

WatchGuard Video

MIC-WRL-TRN-410

SAR Evaluation Report # WTVD0006.1 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





Last Date of Test: July 2, 2018 WatchGuard Video Model: MIC-WRL-TRN-410

Applicable Standard

Test Description	Specification	Test Method	Pass/Fail			
SAR Evaluation		FCC KDB 865664 D01 v01r04				
	FCC 0 1000-0010	FCC KDB 865664 D02 v01r02	Deee			
	FGG 2.1093.2018	FCC KDB 447498 D01 v06	Pass			
		IEEE Std 1528:2013				

Highest SAR Values:

Frequency Bands	Body (W/kg)	Limit (W/kg)	Exposure Environment		
(GHZ)	1g	1g			
0.9	.589	1.6	General Population		

Deviations From Test Standards

None

Approved By:

Don Facteau, Systems Architect

REVISION HISTORY



Revision Number	Description	Date	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

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

Singapore

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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: <u>http://portlandcustomer.element.com/ts/scope/scope.htm</u> <u>http://gsi.nist.gov/global/docs/cabs/designations.html</u>

FACILITIES





California	Minnesota	New York	Oregon	Texas	Washington		
Labs OC01-17	Labs MN01-10	Labs NY01-04	Labs EV01-12	Labs TX01-09	Labs NC01-05		
41 Tesla	9349 W Broadway Ave.	4939 Jordan Rd.	6775 NE Evergreen Pkwy #400	3801 E Plano Pkwy	19201 120 th Ave NE		
Irvine, CA 92618	Brooklyn Park, MN 55445	Elbridge, NY 13060	Hillsboro, OR 97124	Plano, TX 75074	Bothell, WA 98011		
(949) 861-8918	(612)-638-5136	(315) 554-8214	(503) 844-4066	(469) 304-5255	(425)984-6600		
		NV	LAP				
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		
	Innov	ation, Science and Eco	nomic Development Can	ada			
2834B-1, 2834B-3	2834E-1, 2834E-3	N/A	2834D-1, 2834D- <i>2</i>	2834G-1	2834F-1		
		BS	МІ				
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:	MIC-WRL-TRN-410
First Date of Test:	June 18, 2018
Last Date of Test:	July 2, 2018
Receipt Date of Samples:	June 18, 2018
Equipment Design Stage:	Production
Equipment Condition:	No Damage
Purchase Authorization:	Verified

Information Provided by the Party Requesting the Test

Functional Description of the EUT:

The EUT is the MIC-WRL-TRN-410 "Transmitter" component. It communicates with the MIC-WRL-CHG-410 "Base" component. These two components operate as a pair and comprise the operational wireless microphone system.

The EUT has a 900MHz radio that operates and has one antenna. The EUT will be used with a shirt clip or belt clip.

Location of transmit antenna(s):



PRODUCT DESCRIPTION



Testing Locations

All available sides were tested. The EUT will be used with either a belt clip or a shirt clip. All six sides were measured with both clips. Testing was done with a 0 cm spacing to the phantom.

Simultaneous Transmission

The EUT does not have simultaneous transmission capability.

Testing Objective:

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

Scaling:

Power

The maximum power listed on the grant was used for SAR measurement.

Duty Cycle

The EUT was transmitting at nearly 100% duty cycle.





Configuration WTVD0006-1

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
Wireless Microphone	WatchGuard Video	MIC-WRL-TRN-410	Proto1a

Configuration WTVD0006-2

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
Wireless Microphone	WatchGuard Video	MIC-WRL-TRN-410	SAR Unit 1 (Belt)

Configuration WTVD0006-3

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
Wireless Microphone	WatchGuard Video	MIC-WRL-TRN-410	SAR Unit 2 (Shirt)





Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	6/18/2018	Output Power	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	7/2/2018	Radiated Emissions	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	He	ad	Body		
(MHz)	<mark>E</mark> r	σ (S/m)	٤r	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 ρ = 1000 kg/m³)

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:

<u>HEAD</u>

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 (%	6 by weigh	t)								
1,2-		_			_	_	_	64.81		
Propanediol								04.01		
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 (%	6 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		

