

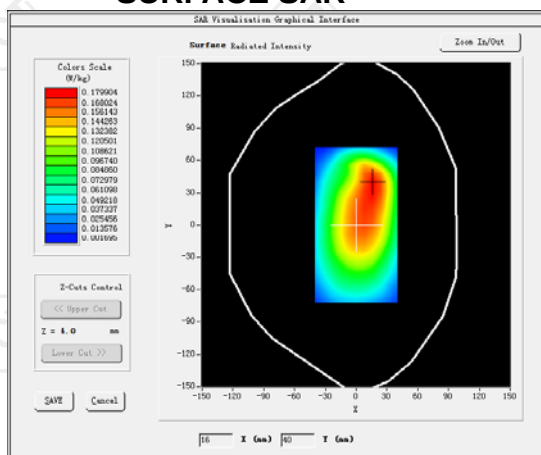
LTE Band 12

MEASUREMENT 1

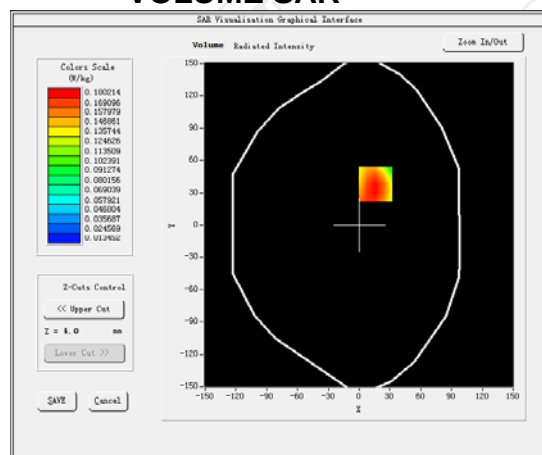
Lower Band SAR (Channel 23060): Date: 05/28/2021

Frequency (MHz)	704.000000
Relative permittivity (real part)	55.260832
Relative permittivity (imaginary part)	12.468860
Conductivity (S/m)	0.934272
Variation (%)	0.060000
Crest Factor	1.0
Probe Conversion factor	1.86
E-Field Probe:	SSE2 (SN 36/20 EPG0346)
Area Scan	dx=8mm dy=8mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm,Complete/ndx=8mm dy=8mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Body back(0mm)
Band	EMTC band 12(1 RB#0)

SURFACE SAR

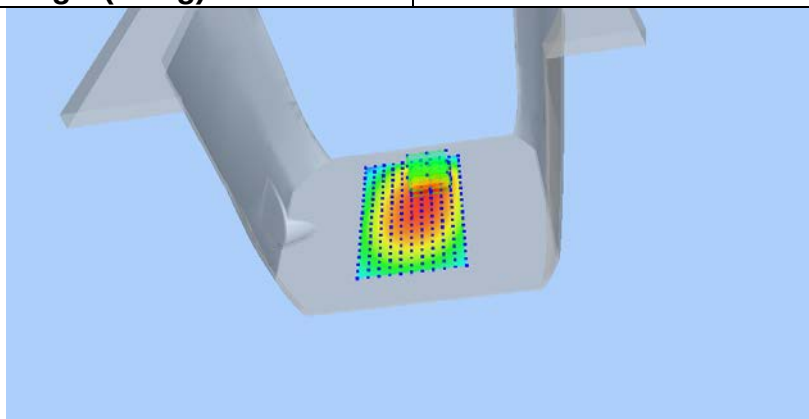


VOLUME SAR

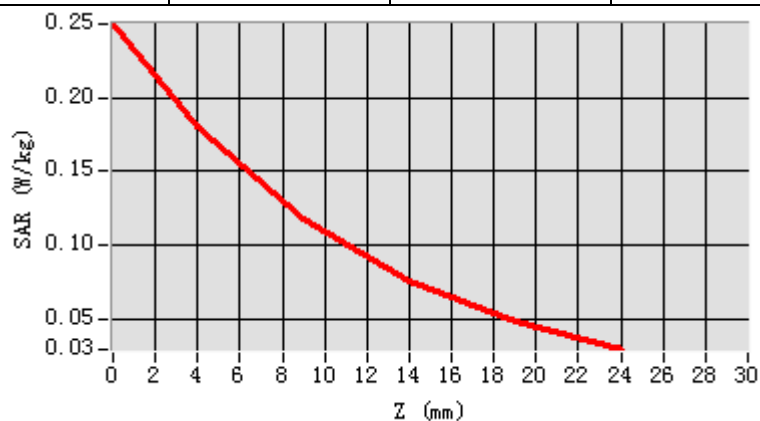


Maximum location: X=6.00, Y=28.00 SAR Peak: 0.15 W/kg

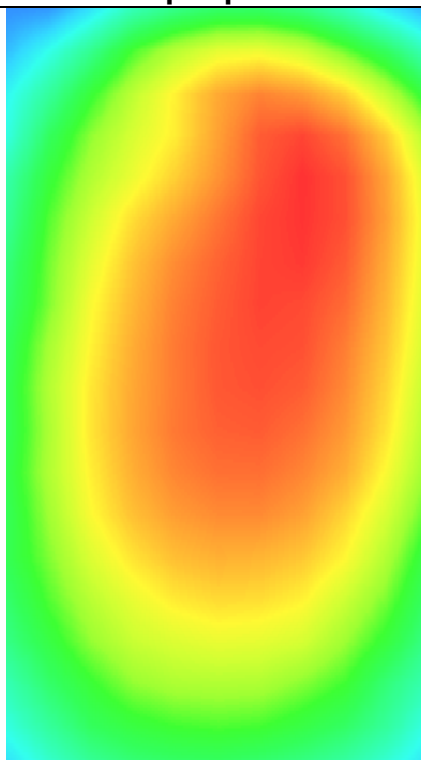
SAR 10g (W/Kg)	0.119621
SAR 1g (W/Kg)	0.382340



