER

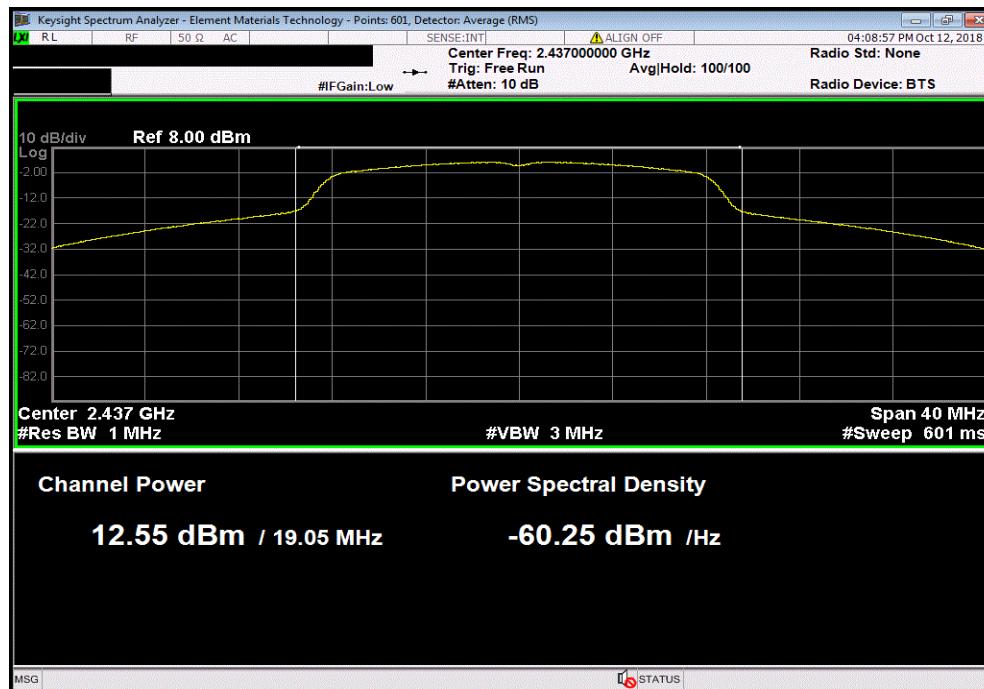


TbTx 2018.09.13 XMI 2017.12.13

2400 MHz - 2483.5 MHz Band, 802.11(g) 12 Mbps, Single Channel 6, 2437 MHz					
Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result	
12.941	1.5	14.5	30	Pass	



2400 MHz - 2483.5 MHz Band, 802.11(g) 18 Mbps, Single Channel 6, 2437 MHz					
Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result	
12.549	2.1	14.6	30	Pass	

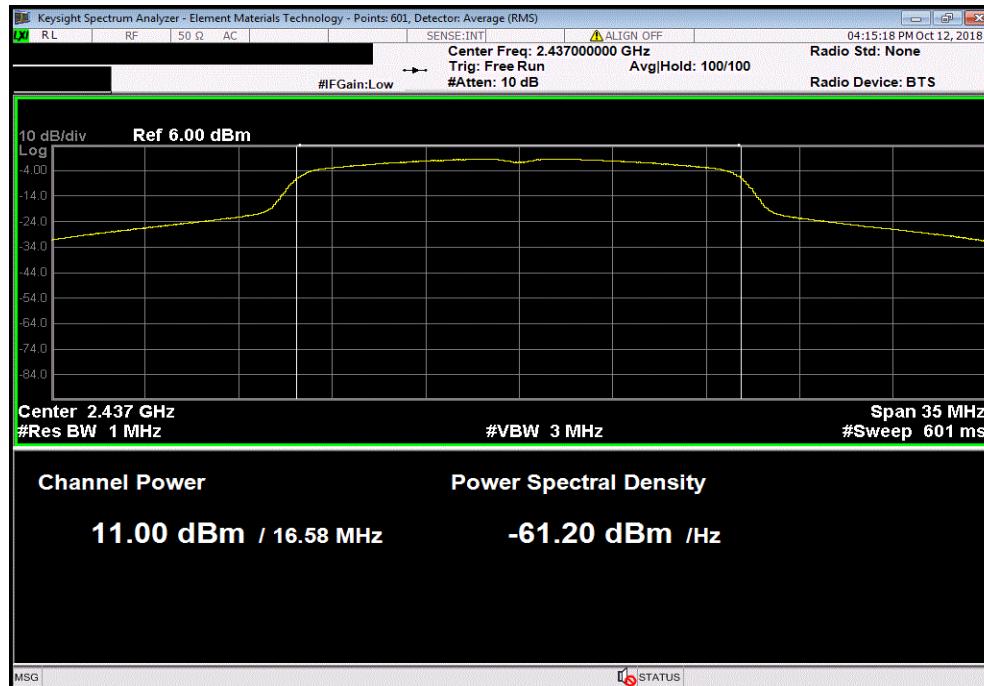


OUTPUT POWER

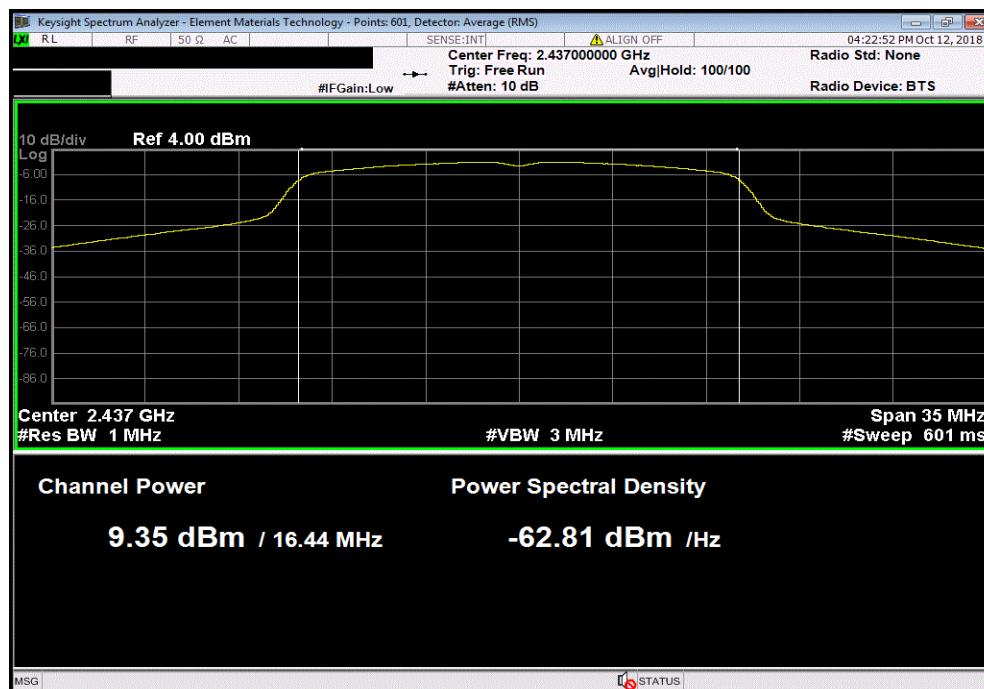


TbTx 2018.09.13 XMI 2017.12.13

2400 MHz - 2483.5 MHz Band, 802.11(g) 24 Mbps, Single Channel 6, 2437 MHz					
Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result	
10.998	2.6	13.6	30	Pass	



2400 MHz - 2483.5 MHz Band, 802.11(g) 36 Mbps, Single Channel 6, 2437 MHz					
Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result	
9.347	3.4	12.7	30	Pass	