<u>BODY</u>

Frequency (MHz)	30	5	0	14	44	4	150	835	90	0
Recipe source number	3	3	2	2	3	2	4	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 8	00	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:	07/02/2018	Temperature:	22.8°C
Tissue:	Body, MSL900, 900MHz	Liquid Temperature:	22°C
Tested By:	Jay Whitworth	Relative Humidity:	43.1%
Job Site:	EV08	Bar. Pressure:	1028 mb

TEST SPECIFICATIONS

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

RESULTS

	Actual	Values	Target Values		Deviat	ion (%)
Frequency (MHz)	Relative Permittivity	Conductivity	Relative Permittivity	Conductivity	Relative Permittivity	Conductivity
900	54.72	1.031	55.0	1.05	0.51	1.81

Frequency (MHz)	Relative Permittivity	Conductivity
500	59.03	0.64
500	59.03	0.64
500	59.03	0.64
550	58.49	0.683
550	58.49	0.683
550	58.49	0.683
600	57.94	0.727
600	57.94	0.727
600	57.94	0.727
650	57.4	0.773
650	57.4	0.773
700	56.85	0.821
700	56.85	0.821
700	56.85	0.821
750	56.31	0.87
750	56.31	0.87
750	56.31	0.87
800	55.77	0.922
800	55.77	0.922
850	55.24	0.975
850	55.24	0.975
850	55.24	0.975
900	54.72	1.031
950	54.2	1.088

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 ± 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 = 15mm, +/- 0.2mm for 300MHz \leq f \geq 1000 MHz:

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

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

RESULTS

Date	Liquid part number and	Conducted Power into the Dipole Factor		Meas	sured	Norma 1	lized to W	Tai (Normaliz Get fror Calibration	get ed to 1W) n Dipole Certificate	% Diffe	erence
	frequency	(dBm)	1 dotor	1g	10g	1g	10g	1g	10g	% Diff 1g -3.57	10g
7/2/2018	MSL 900 (900 MHz)	20.00	10.00	1.08	0.70	10.80	7.01	11.20	7.22	-3.57	-2.91

SAR SYSTEM VERIFICATION



Tested By:	Ethan Schoonover	Room Temperature (°C):	26.5°C
Date:	7/2/2018	Liquid Temperature (°C):	20°C
Configuration:		Humidity (%RH):	43.2%
		Bar. Pressure (mb):	1019 mb

MSL900 System Check 900MHz 7-2-18

DUT: Dipole 900 MHz D900V2; Type: D900V2; Serial: D900V2

Communication System: UID 0, CW (0); Communication System Band: D900 (900.0 MHz); Frequency: 900 MHz;Communication System PAR: 0 dB; PMF: 1

Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m³, Medium parameters used: f = 900 MHz; $\sigma = 1.031$ S/m; ϵ_r = 54.717; ρ = 1000 kg/m³

Phantom section: Flat Section

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

DASY Configuration:

- Probe: ES3DV3 SN3246; ConvF(6.27, 6.27, 6.27); Calibrated: 11/13/2017; • Modulation Compensation:
- Sensor-Surface: 0mm (Fix Surface), Sensor-Surface: 5mm (Mechanical Surface Detection), z = 102.0, 32.0
- Electronics: DAE4 Sn1237; Calibrated: 11/7/2017
- Phantom: ELI v5.0; Type: QDOVA002AA; Serial:
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

System Check/System Check/Z Scan (1x1x21): Measurement grid: dx=20mm, dy=20mm, dz=5mm Maximum value of Total (measured) = 33.31 V/m

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

Reference Value = 32.24 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 1.61 W/kg SAR(1 g) = 1.08 W/kg; SAR(10 g) = 0.701 W/kgMaximum value of SAR (measured) = 1.08 W/kg

System Check/System Check/Area Scan (71x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 1.08 W/kg Maximum value of SAR (measured) = 1.14 W/kg

Approved Bv

SAR SYSTEM VERIFICATION



MSL900 System Check_900MHz 7-2-18



OUTPUT POWER DESCRIPTION



900 MHz Band

The FHSS radio was tested in the low medium and high channels at all available data rates. Output power measurements are on the following pages.