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.2499	0.1801	0.1173	0.0758	0.0481



Hot spot position



LTE Band 13

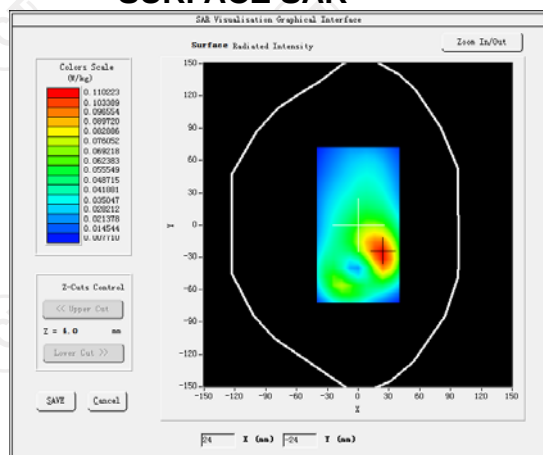
MEASUREMENT 1

Middle Band SAR (Channel 23230):

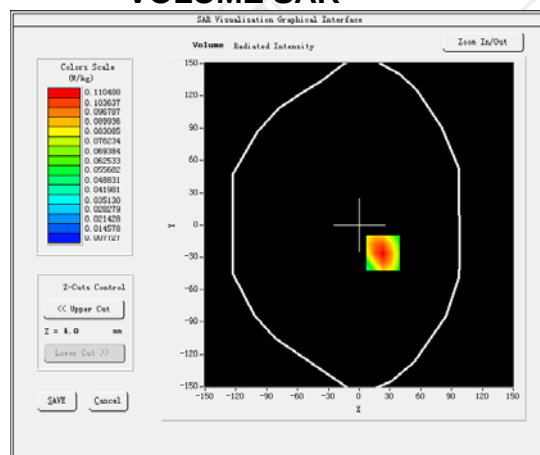
Date: 05/28/2021

Frequency (MHz)	782.000000
Relative permittivity (real part)	55.260832
Relative permittivity (imaginary part)	12.468860
Conductivity (S/m)	0.934272
Variation (%)	-0.650000
Crest Factor	1.0
Probe Conversion factor	1.86
E-Field Probe:	SSE2 (SN 36/20 EPG0346)
Area Scan	dx=8mm dy=8mm, h= 5.00 mm
ZoomScan	5x5x7, dx=8mm dy=8mm dz=5mm, Complete/ndx=8mm dy=8mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Body back(0mm)
Band	EMTC band 13(1 RB#0)

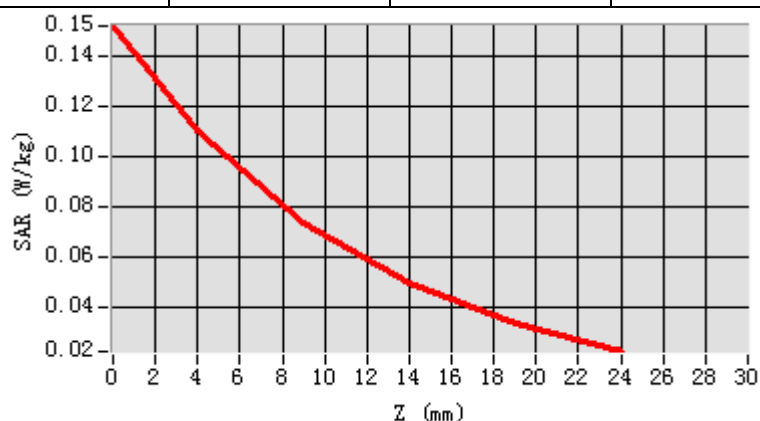
SURFACE SAR



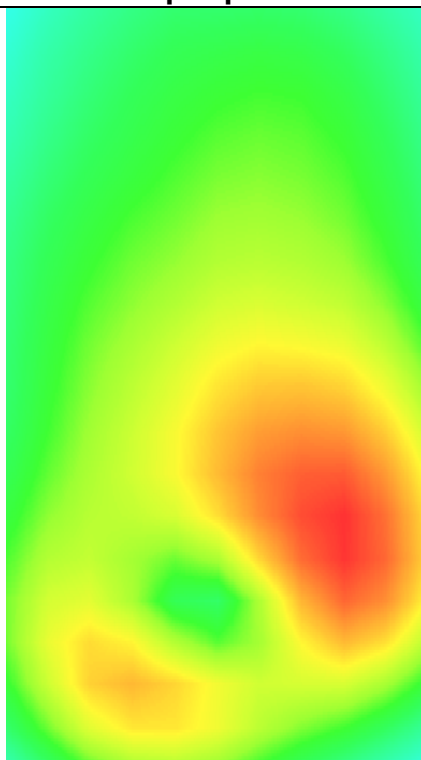
VOLUME SAR



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.1518	0.1105	0.0738	0.0496	0.0339