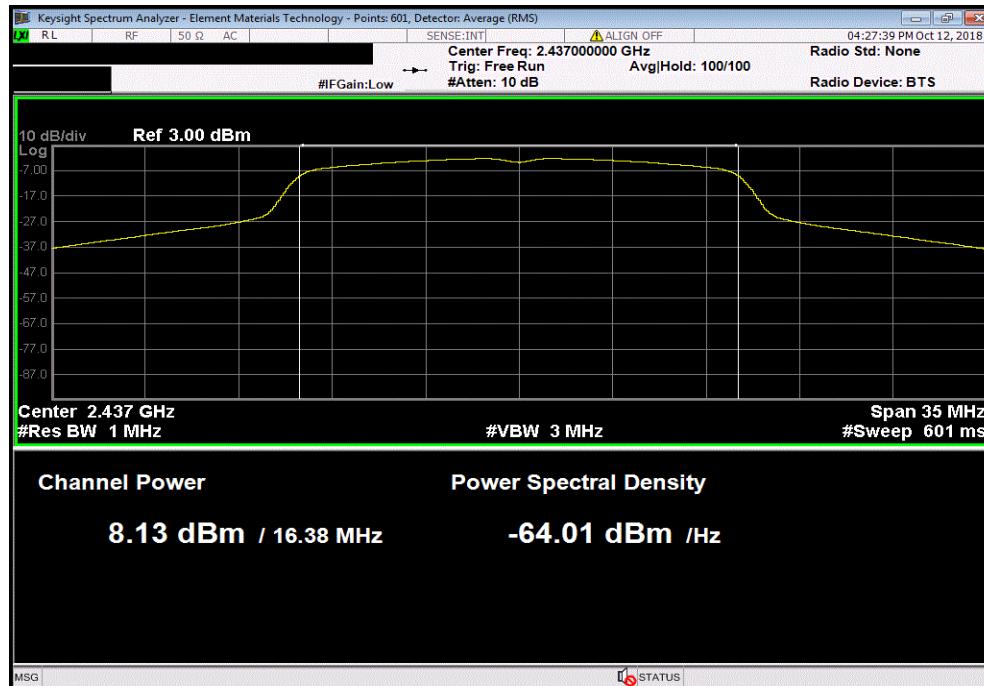


OUTPUT POWER

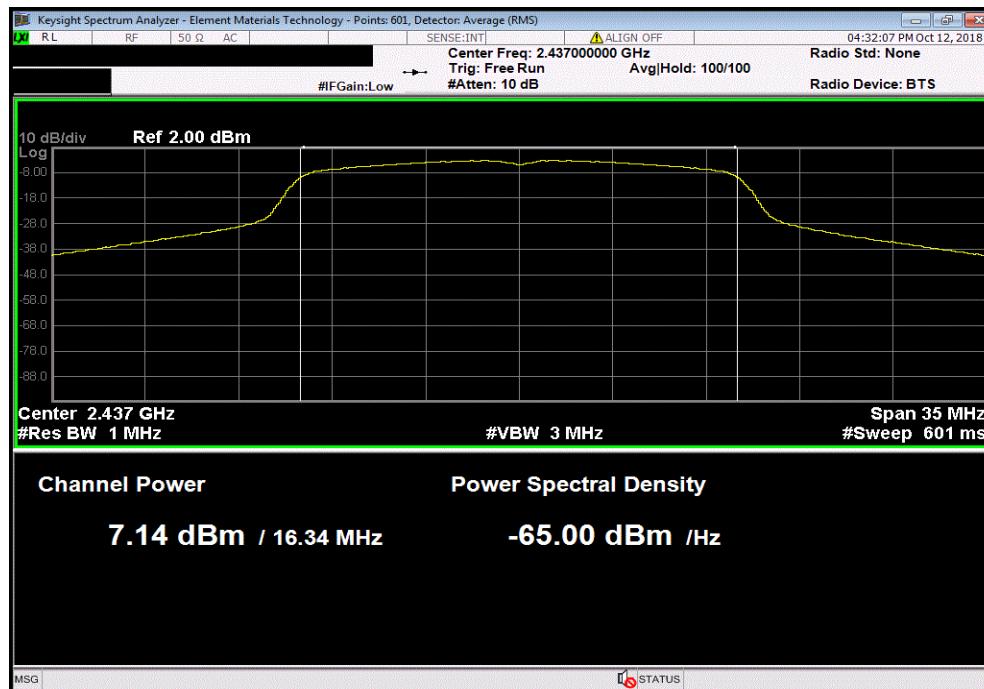


TbTx 2018.09.13 XMI 2017.12.13

2400 MHz - 2483.5 MHz Band, 802.11(g) 48 Mbps, Single Channel 6, 2437 MHz					
Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result	
8.131	4	12.2	30	Pass	

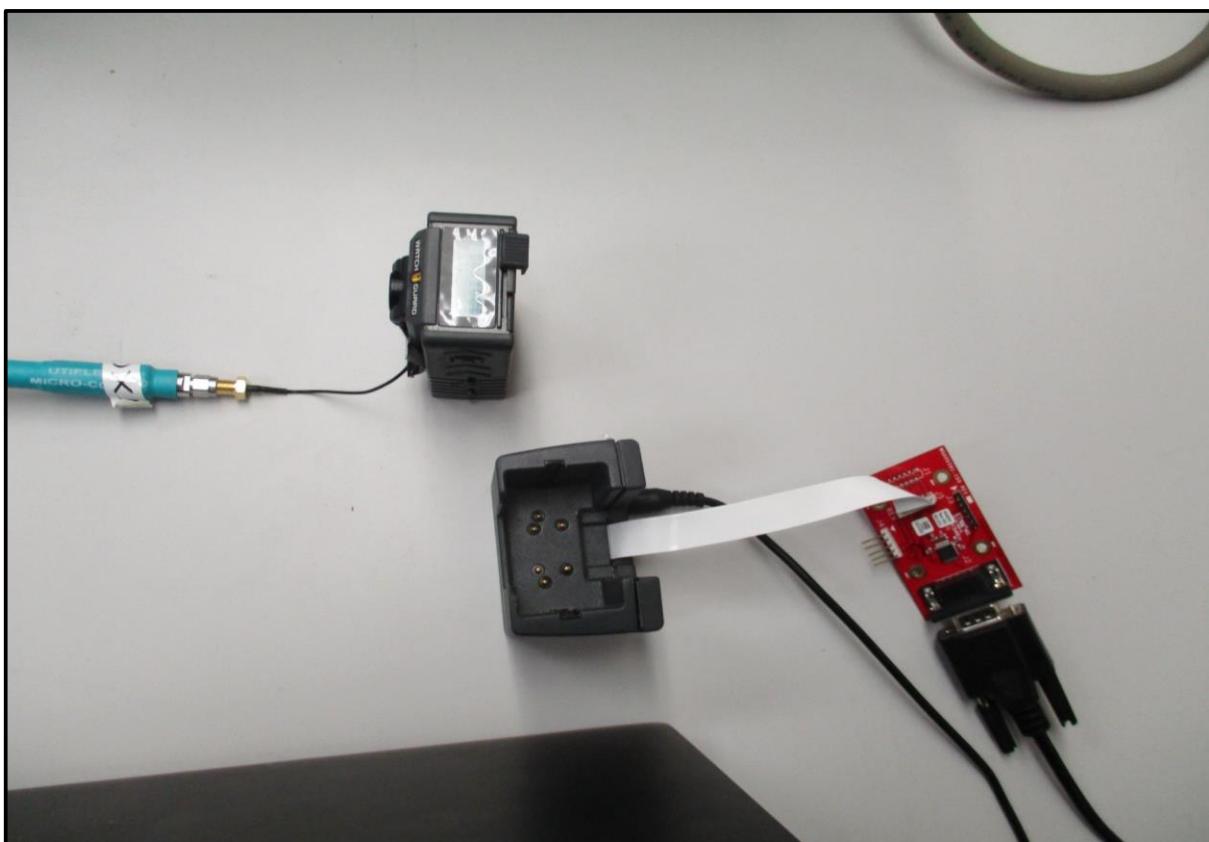
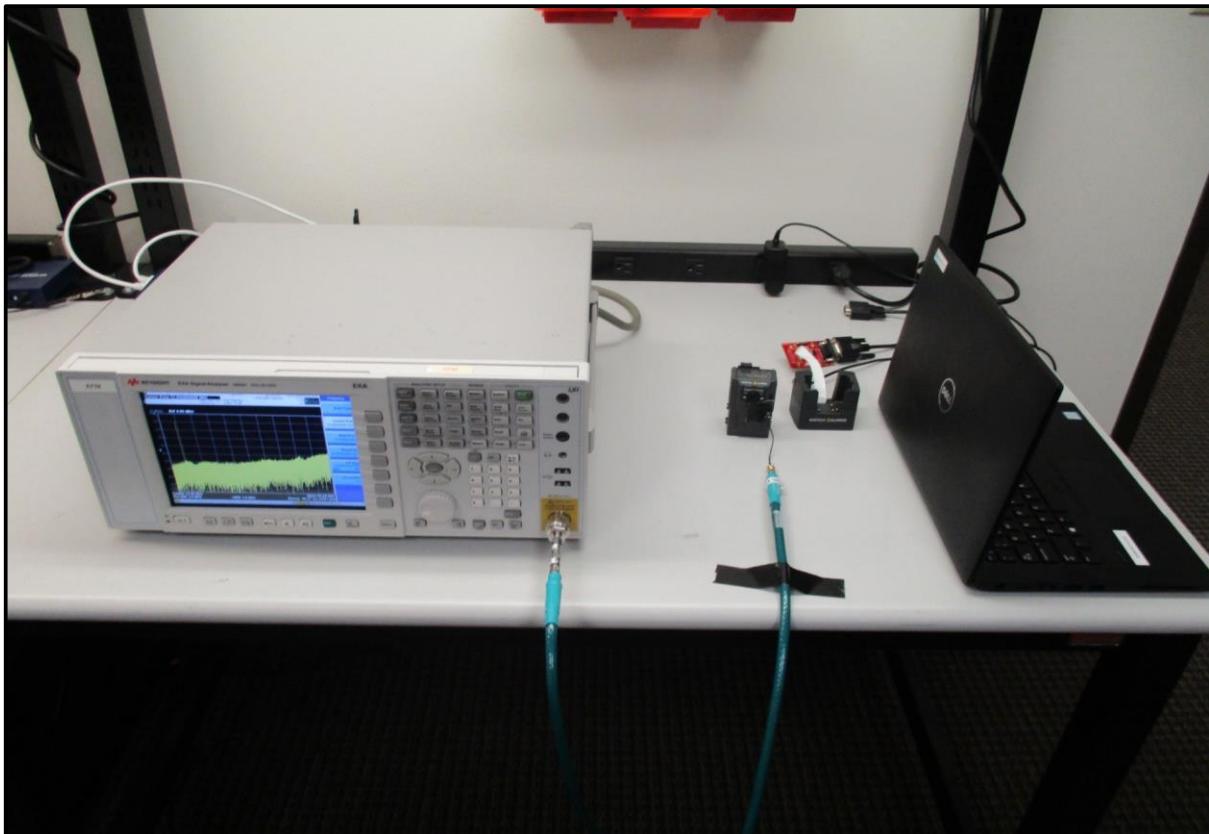


2400 MHz - 2483.5 MHz Band, 802.11(g) 54 Mbps, Single Channel 6, 2437 MHz					
Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result	
7.135	4.3	11.4	30	Pass	



OUTPUT POWER

XMit 2017.12.13



OUTPUT POWER



XMit 2017.12.13



OUTPUT POWER



XMit 2017.12.13

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Attenuator	Fairview Microwave	SA4018-20	TYW	29-Mar-18	29-Mar-19
Block - DC	Fairview Microwave	SD3379	AMM	29-Mar-18	29-Mar-19
Cable	Micro-Coax	UFD150A-1-0720-200200	TXG	10-Oct-18	10-Oct-19
Generator - Signal	Agilent	N5173B	TIW	5-Jul-17	5-Jul-20
Analyzer - Spectrum Analyzer	Keysight	N9010A	AFM	19-Mar-18	19-Mar-19

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer. The fundamental emission output power (maximum average conducted output power) was measured using the channels and modes as called out on the following data sheets. The transmit power was set to its default maximum.

Prior to measuring output power; the emission bandwidth (B) and the transmission pulse duration (T) were measured. Both are required to determine the method of measuring Maximum Conducted Output Power. The transmission pulse duration (T) was measured using a zero span on the spectrum analyzer to see the pulses in the time domain.

The method AVGSA-2 in section 11.9.2.2.4 of ANSI C63.10:2013 was used to make the measurement. This method uses trace averaging across ON and OFF times of the EUT transmissions in the spectrum analyzer channel power function using an RMS detector. Following the measurement a duty cycle correction was applied by adding $[10 \log (1 / D)]$, where D is the duty cycle, to the measured power to compute the average power during the actual transmission times.