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	TYE	17-Nov-17	17-Nov-18
Block - DC	Fairview Microwave	SD3379	AMT	11-Oct-17	11-Oct-18
Cable	Micro-Coax	UFD150A-1-0720-200200	TXG	28-Nov-17	28-Nov-18
Generator - Signal	Agilent	N5173B	TIW	5-Jul-17	5-Jul-20
Analyzer - Spectrum Analyzer	Agilent	N9010A	AFL	15-Mar-18	15-Mar-19

TEST DESCRIPTION

The measurement was made using a direct connection between the RF output of the EUT and a spectrum analyzer. The transmit frequency was set to the required channels in each band. The transmit power was set to its default maximum.

Prior to measuring peak transmit power the DTS bandwidth (B) was measured.

The method found in ANSI C63.10:2013 Section 11.9.1.1 was used because the RBW on the analyzer was greater than the DTS Bandwidth of the radio.

De Facto EIRP Limit: The EUT meets the de facto EIRP limit of +36 dBm.



			TbtTx 2017.12.14	XMit 2017.12.13
EUT:	MIC-WRL-TRN-410	Work Order:	WTVD0006	
Serial Number:	Proto1a	Date:	18-Jun-18	
Customer:	WatchGuard Video	Temperature:	23.2 °C	
Attendees:	Paul Hunt, Navaid Karimi	Humidity:	52.7% RH	
Project:	None	Barometric Pres.:	1019 mbar	
Tested by:	Marty Martin Power: Battery	Job Site:	TX09	
TEST SPECIFICATI	DNS Test Method			
FCC 2.1093:2018	FCC KDB 865664 D01 v01r04			
	FCC KDB 865664 D02 v01r02			
	IEEE Std 1528:2013			
COMMENTS				
EUT operational.				
DEVIATIONS FROM	TEST STANDARD			
None				
Configuration #	Mart Mat			
g	Signature			
			l imit	
		Value	(<)	Result
902 MHz - 928 MHz	Band			
	index 0			
	Low Channel 0, 902.25 MHz	29.316 mW	1 W	Pass
	Mid Channel 25, 914.75 MHz	51.128 mW	1 W	Pass
	High Channel 51, 927.75 MHz	38.248 mW	1 W	Pass
	index 1			
	Low Channel 0, 902.25 MHz	29.487 mW	1 W	Pass
	Mid Channel 25, 914.75 MHz	51.753 mW	1 W	Pass
	High Channel 51, 927.75 MHz	38.894 mW	1 W	Pass



TbtTx 2017.12.14 XMit 2017.12.13 902 MHz - 928 MHz Band, Index 0, Low Channel 0, 902.25 MHz Limit Value (<) 1 W Result 29.316 mW Pass 02:00:51 PMJun 15, 2018 TRACE 1 2 3 4 5 6 TYPE MWWWW DET P P P P P Keysigh RL ALIGN O #Avg Type: Log-Pwr Avg|Hold: 100/100 PNO: Wide ++ Trig: Free Run IFGain:Low #Atten: 20 dB Mkr1 902.228 60 MHz 29.316 mW Ref Offset 20.48 dB Ref 150.0 mW 5 dB/div Log I **≜**1 Center 902.2500 MHz #Res BW 150 kHz Span 250.0 kHz Sweep 1.066 ms (1000 pts) #VBW 470 kHz STATUS 902 MHz - 928 MHz Band, Index 0, Mid Channel 25, 914.75 MHz Limit Value Result (<) 51.128 mW 1 W Pass Keysight Spectrum Analyzer - Element Materials Technology RL RF 50 Ω DC 02:04:15 PM Jun 15, 2018 TRACE 1 2 3 4 5 6 ALIGN OFF #Avg Type: Log-Pwr