Hot spot position

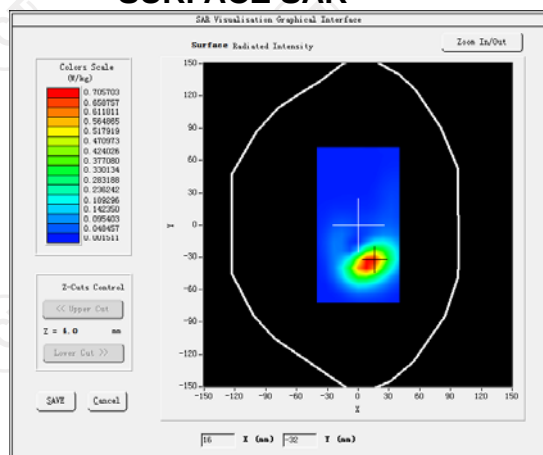


LTE Band 25

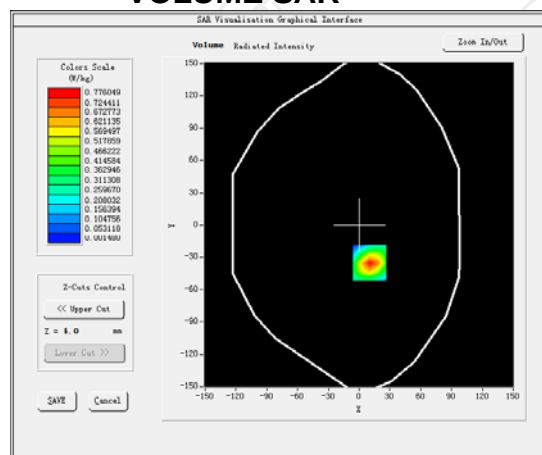
MEASUREMENT 1

Hight Band SAR (Channel 26590):		Date: 05/29/2021
Frequency (MHz)	1905.000000	
Relative permittivity (real part)	53.291337	
Relative permittivity (imaginary part)	15.232400	
Conductivity (S/m)	1.531736	
Variation (%)	-0.270000	
Crest Factor	1.0	
Probe Conversion factor	2.16	
E-Field Probe:	SSE2 (SN 36/20 EPG0346)	
Area Scan	dx=8mm dy=8mm, h= 5.00 mm	
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm,Complete/ndx=8mm dy=8mm, h= 5.00 mm	
Phantom	Validation plane	
Device Position	Body back(0mm)	
Band	EMTC band 25 (1 RB#0)	

SURFACE SAR



VOLUME SAR



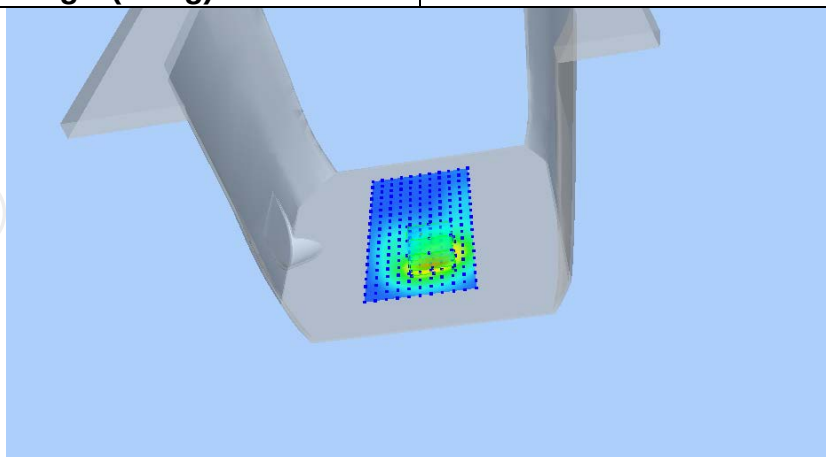
Maximum location: X=9.00, Y=-30.00 SAR Peak: 1.00 W/kg

SAR 10g (W/Kg)

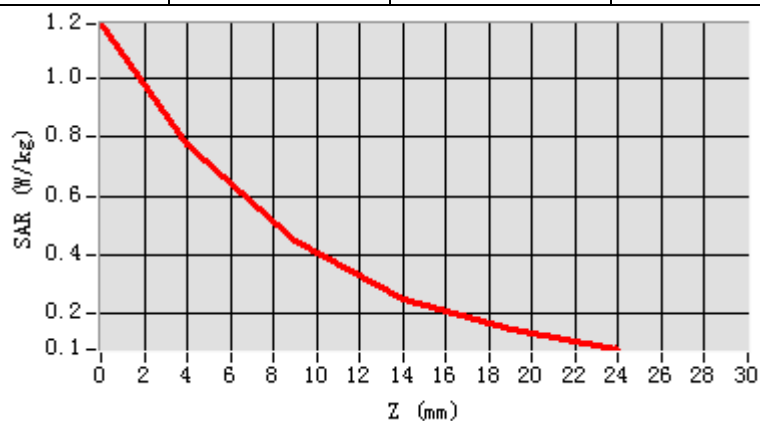
0.352250

SAR 1g (W/Kg)