OUTPUT POWER



TbitTx 2018.09.13

XMR 2017.12.13

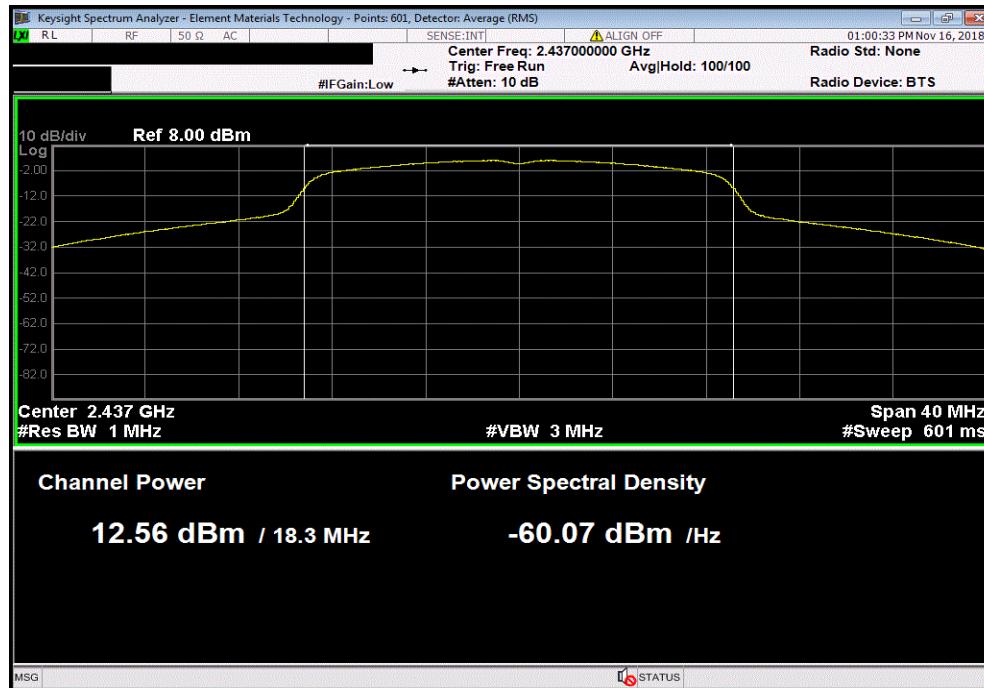
EUT:	VISTA WiFi		Work Order:	WTVD0018			
Serial Number:	WFC1-009113		Date:	16-Nov-18			
Customer:	WatchGuard Video		Temperature:	23.8 °C			
Attendees:	Navaid Karimi		Humidity:	26.6% RH			
Project:	None		Barometric Pres.:	1023 mbar			
Tested by:	Jonathan Kiefer	Power:	Battery	Job Site: TX09			
TEST SPECIFICATIONS		Test Method					
FCC 15.247:2018		ANSI C63.10:2013					
COMMENTS							
None							
DEVIATIONS FROM TEST STANDARD							
None							
Configuration #	2	Signature	Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result
2400 MHz - 2483.5 MHz Band							
802.11(n) MCS0							
Single Channel 6, 2437 MHz							
12.557 1 13.6 30 Pass							
802.11(n) MCS4							
Single Channel 6, 2437 MHz							
9.093 3.7 12.8 30 Pass							
802.11(n) MCS7							
Single Channel 6, 2437 MHz							
5.386 4.8 10.2 30 Pass							

OUTPUT POWER

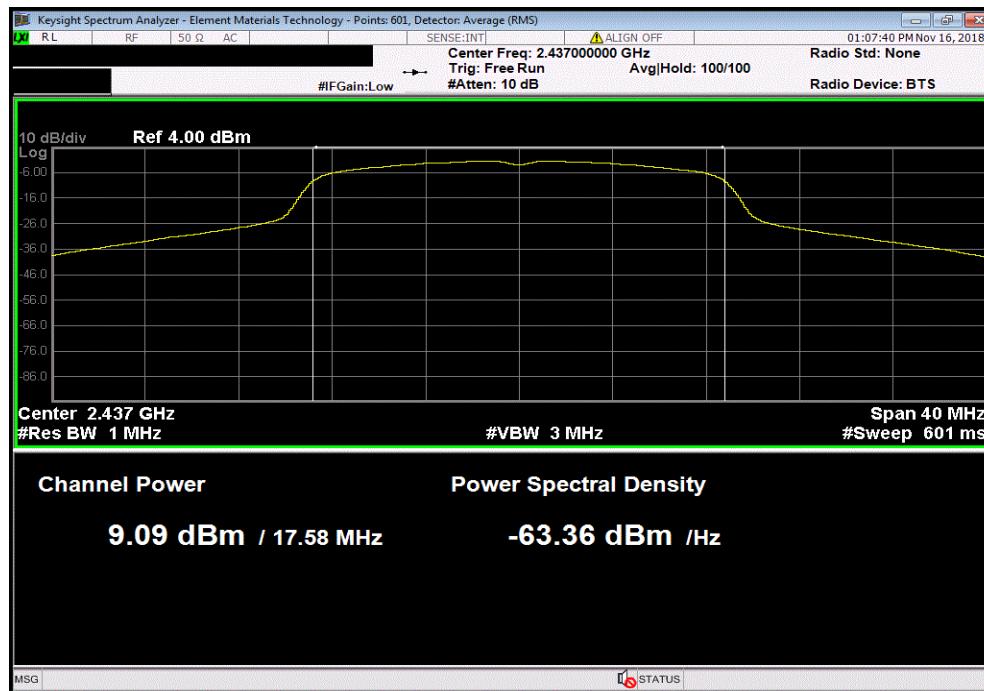


TbTx 2018.09.13 XMI 2017.12.13

2400 MHz - 2483.5 MHz Band, 802.11(n) MCS0, Single Channel 6, 2437 MHz					
Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result	
12.557	1	13.6	30	Pass	



2400 MHz - 2483.5 MHz Band, 802.11(n) MCS4, Single Channel 6, 2437 MHz					
Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result	
9.093	3.7	12.8	30	Pass	

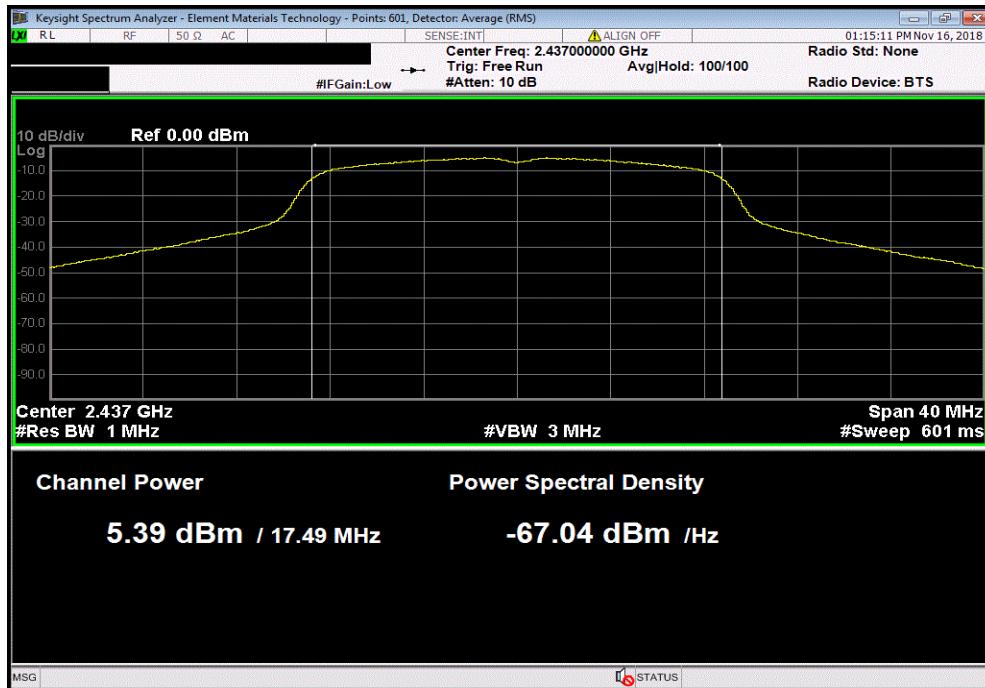


OUTPUT POWER



TbTx 2018.09.13 XM1 2017.12.13

2400 MHz - 2483.5 MHz Band, 802.11(n) MCS7, Single Channel 6, 2437 MHz					
Avg Cond Pwr (dBm)	Duty Cycle Factor (dB)	Out Pwr (dBm)	Limit (dBm)	Result	
5.386	4.8	10.2	30	Pass	





TEST RESULTS

Test Configurations

Test Locations

All sides except the camera face were tested. There are no authorized accessories to wear the device on the body. Testing was done with a 0 cm spacing to the phantom.

Summary

The following table summarizes the measured SAR values. The EUT was transmitting at nearly 100% duty cycle.

Per FCC KDB 447498, the measured SAR values were scaled to the maximum tune-up tolerance limit. The results are referred to as the "Reported SAR" values. The measured SAR data was scaled by a factor of 1 to calculate the reported SAR values. The following formula was used to calculate the linear SAR scaling factor:

$$\begin{aligned}\text{SAR scaling factor} &= 10^{((\text{Maximum Rated Power}^1 \text{ (dBm)} - \text{Measured Power (dBm)}) / 10)} \\ \text{SAR scaling factor} &= 10^{(14.6-14.6)/10} \\ \text{SAR scaling factor} &= 1\end{aligned}$$

Per FCC KDB 447498, SAR must be measured on the channel with the highest conducted output power. When the SAR measured on the highest output channel is >0.8 W/kg, SAR evaluation for the other required test channels is necessary.