		PNO: Wide ↔ IFGain:Low	Trig: Free Ru #Atten: 20 di	un Avg Hold B	: 100/100	Т	YPE MWWWWW DET PPPPPP
5 dB/div Log	Ref Offset 20.48 dB Ref 200.0 mW		1	1	Mkr	1 914.77 51	6 65 MHz .128 mW
63.2 mW				1			
20.0 mW							
6.32 mW							
2.00 mW							
632 µW							
200 µ₩							
63.2 μW							
20.0 μW							
6.32 µW							
Center #Res E	914.7500 MHz 3W 150 kHz	#VBW	470 kHz		Sweep	Span 0 1.066 ms	250.0 kHz (1000 pts)
MSG				STATUS			



TbtTx 2017.12.14 XMit 2017.12.13 902 MHz - 928 MHz Band, Index 0, High Channel 51, 927.75 MHz Limit Value (<) 1 W Result 38.248 mW Pass Keysigh 02:06:57 PM Jun 15, 2018 RL ALIGN TRACE 1 2 3 4 5 6 TYPE MWWWW DET P P P P P #Avg Type: Log-Pwr Avg|Hold: 100/100 PNO: Wide ++ Trig: Free Run IFGain:Low #Atten: 20 dB Mkr1 927.778 90 MHz 38.248 mW Ref Offset 20.48 dB Ref 150.0 mW 5 dB/div Log i 1 Center 927.7500 MHz #Res BW 150 kHz Span 250.0 kHz Sweep 1.066 ms (1000 pts) #VBW 470 kHz STATUS 902 MHz - 928 MHz Band, Index 1, Low Channel 0, 902.25 MHz Limit Result Value (<) 29.487 mW 1 W Pass 02:10:26 PM Jun 15, 2018 TRACE 1 2 3 4 5 6 TYPE MWWWW DET P P P P P 📜 Keysight Sp 💴 R L ectrum Analyzer - Element Materials Technology ALIGN OFF #Avg Type: Log-Pwr Avg|Hold: 100/100 PNO: Fast ++ Trig: Free Run IFGain:Low #Atten: 20 dB Mkr1 902.209 5 MHz 29.487 mW Ref Offset 20.48 dB Ref 150.0 mW 5 dB/div Log I 1

Center 902.2500 MHz #Res BW 300 kHz

STATUS

#VBW 910 kHz

Span 1.000 MHz Sweep 1.066 ms (1000 pts)



TbtTx 2017.12.14 XMit 2017.12.13 902 MHz - 928 MHz Band, Index 1, Mid Channel 25, 914.75 MHz Limit Value (<) 1 W Result 51.753 mW Pass Keysigh 02:13:56 PM Jun 15, 2018 RL ALIGN TRACE 1 2 3 4 5 6 TYPE M WWWW DET P P P P P #Avg Type: Log-Pwr Avg|Hold: 100/100 PNO: Fast ++ Trig: Free Run IFGain:Low #Atten: 20 dB Mkr1 914.806 6 MHz 51.753 mW Ref Offset 20.48 dB Ref 200.0 mW 5 dB/div Log i ▲1 Center 914.7500 MHz #Res BW 300 kHz Span 1.000 MHz Sweep 1.066 ms (1000 pts) #VBW 910 kHz STATUS 902 MHz - 928 MHz Band, Index 1, High Channel 51, 927.75 MHz Limit Result Value (<) 38.894 mW 1 W Pass 02:16:38 PM Jun 15, 2018 TRACE 1 2 3 4 5 6 TYPE MWWWW DET P P P P P 📜 Keysight Sp 💴 R L ectrum Analyzer - Element Materials Technology ALIGN OFF #Avg Type: Log-Pwr Avg|Hold: 100/100 PNO: Fast ++ Trig: Free Run IFGain:Low #Atten: 20 dB Mkr1 927.807 6 MHz 38.894 mW Ref Offset 20.48 dB Ref 150.0 mW 5 dB/div Log I

Ref Offset 20.48 dB
Mkr1 927.807 6 MHz

47.4 mW
1
1

150 mW
1
1

174 mW
1
1

150 mW
1
1

174 mW
1
1

150 mW
1
1

174 mW
1
1
1

174 mW
1
1
1

174 mW
1
1
1

175 mW
1
1
1
1

175 mW
1
1
1
1

176 mW
1
1
1
1
1

177 mW
1
1
1

TEST RESULTS



Test Configurations

Test Locations

All available sides were tested. The EUT will be used with either a belt clip or a shirt clip. All six sides were measured with both clips. 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, 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:	MIC-WRL-TRN-410	Work Order:	WTVD0006
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