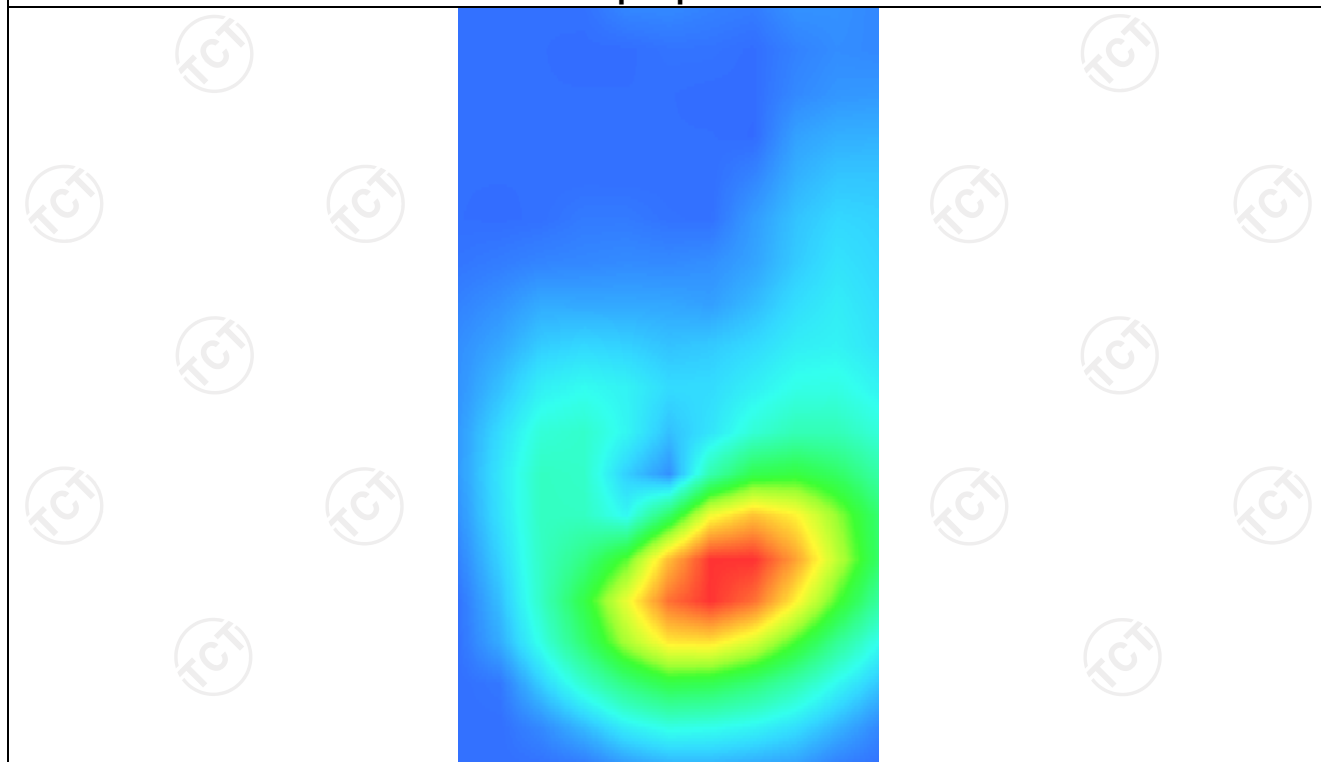
0.711180



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.1879	0.7760	0.4425	0.2492	0.1412



Hot spot position

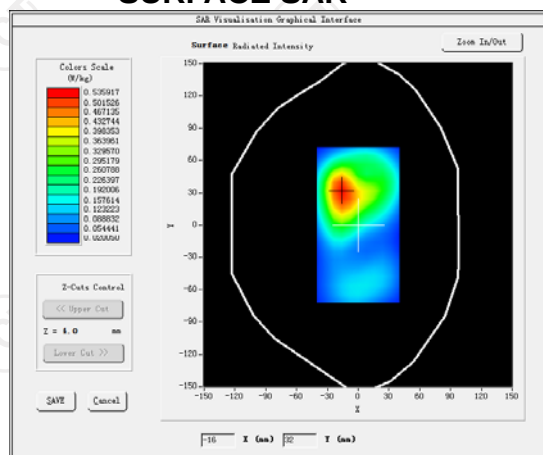


LTE Band 66

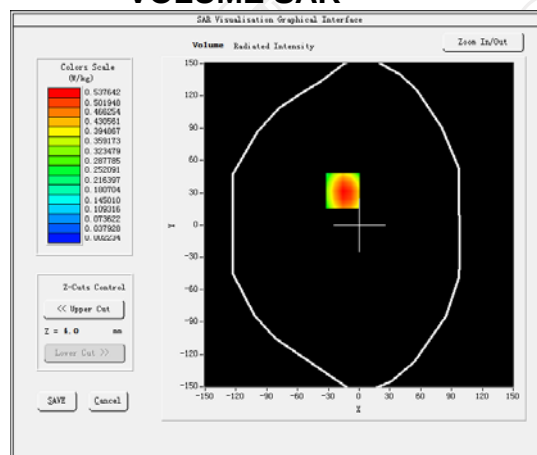
MEASUREMENT 1

Lower Band SAR (Channel 132072):		Date: 05/29/2021
Frequency (MHz)	1720.000000	
Relative permittivity (real part)	53.341249	
Relative permittivity (imaginary part)	15.168850	
Conductivity (S/m)	1.492592	
Variation (%)	1.290000	
Crest Factor	1.0	
Probe Conversion factor	2.16	
E-Field Probe:	SSE2 (SN 36/20 EPG0346)	
Area Scan	dx=8mm dy=8mm, h= 5.00 mm	
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm,Complete/ndx=8mm dy=8mm, h= 5.00 mm	
Phantom	Validation plane	
Device Position	Body back(0mm)	
Band	EMTC band 66(1 RB#0)	