SAR TEST DATA



EUT:	Vista WiFi	Work Order:	WTVD0001
Customer:	WatchGuard Video	Job Site:	EV08
Attendees:	None	Customer Project:	None

TEST SPECIFICATIONS

Specification:	Method:
FCC 2.1093:2018	FCC KDB 865664 D01 v01r04
	FCC KDB 865664 D02 v01r02
	FCC KDB 447498 D01 v06
	IEEE Std 1528:2013

COMMENTS

None

DEVIATIONS FROM TEST STANDARD

None

RESULTS

Test Configuration	Frequency Band	Transmit Frequency (MHz)	Transmit Channel	Data Rate (Mbps)	Channel Bandwidth (MHz)	Antenna Port	EUT Position	Power Drift During Test (dB)	Measured 1g SAR Level (mW/g)	Measured 10g SAR Level (mW/g)	Test #
Body	2.4	2437	6	6	20	A	Back	-0.44	0.045	0.026	1
Body	2.4	2437	6	6	20	A	Top	0.08	0.100	0.054	2
Body	2.4	2437	6	6	20	A	Bottom	0.23	0.043	0.019	3
Body	2.4	2437	6	6	20	A	Left	0.71	0.017	0.009	4
Body	2.4	2437	6	6	20	A	Right	0.42	0.011	0.006	5

SAR TEST DATA



Tested By:	Ethan Schoonover	Room Temperature (°C):	24.6°C
Date:	10/26/2018 10:01:40 AM	Liquid Temperature (°C):	21.8°C
Serial Number:	WFC1-039084	Humidity (%RH):	46.7%
Configuration:	WTVD0001-6	Bar. Pressure (mb):	1017 mb
Comments:	None		

Test 2

DUT: Vista Wi-Fi; Type: Sample; Serial: WFC1-039084

Communication System: UID 0, CW; Communication System Band: D2450 (2450.0 MHz); Frequency: 2437 MHz; Communication System PAR: 0 dB; PMF: 1

Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.896$ S/m; $\epsilon_r = 50.587$; $\rho = 1000$ kg/m³, Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: EX3DV4 - SN3746; ConvF(7.02, 7.02, 7.02); Calibrated: 11/15/2017;
 - Modulation Compensation:
- Sensor-Surface: 3mm (Mechanical Surface Detection), Sensor-Surface: 0mm (Fix Surface), $z = 31.0, 101.0$
- Electronics: DAE4 Sn1237; Calibrated: 11/7/2017
- Phantom: ELI v5.0; Type: QDOVA002AA
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Body/Body/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 8.203 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 0.179 W/kg

SAR(1 g) = 0.100 W/kg; SAR(10 g) = 0.054 W/kg

Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of SAR (measured) = 0.125 W/kg

Body/Body/Area scan (51x51x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of SAR (interpolated) = 0.125 W/kg

Body/Body/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm

Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of Total (measured) = 2.919 V/m

Body/Body/Reference scan (31x31x1): Interpolated grid: dx=3.000 mm, dy=3.000 mm

Info: Interpolated medium parameters used for SAR evaluation.

Maximum value of SAR (interpolated) = 0.0935 W/kg

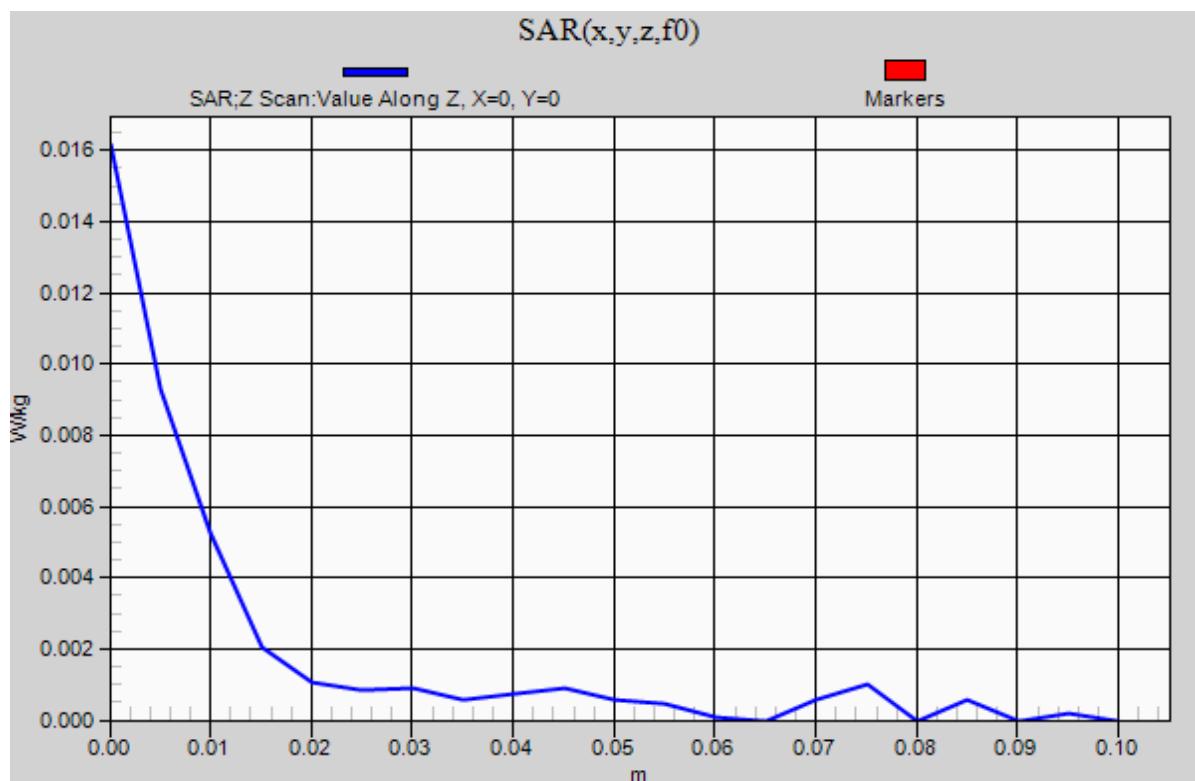
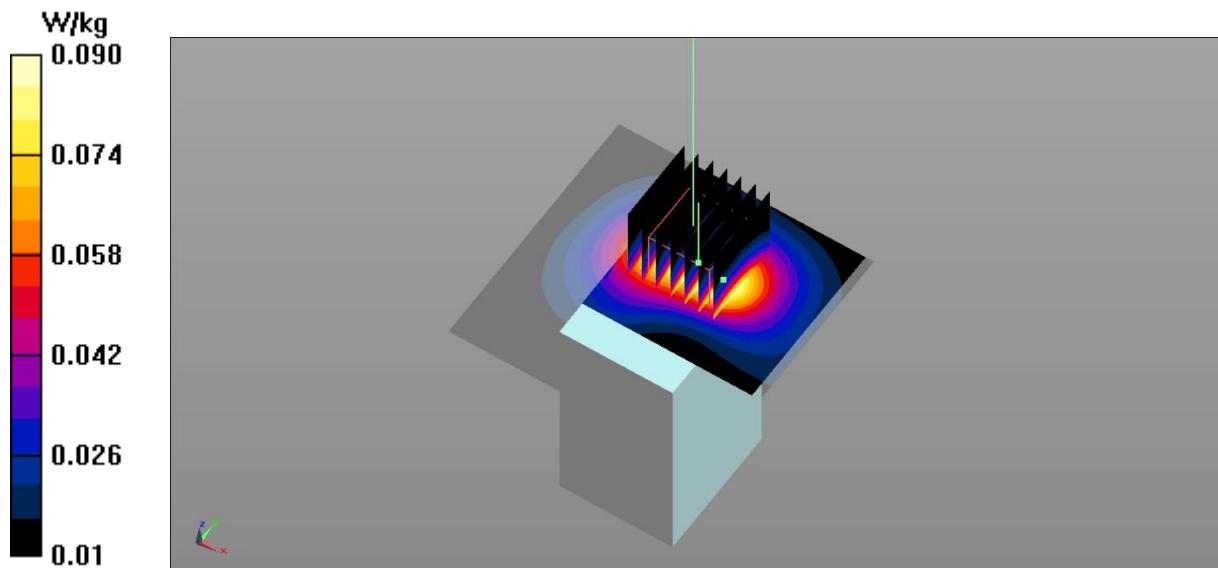
Maximum value of SAR (measured) = 0.0162 W/kg

Approved By

SAR TEST DATA



Test 2



SYSTEM AND TEST SITE DESCRIPTION

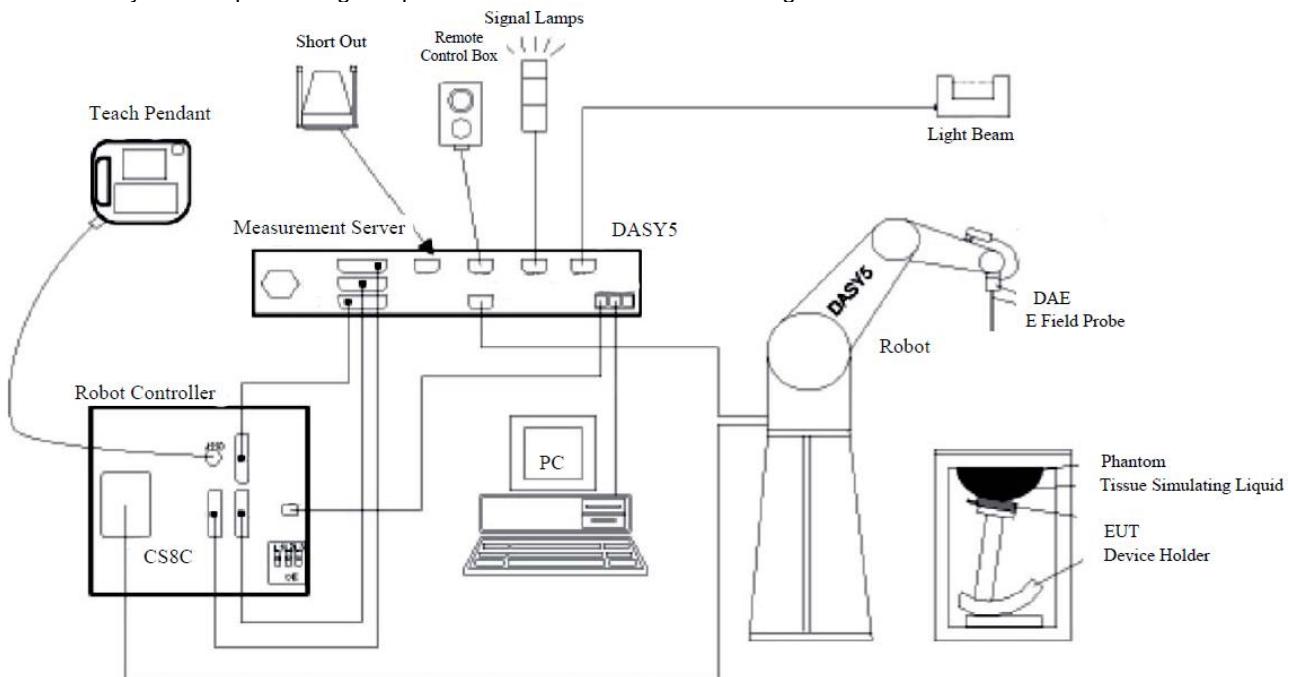


SAR MEASUREMENT SYSTEM

Schmid & Partner Engineering AG, DASY52

Element selected the leader in SAR evaluation systems to provide the measurement tools for this evaluation. SPEAG's DASY52 is the fastest and most accurate scanner on the market. It is fully compatible with all world-wide standards for transmitters operating at the ear or within 20cm of the body. It provides full compatibility with IEC 62209-1, IEC 62209-2, IEEE 1528 as well as national adaptations such as FCC OET-65c and Korean Std. MIC #2000-93

The DASY52 system for performing compliance tests consists of the following items:



- A standard high precision 6-axis robot (Staubli 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 WinXP and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom, oval flat phantom, device holder, tissue simulating liquids, and validation dipole kits.