See Comments

DEVIATIONS FROM TEST STANDARD

None

RESULTS

Test Configuration	Frequency Band	Transmit Frequency (MHz)	Transmit Channel	Configuration	EUT Position	Scaling Factor	Power Drift During Test (dB)	Measured 1g SAR Level (mW/g)	Measured 10g SAR Level (mW/g)	Scaled 1g SAR Level (mW/g)	Scaled 10g SAR Level (mW/g)	Test #
Body	900	914.75	25	Belt	Front	1.00	-0.46	0.462	0.155	0.462	0.155	1
Body	900	914.75	25	Belt	Back	1.00	-0.04	0.013	0.009	0.013	0.009	2
Body	900	914.75	25	Belt	Left	1.00	0.24	0.008	0.005	0.008	0.005	3
Body	900	914.75	25	Belt	Right	1.00	-0.13	0.107	0.058	0.107	0.058	4
Body	900	914.75	25	Belt	Тор	1.00	-0.03	0.006	0.004	0.006	0.004	5
Body	900	914.75	25	Belt	Bottom	1.00	0.05	0.017	0.011	0.017	0.011	6
Body	900	914.75	25	Shirt	Front	1.00	-0.45	0.589	0.197	<mark>0.589</mark>	0.197	7
Body	900	914.75	25	Shirt	Back	1.00	-1.58	0.022	0.015	0.022	0.015	8
Body	900	914.75	25	Shirt	Left	1.00	0.05	0.018	0.012	0.018	0.012	9
Body	900	914.75	25	Shirt	Right	1.00	-0.03	0.229	0.126	0.229	0.126	10
Body	900	914.75	25	Shirt	Тор	1.00	0.03	0.015	0.010	0.015	0.010	11
Body	900	914.75	25	Shirt	Bottom	1.00	0.09	0.117	0.069	0.117	0.069	12

SAR TEST DATA



Tested By:	Ethan Schoonover	Room Temperature (°C):	26.9
Date:	7/2/2018 10:32:33 AM	Liquid Temperature (°C):	20.7
Serial Number:	SAR Unit 2	Humidity (%RH):	40.7
Configuration:	WTVD0006-3	Bar. Pressure (mb):	1025
Comments:	None		

Test 7

DUT: MIC-WRL-TRN-410; Type: Sample; Serial: SAR Unit 2

Communication System: UID 0, CW (0); Communication System Band: D900 (900.0 MHz); Frequency: 914.75 MHz;Communication System PAR: 0 dB; PMF: 1

Medium parameters used (interpolated): f = 914.75 MHz; σ = 1.048 S/m; ϵ_r = 54.564; ρ = 1000 kg/m³. Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY Configuration:

- Probe: ES3DV3 SN3246; ConvF(6.27, 6.27, 6.27); Calibrated: 11/13/2017;
 - Modulation Compensation:
- Sensor-Surface: 3mm (Mechanical Surface Detection), Sensor-Surface: 0mm (Fix Surface), z = 2.0, • 32.0. 107.0
- Electronics: DAE4 Sn1237; Calibrated: 11/7/2017
- Phantom: ELI v5.0; Type: QDOVA002AA
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373) ٠

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) = 0.544 W/kg

Body/Body/Zoom Scan (5x6x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm Reference Value = 31.56 V/m; Power Drift = -0.45 dB Peak SAR (extrapolated) = 2.46 W/kg SAR(1 g) = 0.589 W/kg; SAR(10 g) = 0.197 W/kg

Info: Interpolated medium parameters used for SAR evaluation. Maximum value of SAR (measured) = 0.970 W/kg

Body/Body/Area scan (41x41x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Info: Interpolated medium parameters used for SAR evaluation. Maximum value of SAR (interpolated) = 0.825 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) = 15.47 V/m Maximum value of SAR (measured) = 0.251 W/kg

Approved By

SAR TEST DATA



Test 7





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



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.