SURFACE SAR



VOLUME SAR



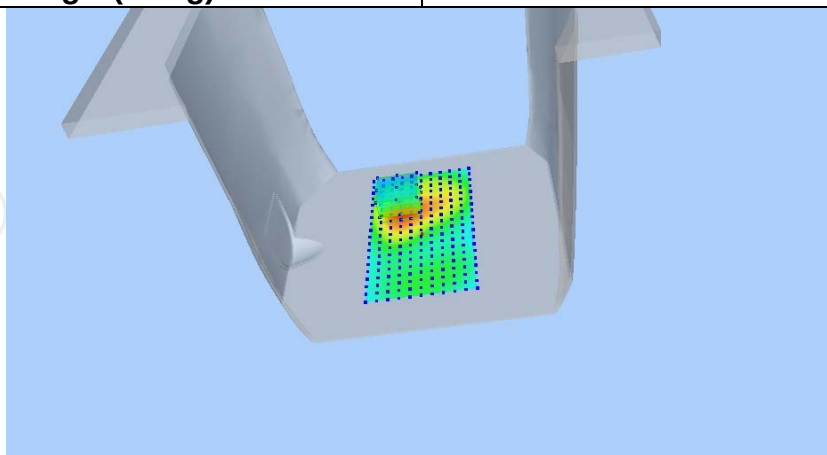
Maximum location: X=-14.00, Y=30.00 SAR Peak: 0.94 W/kg

SAR 10g (W/Kg)

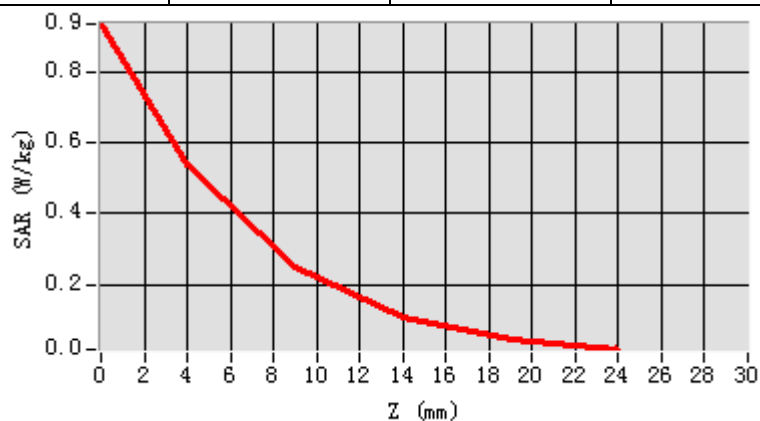
0.265146

SAR 1g (W/Kg)

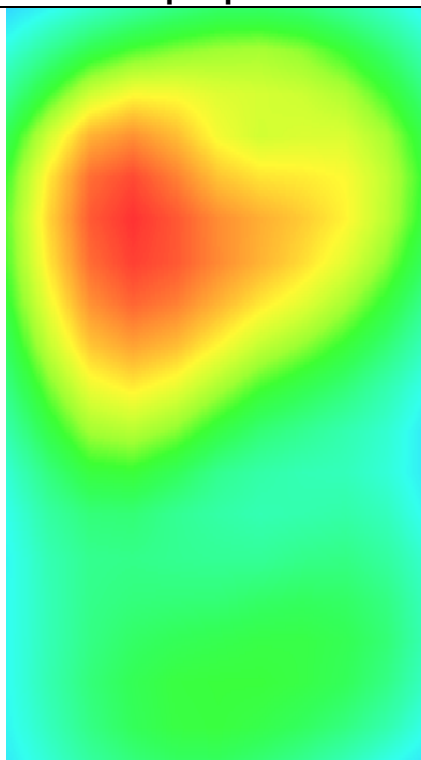
0.517124



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.9355	0.5376	0.2491	0.1082	0.0456



Hot spot position



WLAN 2.4G

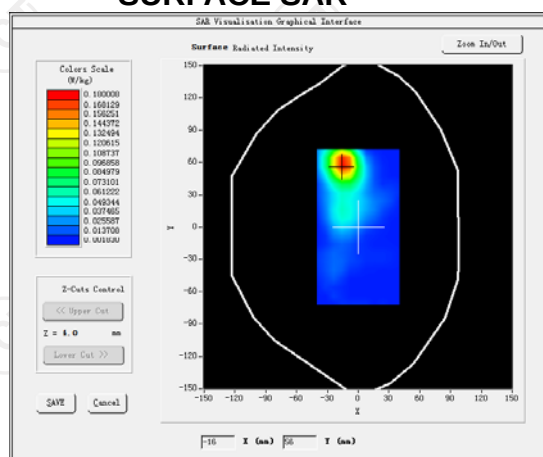
MEASUREMENT 1

Hight Band SAR (Channel 11):

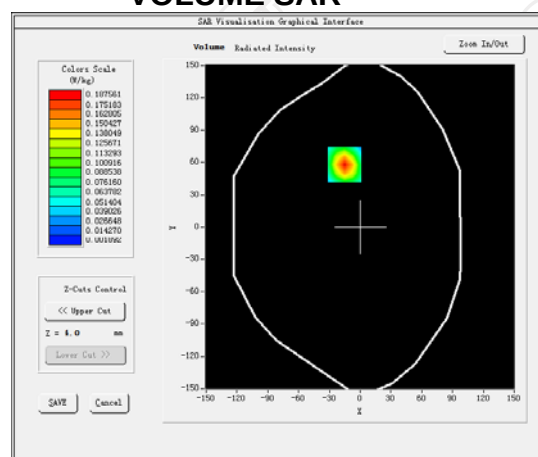
Date: 05/29/2021

Frequency (MHz)	2462.000000
Relative permittivity (real part)	54.630667
Relative permittivity (imaginary part)	14.318428
Conductivity (S/m)	1.982536
Variation (%)	4.010000
Crest Factor	1.0
Probe Conversion factor	2.37
E-Field Probe:	SSE2 (SN 36/20 EPG0346)
Area Scan	<u>dx=8mm dy=8mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7,dx=8mm dy=8mm</u> <u>dz=5mm,Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>
Phantom	Validation plane
Device Position	Body back(0mm)
Band	<u>IEEE 802.11b ISM</u>