SYSTEM AND TEST SITE DESCRIPTION



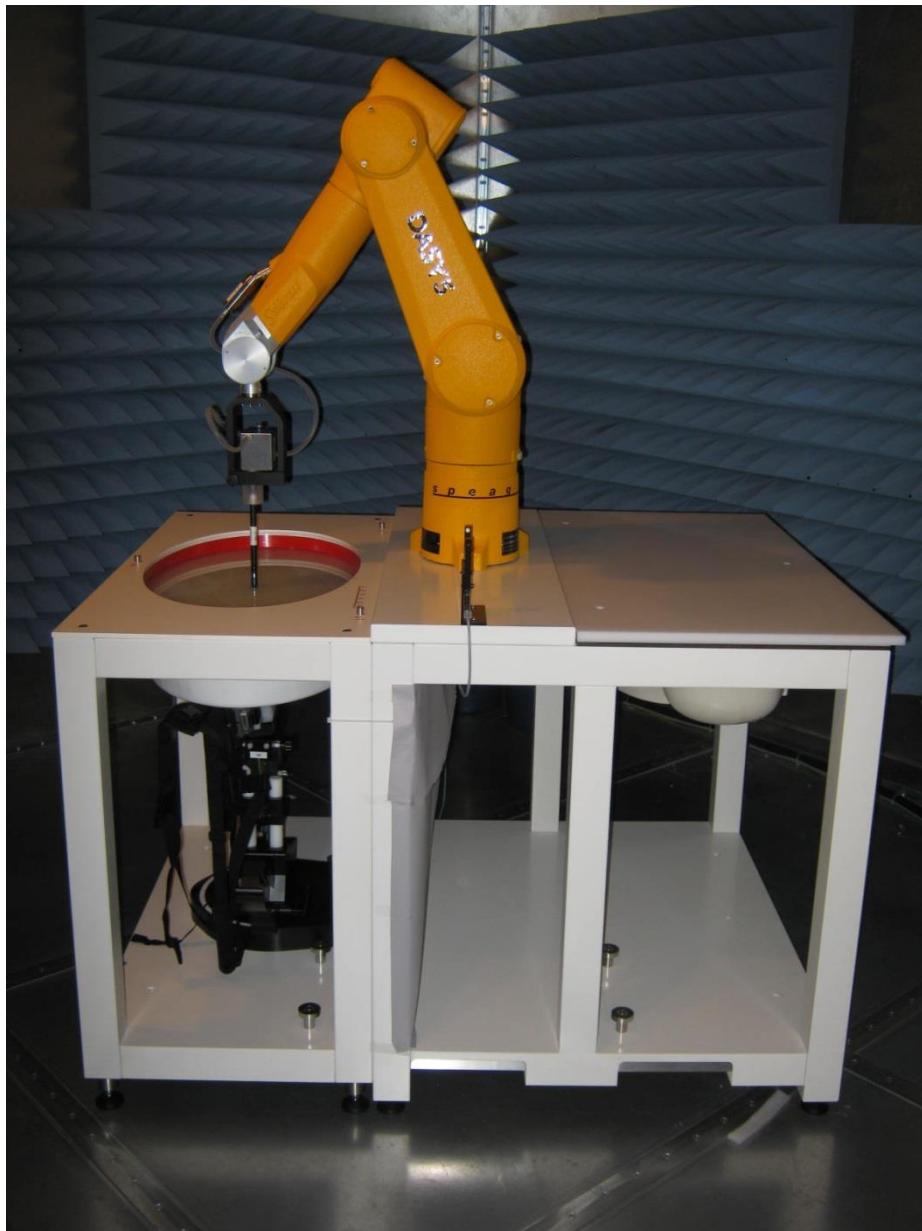
WSTD.2017.1.31

TEST SITE

Element, Lab EV08

The SAR measurement system is located in a semi-anechoic chamber. This provides an ambient free environment that also eliminates reflections.

The chamber is 12 ft wide by 16 ft long x 8 ft high. A dedicated HVAC unit provides +/- 1 degree C temperature control.





WSEQ.2016.12.19

TEST EQUIPMENT

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Interval
Amplifier	Mini Circuits	ZVE-3W-83+	TTA	NCR ¹	0 mo
Antenna - Dipole	SPEAG	D2450V2	ADL	11/7/2017	12 mo
DAE	SPEAG	SD 000 D04 EJ	SAH	11/7/2017	12 mo
Dielectric Assessment Kit	SPEAG	DAKS:200	IPR	3/17/2016	36 mo
Generator - Signal	Agilent	V2920A	TIH	NCR	0 mo
Meter - Power	Agilent	N1913A	SQR	10/2/2018	12 mo
Power Sensor	Agilent	E9300H	SQO	10/2/2018	12 mo
Probe - Dielectric	SPEAG	DAKS-3.5	IPRA	11/1/2016	36 mo
Probe - SAR	SPEAG	EX3DV4	SAG	11/15/2017	12 mo
SAR - Tissue Test Solution	SPEAG	MSL 2450	SAM	At start of testing	
SAR Test System	Staeubli	DAY5	SAK	11/1/2016	36 mo
SAR Test System	SPEAG	QD OVA 001 BB	SAC	NCR	0 mo
Thermometer	Omegaette	HH311	DTX	3/29/2018	36 mo

Note 1: The output of the signal generator / amplifier is verified with the calibrated power meter listed above.

MEASUREMENT UNCERTAINTY



MEASUREMENT UNCERTAINTY BUDGETS PER IEEE 1528:2013

300-3000 MHz Range								
Uncertainty Component	Tolerance (+/- %)	Probability Distribution	Divisor	c _i (1g)	c _i (10g)	u _i (1g) (+/-%)	u _i (10g) (+/-%)	v _i
Measurement System								
Probe calibration (k=1)	5.5	normal	1	1	1	5.5	5.5	∞
Axial isotropy	4.7	rectangular	1.732	0.707	0.707	1.9	1.9	∞
Hemispherical isotropy	9.6	rectangular	1.732	0.707	0.707	3.9	3.9	∞
Boundary effect	1.0	rectangular	1.732	1	1	0.6	0.6	∞
Linearity	4.7	rectangular	1.732	1	1	2.7	2.7	∞
System detection limits	1.0	rectangular	1.732	1	1	0.6	0.6	∞
Readout electronics	0.3	normal	1	1	1	0.3	0.3	∞
Response time	0.8	rectangular	1.732	1	1	0.5	0.5	∞
Integration time	2.6	rectangular	1.732	1	1	1.5	1.5	∞
RF ambient conditions - noise	1.7	rectangular	1.732	1	1	1.0	1.0	∞
RF Ambient Reflections	0.0	rectangular	1.732	1	1	0.0	0.0	∞
Probe positioner mechanical tolerance	0.4	rectangular	1.732	1	1	0.2	0.2	∞
Probe positioner with respect to phantom shell	2.9	rectangular	1.732	1	1	1.7	1.7	∞
Extrapolation, interpolation, and integration algorithms for max. SAR evaluation	1.0	rectangular	1.732	1	1	0.6	0.6	∞
Test Sample Related								
Device Positioning	2.9	normal	1	1	1	2.9	2.9	145
Device Holder	3.6	normal	1	1	1	3.6	3.6	5
Power Drift	5.0	rectangular	1.732	1	1	2.9	2.9	∞
Phantom and tissue parameters								
Phantom Uncertainty - shell thickness tolerances	4.0	rectangular	1.732	1	1	2.3	2.3	∞
Liquid conductivity - deviation from target values	5.0	rectangular	1.732	0.64	0.43	1.8	1.2	∞
Liquid conductivity - measurement uncertainty	6.5	normal	1	0.64	0.43	4.2	2.8	∞
Liquid permittivity - deviation from target values	5.0	rectangular	1.732	0.6	0.49	1.7	1.4	∞
Liquid permittivity - measurement uncertainty	3.2	normal	1	0.6	0.49	1.9	1.6	∞
Combined Standard Uncertainty				RSS		11.2	10.6	387
Expanded Measurement Uncertainty (95% Confidence/				normal (k=2)		22.5	21.2	

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



S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
SCS 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 **Element**

Certificate No.: **D2450V2-855_Nov17**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN:855**

Calibration procedure(s) **QA CAL-05.v9**
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: **November 07, 2017**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-17 (No. 217-02521/02522)	Apr-18
Power sensor NRP-Z91	SN: 103244	04-Apr-17 (No. 217-02521)	Apr-18
Power sensor NRP-Z91	SN: 103245	04-Apr-17 (No. 217-02522)	Apr-18
Reference 20 dB Attenuator	SN: 5058 (20k)	07-Apr-17 (No. 217-02528)	Apr-18
Type-N mismatch combination	SN: 5047.2 / 06327	07-Apr-17 (No. 217-02529)	Apr-18
Reference Probe EX3DV4	SN: 7349	31-May-17 (No. EX3-7349_May17)	May-18
DAE4	SN: 601	26-Oct-17 (No. DAE4-601_Oct17)	Oct-18

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-17)	In house check: Oct-18

Calibrated by:	Name	Function	Signature
	Leif Klysnar	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

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

Issued: November 8, 2017



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

Accreditation No.: SCS 0108

Glossary:

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

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.10.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.8 ± 6 %	1.86 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.5 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	52.7 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.26 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	24.7 W/kg ± 16.5 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.5 ± 6 %	2.02 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	13.0 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	50.9 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.07 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.0 W/kg ± 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	$53.3 \Omega + 3.9 j\Omega$
Return Loss	- 26.1 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	$50.3 \Omega + 5.1 j\Omega$
Return Loss	- 25.8 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.157 ns
----------------------------------	----------