TEST EQUIPMENT

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Interval
Amplifier	Mini Circuits	ZHL-5W-2G-S+	TRZ	NCR ¹	0 mo
Antenna - Dipole	SPEAG	D900V2	ADP	11/9/2017	12 mo
DAE	SPEAG	SD 000 D04 EJ	SAH	11/7/2017	12 mo
Device Holder	SPEAG	N/A	SAW	NCR	0 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	10/12/2017	12 mo
Power Sensor	Agilent	E9300H	SQO	10/12/2017	12 mo
Probe - Dielectric	SPEAG	DAKS-3.5	IPRA	11/1/2016	36 mo
Probe - SAR	SPEAG	ES3DV3	SAF	11/13/2017	12 mo
SAR - Tissue Test Solution	SPEAG	MSL 900	SAT	At start of	testing
SAR Test System	Staeubli	DAYS5	SAK	11/1/2016	36 mo
SAR Test System	SPEAG	QD OVA 001 BB	SAC	NCR	0 mo
SAR Test System	Staeubli	N/A	SAJ	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) (+/-%)	Vi
Measurement System								
Probe calibration (k=1)	5.5	normal	1	1	1	5.5	5.5	8
Axial isotropy	4.7	rectangular	1.732	0.707	0.707	1.9	1.9	8
Hemispherical isotropy	9.6	rectangular	1.732	0.707	0.707	3.9	3.9	8
Boundary effect	1.0	rectangular	1.732	1	1	0.6	0.6	8
Linearity	4.7	rectangular	1.732	1	1	2.7	2.7	8
System detection limits	1.0	rectangular	1.732	1	1	0.6	0.6	8
Readout electronics	0.3	normal	1	1	1	0.3	0.3	8
Response time	0.8	rectangular	1.732	1	1	0.5	0.5	8
Integration time	2.6	rectangular	1.732	1	1	1.5	1.5	8
RF ambient conditions - noise	1.7	rectangular	1.732	1	1	1.0	1.0	8
RF Ambient Reflections	0.0	rectangular	1.732	1	1	0.0	0.0	8
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	17	17	8
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	8
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	8
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	8
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% Co	nfidence/		normal //	(-2)		22.5	21.2	

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

Element

Client

Schweizerischer Kalibrierdienst S

Service suisse d'étalonnage С

Servizio svizzero di taratura S

Swiss Calibration Service

Accreditation No.: SCS 0108

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

STATE STOLEN

Certificate No: D900V2-1d106_Nov17

LOTAVEI DI RVAVITI DI NER	MERANIALO7444		
Object	D900V2 SN-1d	106	
Calibration procedure(s)	QA-CAL-05:v9 Calibration:proce	edure for dipole validation kits ab	ove 700 MHz
Calibration date:	November 09, 20	D177	
This calibration certificate docum The measurements and the unce	ents the traceability to nat rtainties with confidence p	ional standards, which realize the physical us probability are given on the following pages a	nits of measurements (SI). nd are part of the certificate.
All calibrations have been conduc	cted in the closed laborato	ry facility: environment temperature (22 \pm 3)°	°C and humidity < 70%.
Calibration Equipment used (M&1	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)	Anr.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)	Mav-18
DAE4	SN: 601	26-Oct-17 (No. DAE4-601_Oct17)	Oct-18
Secondary Standards	D#	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
	Name	Function	Signature
Calibrated by:	Claudio Leubles	L'aboratory Technician	
Approved by:	Katja:Pokovic	Technical Manager	, Lll
This calibration certificate shall no	t be reproduced excent in	full without written approval of the laboration	Issued: November 9, 2017
			•

Certificate No: D900V2-1d106_Nov17

Calibration Laboratory of

Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland

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

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

Accreditation No.: SCS 0108

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52 10 0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	900 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.5	0.97 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	41.3 ± 6 %	0.94 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

SAR result with Head TSL

(10 g) bi Head 15L	condition			
SAR measured	250 mW input power	1.71 W/kg		
SAR for nominal Head TSL parameters	normalized to 1W	6.96 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	55.0	1.05 mho/m	
Measured Body TSL parameters	(22.0 ± 0.2) °C	53.9 ± 6 %	1.04 mho/m ± 6 %	
Body TSL temperature change during test	< 0.5 °C			