SURFACE SAR

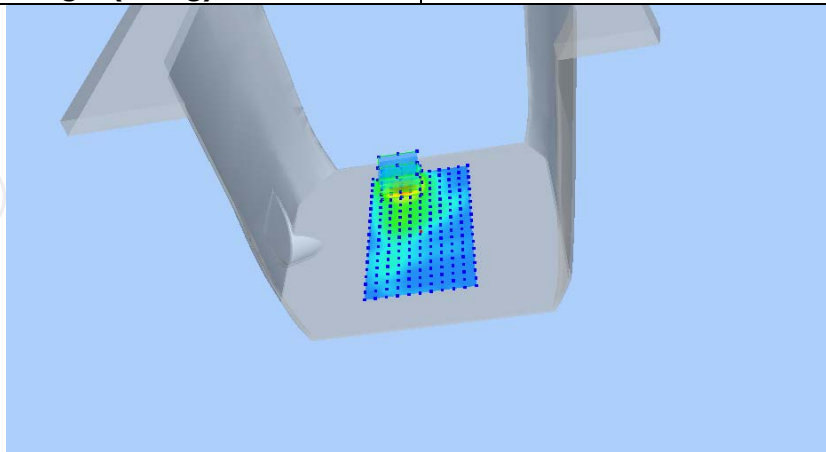


VOLUME SAR

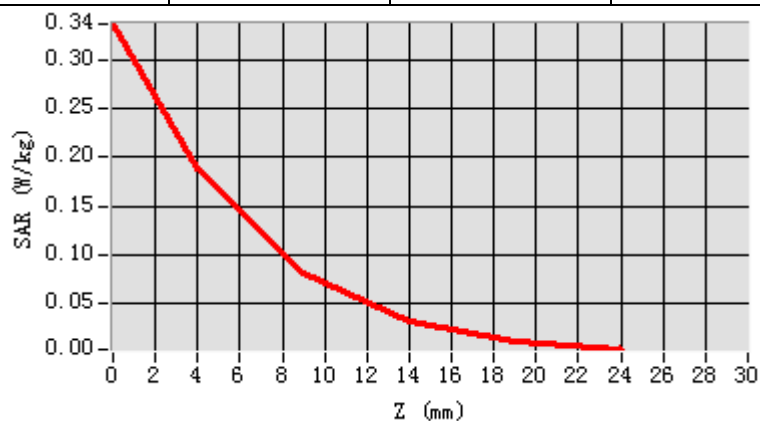


Maximum location: X=-15.00, Y=58.00 SAR Peak: 0.34 W/kg

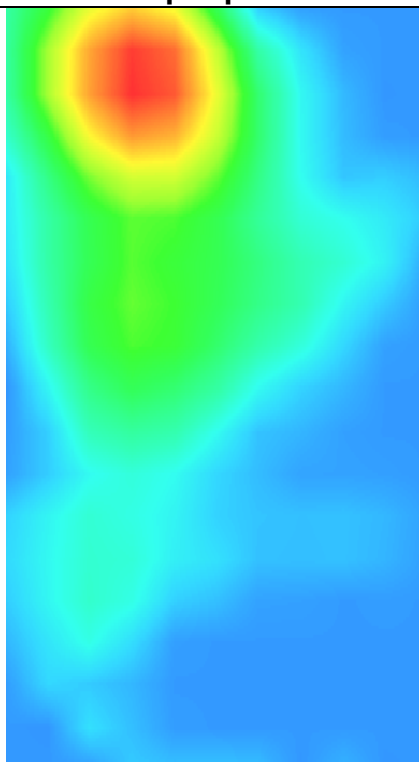
SAR 10g (W/Kg)	0.077530
SAR 1g (W/Kg)	0.203292



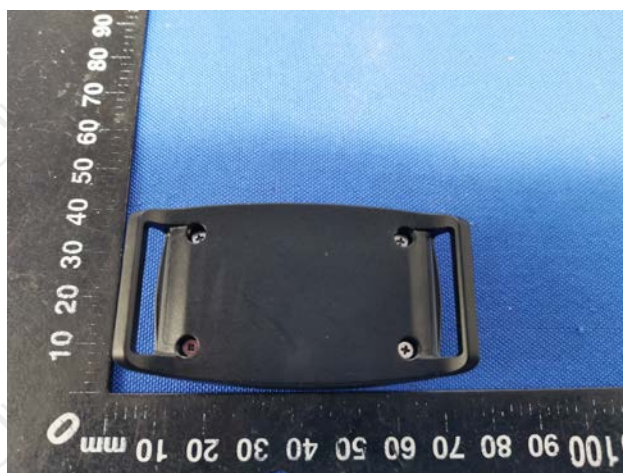
Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.3372	0.1876	0.0816	0.0317	0.0109