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

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

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

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	November 10, 2009

DASY5 Validation Report for Head TSL

Date: 07.11.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:855

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450 \text{ MHz}$; $\sigma = 1.86 \text{ S/m}$; $\epsilon_r = 37.8$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.12, 8.12, 8.12); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

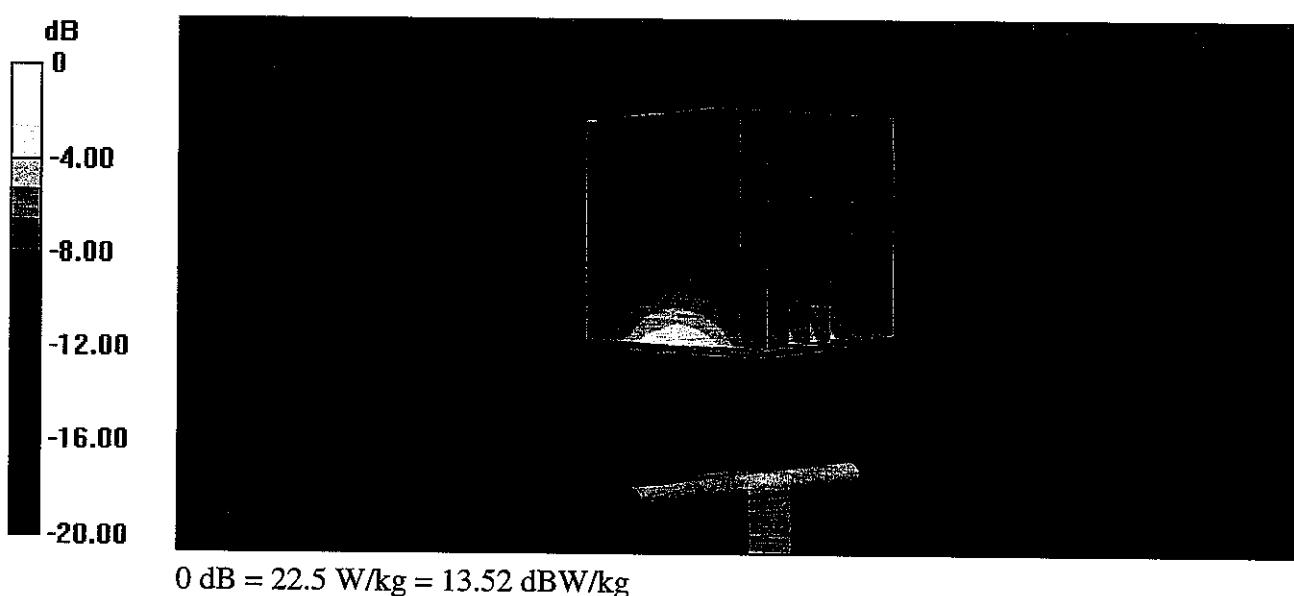
Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 116.1 V/m; Power Drift = -0.04 dB

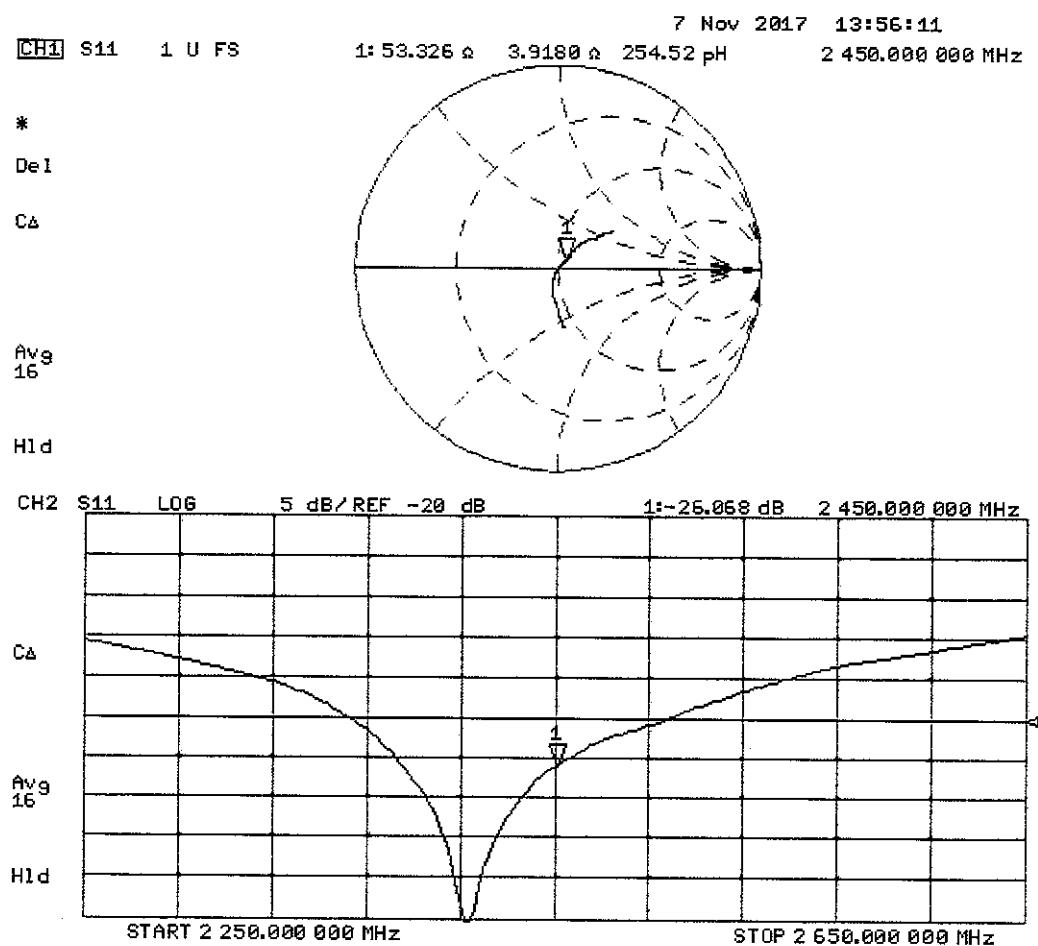
Peak SAR (extrapolated) = 27.6 W/kg

SAR(1 g) = 13.5 W/kg; SAR(10 g) = 6.26 W/kg

Maximum value of SAR (measured) = 22.5 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 07.11.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:855

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450 \text{ MHz}$; $\sigma = 2.02 \text{ S/m}$; $\epsilon_r = 51.5$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.1, 8.1, 8.1); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

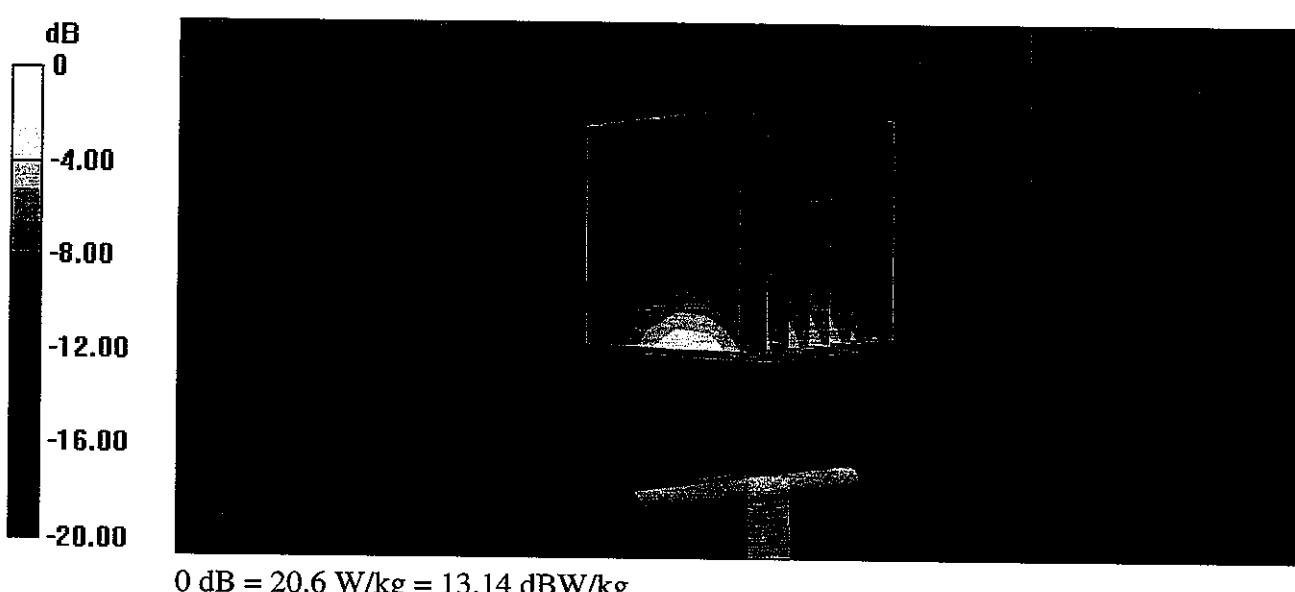
Measurement grid: $dx=5\text{mm}$, $dy=5\text{mm}$, $dz=5\text{mm}$