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.79 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	11.2 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.80 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	7.22 W/kg ± 16.5 % (k=2)

Certificate No: D900V2-1d106_Nov17

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.6 Ω - 6.0 iQ
Return Loss	
	- 24.4 UB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	45.8 Ω - 7.6 jΩ
Return Loss	- 20.8 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.404 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	September 22, 2009

DASY5 Validation Report for Head TSL

Date: 09.11.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN:1d106

Communication System: UID 0 - CW; Frequency: 900 MHz Medium parameters used: f = 900 MHz; $\sigma = 0.94$ S/m; $\epsilon_r = 41.3$; $\rho = 1000$ kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(9.86, 9.86, 9.86); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 65.20 V/m; Power Drift = 0.01 dB Peak SAR (extrapolated) = 4.23 W/kg SAR(1 g) = 2.69 W/kg; SAR(10 g) = 1.71 W/kg Maximum value of SAR (measured) = 3.67 W/kg

0 dB = 3.67 W/kg = 5.65 dBW/kg

Certificate No: D900V2-1d106_Nov17

DASY5 Validation Report for Body TSL

Date: 09.11.2017

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN:1d106

Communication System: UID 0 - CW; Frequency: 900 MHz Medium parameters used: f = 900 MHz; $\sigma = 1.04$ S/m; $\epsilon_r = 53.9$; $\rho = 1000$ kg/m³ Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 SN7349; ConvF(9.94, 9.94, 9.94); Calibrated: 31.05.2017;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 26.10.2017
- Phantom: Flat Phantom 4.9 (Back); Type: QD 00R P49 AA; Serial: 1005
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

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

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 63.39 V/m; Power Drift = -0.03 dB Peak SAR (extrapolated) = 4.16 W/kg SAR(1 g) = 2.79 W/kg; SAR(10 g) = 1.8 W/kg Maximum value of SAR (measured) = 3.71 W/kg

0 dB = 3.71 W/kg = 5.69 dBW/kg

Certificate No: D900V2-1d106 Nov17

Calibration Labora Schmid & Partner Engineering AG ^{Zeughausstrasse} 43, 8004 2	atory of Zurich, Switzerland	BC MRA	Schweizerischer Kalibrierdienst Service suisse d'étalonnage Servizio svizzero di taratura Swiss Calibration Service
Accredited by the Swiss Accr The Swiss Accreditation Se Multilateral Agreement for t	editation Service (SAS) rvice is one of the signatorie: he recognition of calibration	s to the EA	Accreditation No.: SCS 0108
Client Element		Certificate N	o. ES3-3246 Nov17
CALIBRATION			
Object	ES3DV3 - SN:324	16	
Calibration procedure(s)	QA CAL-01:v9, Q Calibration proced	A CAL-12 v9, QA CAL-23 v5, Q lure for dosimetric E-field probes	A.CAL-25.v6
Calibration date:	November 13, 201	7	
All calibrations have been con Calibration Equipment used (N	ducted in the closed laboratory	facility are given on the following pages and facility: environment temperature (22 ± 3)°C	are part of the certificate. and humidity < 70%.
Primary Standards			
Power meter NRP	SN: 104778	Cai Date (Certificate No.)	Scheduled Calibration
Power sensor NRP-Z91	SN: 103244	04-Apr-17 (No. 217-02521/02522)	Apr-18
Power sensor NRP-Z91	SN: 103245	04-Apr-17 (No. 217-02521)	Apr-18
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-17 (No. 217-02525)	Apr-18
Reference Probe ES3DV2	SN: 3013	31-Dec-16 (No. 552 2012, D-140)	Apr-18
DAE4	SN: 660	7-Dec-16 (No. DAE4-660 Docto)	Dec-17
			Dec-1/
Secondary Standards	ID	Check Date (in house)	Schodulad Ol
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check lun-16)	Scheduled Check
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 19
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-17)	In house check: Oct-18
Calibrated by:	Name Claudio:Leubler	Function Laboratory Technician:	Sgnature
приочеа ву:	Katja Pokovic	Technical Manager	Lelles -