Hot spot position



Appendix A: EUT Photos



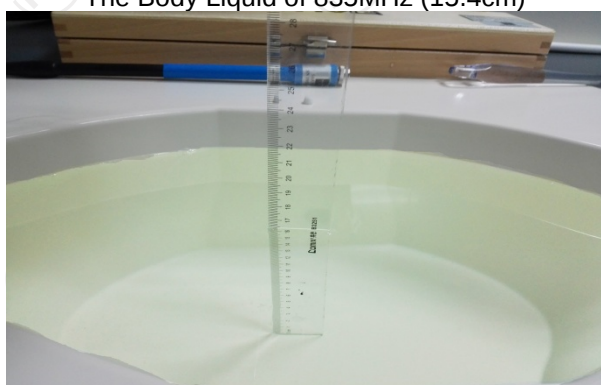
Liquid depth



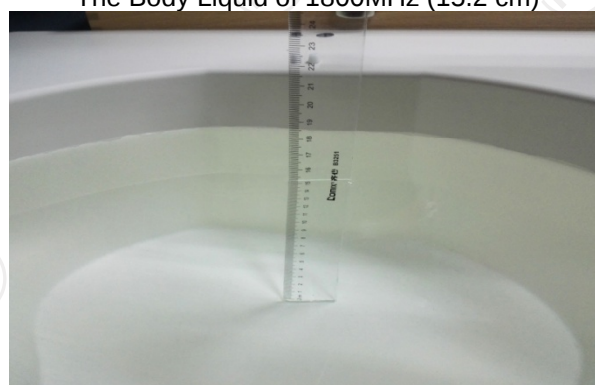
The Body Liquid of 835MHz (15.4cm)



The Body Liquid of 1800MHz (15.2 cm)



The Body Liquid of 1900MHz (16.4 cm)



The Body Liquid of 2450MHz (15.3cm)

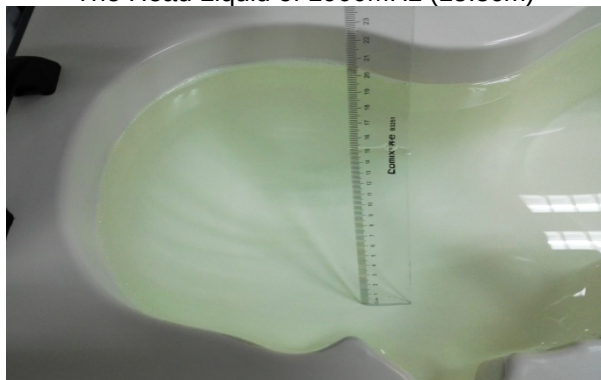
)



The Head Liquid of 1900MHz (15.5cm)



The Head Liquid of 2450MHz (15.6cm)



The Head Liquid of 835MHz (15.3cm)

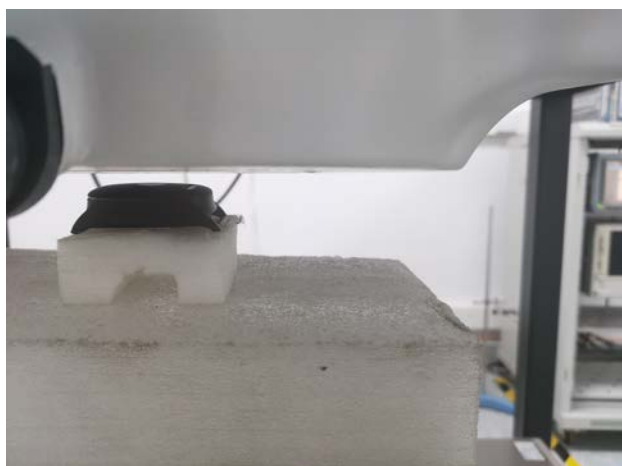


The Head Liquid of 1800MHz (15.2cm)

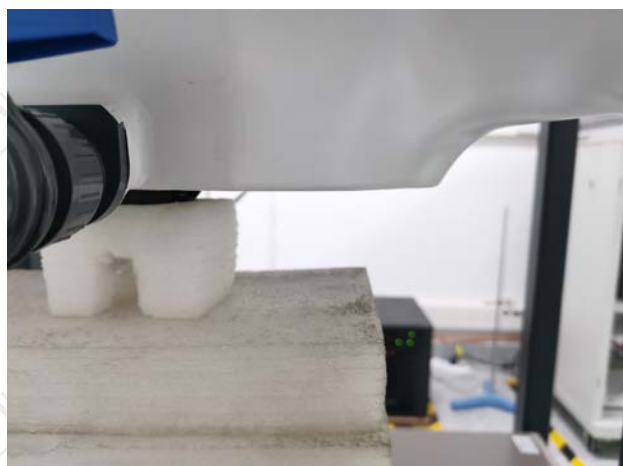


The Head Liquid of 1800MHz (15.2cm)

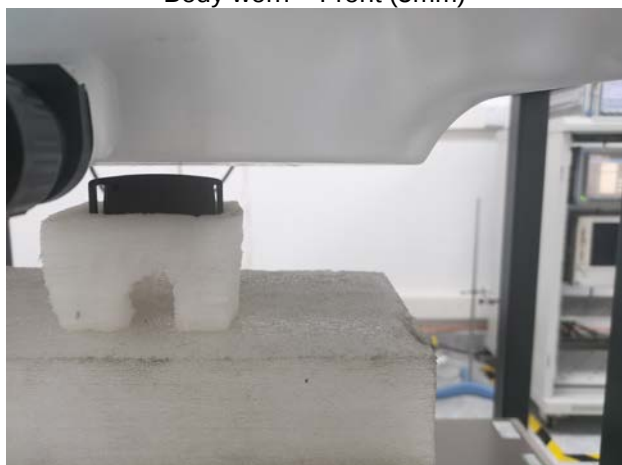
Appendix B: Test Setup Photos



Body worn – Front (5mm)