Reference Value = 106.7 V/m; Power Drift = -0.06 dB

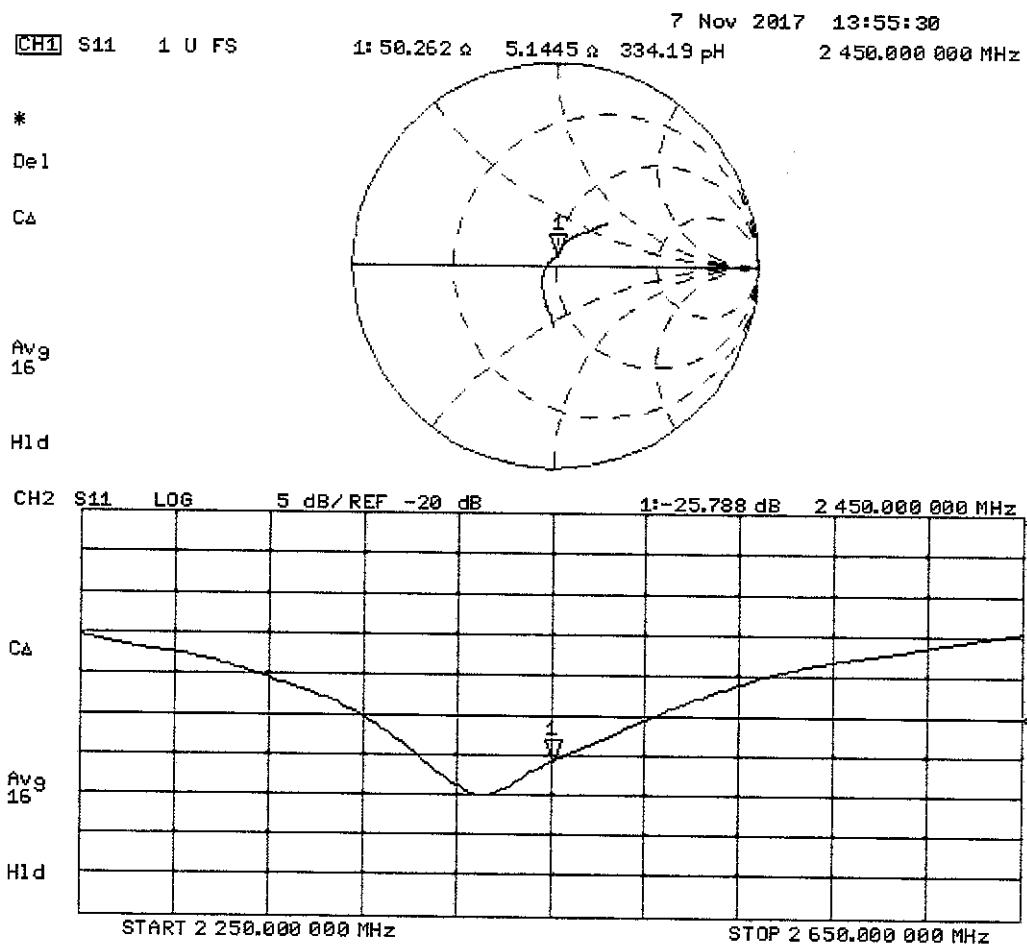
Peak SAR (extrapolated) = 25.9 W/kg

SAR(1 g) = 13 W/kg; SAR(10 g) = 6.07 W/kg

Maximum value of SAR (measured) = 20.6 W/kg



Impedance Measurement Plot for Body TSL



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



S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
SCS 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 **Element**Certificate No.: **EX3-3746_Nov17**

CALIBRATION CERTIFICATE

Object	EX3DV4 SN:3746
Calibration procedure(s)	QA CAL-01 v9, QA CAL-14 v4, QA CAL-23 v5, QA CAL-25 v6 Calibration procedure for dosimetric E-field probes
Calibration date:	November 15, 2017
<p>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.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.</p> <p>Calibration Equipment used (M&TE critical for calibration)</p>	

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-17 (No. 217-02521/02522)	Apr-18
Power sensor NRP-Z91	SN: 103244	04-Apr-17 (No. 217-02521)	Apr-18
Power sensor NRP-Z91	SN: 103245	04-Apr-17 (No. 217-02525)	Apr-18
Reference 20 dB Attenuator	SN: S5277 (20x)	07-Apr-17 (No. 217-02528)	Apr-18
Reference Probe ES3DV2	SN: 3013	31-Dec-16 (No. ES3-3013_Dec16)	Dec-17
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-17)	In house check: Oct-18

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

Issued: November 15, 2017

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



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 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., $\theta = 0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, ", "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
- c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

- $NORMx,y,z$: Assessed for E-field polarization $\theta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). $NORMx,y,z$ are only intermediate values, i.e., the uncertainties of $NORMx,y,z$ does not affect the E^2 -field uncertainty inside TSL (see below *ConvF*).
- $NORM(f)x,y,z = NORMx,y,z * frequency_response$ (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- $DCPx,y,z$: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- 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 $NORMx,y,z * ConvF$ whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy)*: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle*: The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

Probe EX3DV4

SN:3746

Manufactured: March 26, 2010
Calibrated: November 15, 2017

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3746

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.48	0.45	0.48	$\pm 10.1 \%$
DCP (mV) ^B	96.8	101.0	93.1	

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	143.2	$\pm 3.5 \%$
		Y	0.0	0.0	1.0		144.2	
		Z	0.0	0.0	1.0		148.1	

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.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3746

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)
2300	39.5	1.67	7.32	7.32	7.32	0.34	0.85	± 12.0 %
2450	39.2	1.80	6.88	6.88	6.88	0.41	0.86	± 12.0 %
2550	39.1	1.91	6.86	6.86	6.86	0.40	0.82	± 12.0 %
5200	36.0	4.66	5.25	5.25	5.25	0.35	1.80	± 13.1 %
5300	35.9	4.76	5.05	5.05	5.05	0.35	1.80	± 13.1 %
5500	35.6	4.96	4.66	4.66	4.66	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.61	4.61	4.61	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.58	4.58	4.58	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.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3746

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)
2300	52.9	1.81	7.22	7.22	7.22	0.41	0.88	± 12.0 %
2450	52.7	1.95	7.02	7.02	7.02	0.37	0.90	± 12.0 %
2550	52.6	2.09	6.88	6.88	6.88	0.34	0.92	± 12.0 %
5200	49.0	5.30	4.55	4.55	4.55	0.40	1.90	± 13.1 %
5300	48.9	5.42	4.39	4.39	4.39	0.40	1.90	± 13.1 %
5500	48.6	5.65	4.11	4.11	4.11	0.45	1.90	± 13.1 %
5600	48.5	5.77	3.95	3.95	3.95	0.45	1.90	± 13.1 %
5800	48.2	6.00	4.18	4.18	4.18	0.45	1.90	± 13.1 %

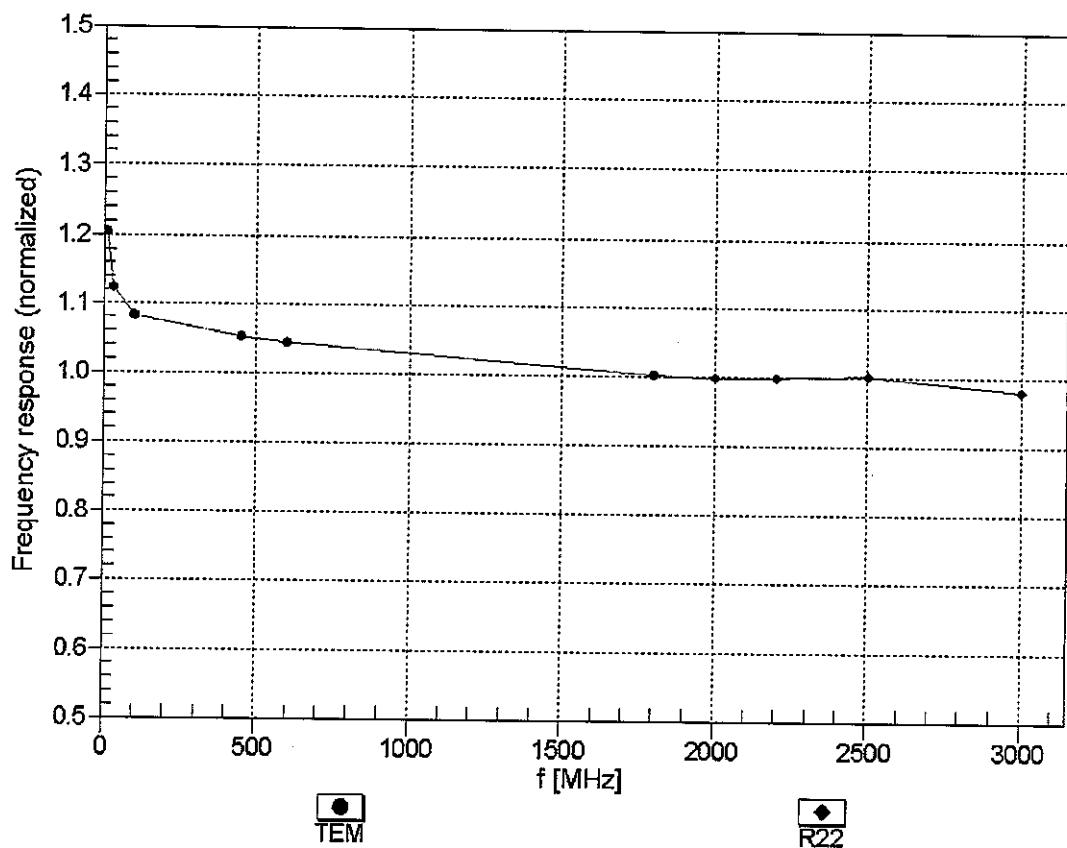
^C Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 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.

Frequency Response of E-Field

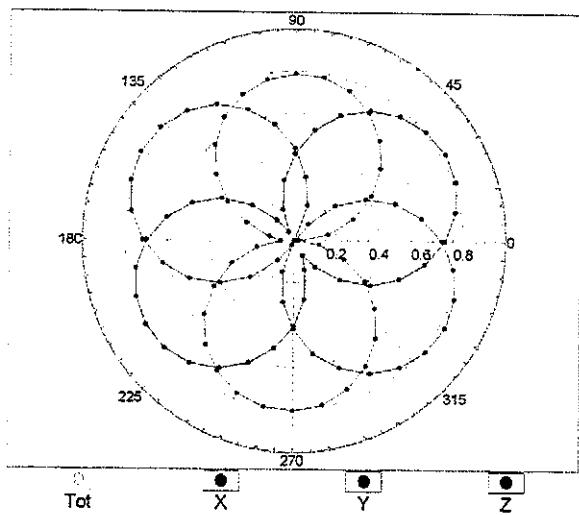
(TEM-Cell:ifi110 EXX, Waveguide: R22)