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Issued: November 15, 2017

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Calibration Laboratory of

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Accreditation No.: SCS 0108

Glossary:

ISL NORMx,y,z	tissue simulating liquid sensitivity in free space
DCP CE	sensitivity in TSL / NORMx,y,z diode compression point
A, B, C, D	crest factor (1/duty_cycle) of the RF signal modulation dependent linearization parameters
Polarization φ Polarization θ	φ rotation around probe axis
Connector Angle	i.e., $\vartheta = 0$ is normal to probe axis 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 handheld 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 $\vartheta = 0$ (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx, y, z are only intermediate values, i.e., the uncertainties of NORMx, y, z does not affect the E²-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
- 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 ≤ 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
- 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).

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Probe ES3DV3

SN:3246

Manufactured: Calibrated:

May 5, 2009 November 13, 2017

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

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Basic Calibration Parameters

	Sensor V	A		
Norma () (() ())2)A	Jensol A	Sensor Y	Sensor Z	Unc (k=2)
<u>Norm (μν/(v/m)-).</u>	1.37	1.02	1 20	
DCP (mV) ^b	100.0	00.0	1.20	± 10.1 %
		99.9	100.2	

Modulation Calibration Parameters

Communication System Name		A dB	B dBõV	С	D dB	VR mV	Unc [±] (k=2)
	<u> </u>	0.0	0.0	1.0	0.00	191.6	±3.5 %
	<u> </u>	0.0	0.0	1.0		176.8	
 <u></u>	<u> </u>	0.0	0.0	1.0		198.6	

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). ^a 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

	Bolatives							
f (MHz) ^C	Permittivity ^F	(S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G	
750	41.9	0.89	6.48	6.48	6.48	0.71	1 30	+ 12.0.0/
835	41.5	0.90	6.33	6.33	6.33	0.80	1 15	± 12.0 %
900	41.5	0.97	6.17	6 17	6 17	0.00	1.15	<u>± 12.0 %</u>
1750	40.1	1.37	5 4 4	5.44	<u> </u>	0.30	1.00	± 12.0 %
1900	40.0	1.40	E 00	<u>0.74</u>	5,44	0.46	1.50	<u>± 12.0 %</u>
		1.40		5.23	5.23	0.80	1.20	± 12.0 %

Calibration Parameter Determined in Head Tissue Simulating Media

^c Frequency validity above 300 MHz of \pm 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to \pm 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity validity can be extended to \pm 10 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency

At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to \pm 10% if liquid compensation formula is applied to the ConvF uncertainty for indicated target tissue parameters.

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

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	Deletion							
f (MHz) ^C	Permittivity ^F	(S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unc (k=2)
450	56.7	0.94	7.44	7.44	7.44	0.13	1.90	+ 13 3 %
750	55.5	0.96	6.54	6.54	6.54	0.54	1 41	+ 12 0 %
835	55.2	0.97	6.31	6.31	6.31	0.70	1 10	± 12.0 %
900	55.0	1.05	6.27	6.27	6.07	0.79	1.19	_ <u>± 12.0 %</u> _
1750	53.4	1 / 0	5.10	0.21	0.27	0.80	1.11	<u>± 12.0 %</u>
1000					5.12	0.67	1.32	<u>± 12.0 %</u>
1900	53.3	1.52	4.88	4.88	4.88	0.40	1.78	_± 12.0 %

Calibration Parameter Determined in Body Tissue Simulating Media

^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 \pm 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 (s and o) 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

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

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November 13, 2017

Receiving Pattern (ϕ), $\vartheta = 0^{\circ}$

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

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

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Conversion Factor Assessment

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Other Probe Parameters

	Triangular
Connector Angle (°)	
Mechanical Surface Detection Mode	67.9
Ontical Surface Detection Mode	enabled
Probe Querell Land	disabled
	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	
Probe Tip to Sensor X Calibration Point	4 mm
Probe Tip to Sensor V Colibration Point	2 mm
Probe Tip to Censor 7 Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm

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