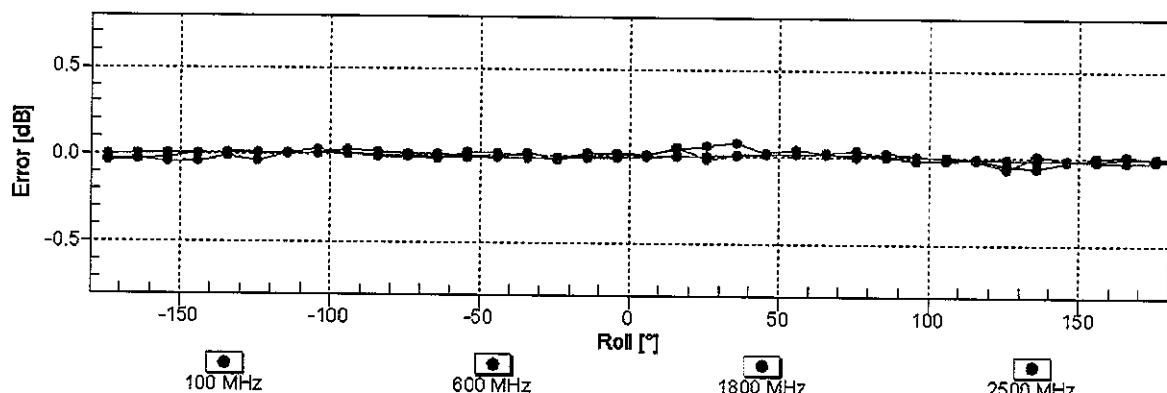
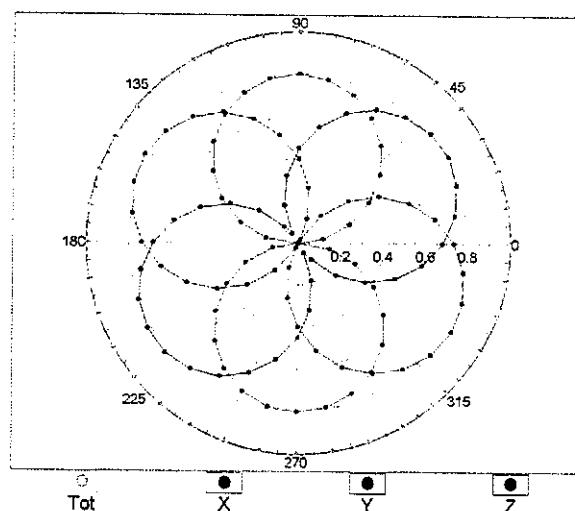
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

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

$f=600 \text{ MHz, TEM}$

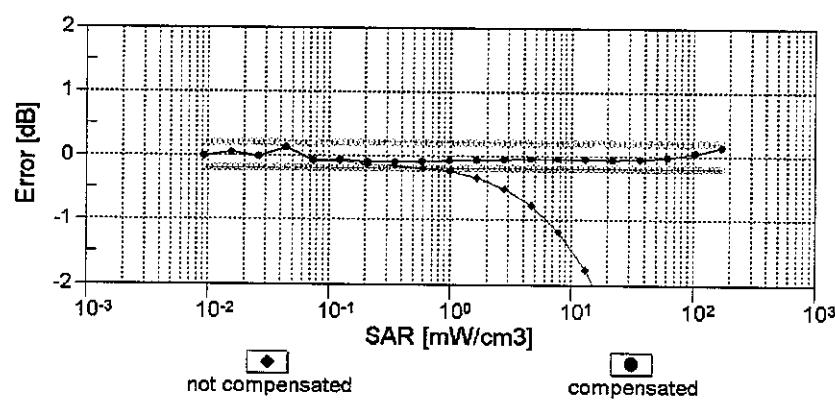
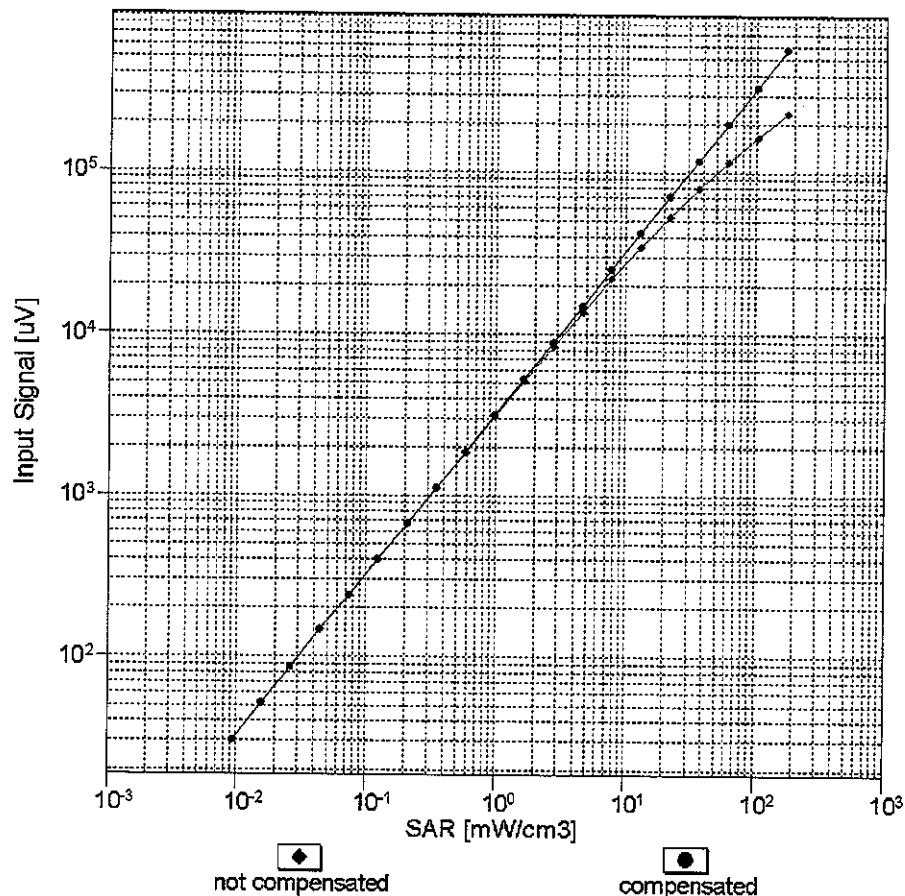


$f=1800 \text{ MHz, R22}$



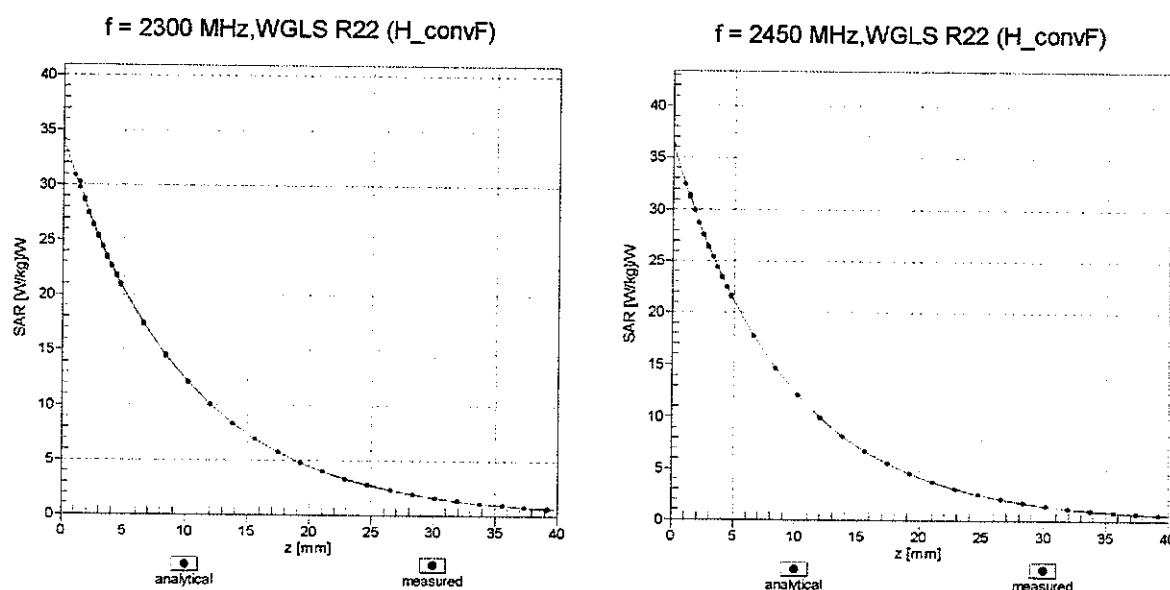
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

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

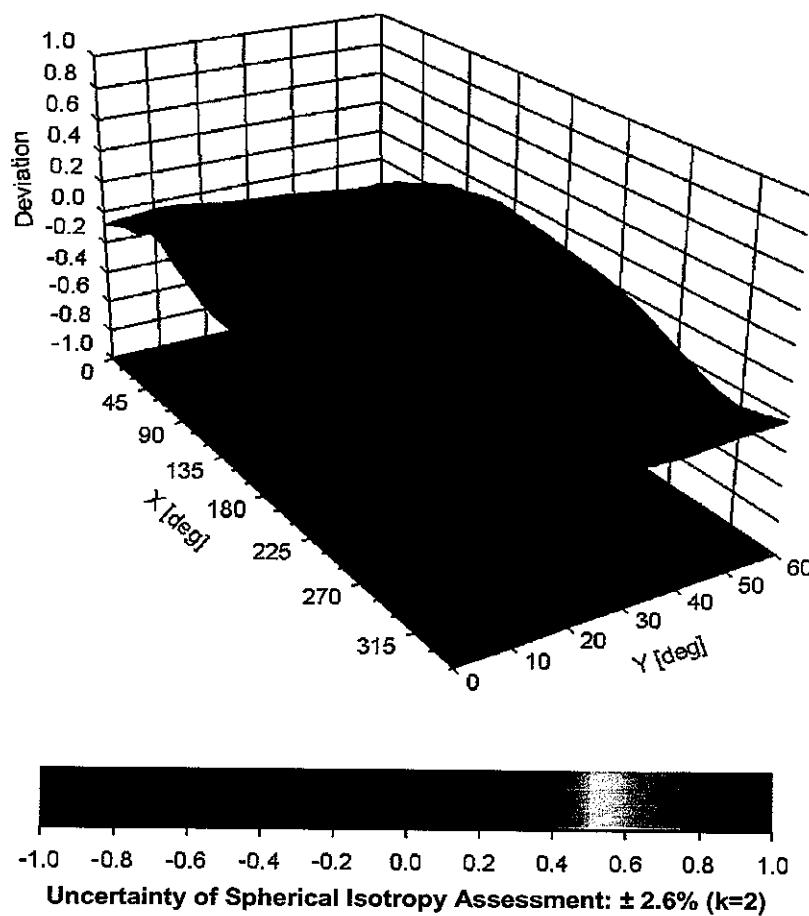


Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment



Deviation from Isotropy in Liquid Error (ϕ, θ), $f = 900 \text{ MHz}$



DASY/EASY - Parameters of Probe: EX3DV4 - SN:3746

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	45.7
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