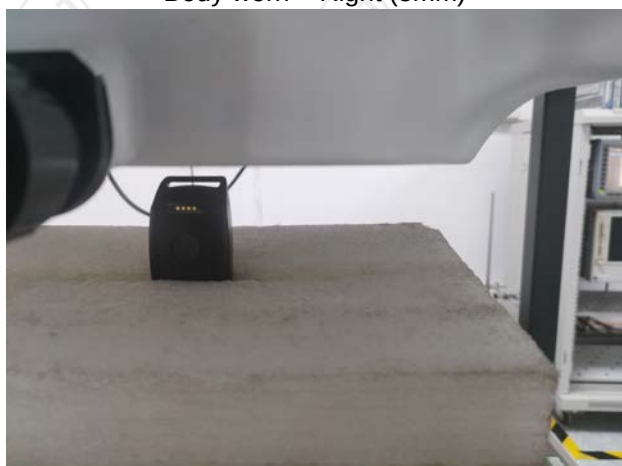
Body worn – Back (0mm)



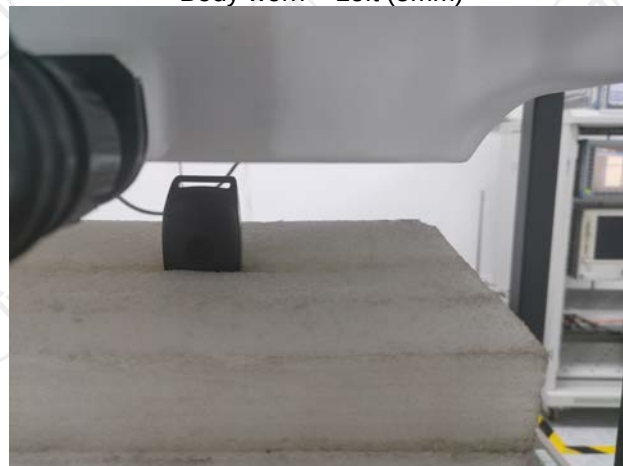
Body worn – Right (5mm)



Body worn – Left (5mm)



Body worn – Bottom (5mm)



Body worn – Top (5mm)

Appendix C: Probe Calibration Certificate

COMOSAR E-FIELD Probe



COMOSAR E-Field Probe Calibration Report

Ref : ACR.297.1.20.MVGB.A

SHENZHEN TONGCE TESTING LAB.
TCT TESTING INDUSTRIAL PARK, FUQIAO 5TH
INDUSTRIAL ZONE, FUHAI STREET,
BAOAN DISTRICT, SHENZHEN, GUANGDONG ,
518103, PEOPLES REPUBLIC OF CHINA
MVG COMOSAR DOSIMETRIC E-FIELD PROBE
SERIAL NO.: SN 36/20 EPG0346

Calibrated at MVG
Z.I. de la pointe du diable
Technopôle Brest Iroise – 295 avenue Alexis de Rochon
29280 PLOUZANE - FRANCE

Calibration date: 10/23/2020



Accreditations #2-6789 and #2-6814
Scope available on www.cofrac.fr

Summary:

This document presents the method and results from an accredited COMOSAR E-Field Probe calibration performed at MVG, using the CALIPROBE test bench, for use with a MVG COMOSAR system only. The test results covered by accreditation are traceable to the International System of Units (SI).



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.297.1.20.MVGB.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Technical Manager	10/23/2020	<i>JS</i>
Checked by :	Jérôme LUC	Technical Manager	10/23/2020	<i>JS</i>
Approved by :	Yann Toutain	Laboratory Director	10/26/2020	<i>Yann Toutain</i>

2020.10.2
6 09:25:59
+01'00'

	Customer Name
Distribution :	SHENHEN TONGCE TESTING LAB.

Issue	Name	Date	Modifications
A	Jérôme LUC	10/23/2020	Initial release



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.297.1.20.MVGB.A

TABLE OF CONTENTS

1	Device Under Test	4
2	Product Description	4
2.1	General Information	4
3	Measurement Method	4
3.1	Linearity	4
3.2	Sensitivity	5
3.3	Lower Detection Limit	5
3.4	Isotropy	5
3.1	Boundary Effect	5
4	Measurement Uncertainty	6
5	Calibration Measurement Results	6
5.1	Sensitivity in air	6
5.2	Linearity	7
5.3	Sensitivity in liquid	8
5.4	Isotropy	9
6	List of Equipment	10



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.297.1.20.MVGB.A

1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE
Manufacturer	MVG
Model	SSE2
Serial Number	SN 36/20 EPG0346
Product Condition (new / used)	New
Frequency Range of Probe	0.15 GHz-6GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.217 MΩ Dipole 2: R2=0.245 MΩ Dipole 3: R3=0.219 MΩ

2 PRODUCT DESCRIPTION

2.1 GENERAL INFORMATION

MVG's COMOSAR E field Probes are built in accordance to the IEEE 1528, FCC KDB865664 D01, CENELEC EN62209 and CEI/IEC 62209 standards.



Figure 1 – MVG COMOSAR Dosimetric E field Dipole

Probe Length	330 mm
Length of Individual Dipoles	2 mm
Maximum external diameter	8 mm
Probe Tip External Diameter	2.5 mm
Distance between dipoles / probe extremity	1 mm

3 MEASUREMENT METHOD

The IEEE 1528, FCC KDB865664 D01, CENELEC EN62209 and CEI/IEC 62209 standards provide recommended practices for the probe calibrations, including the performance characteristics of interest and methods by which to assess their affect. All calibrations / measurements performed meet the fore mentioned standards.

3.1 LINEARITY

The evaluation of the linearity was done in free space using the waveguide, performing a power sweep to cover the SAR range 0.01W/kg to 100W/kg.

Page: 4/10

Template_ACR.DDD.N.YY.MVGB.ISSUE_COMOSAR Probe vH

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3.2 SENSITIVITY

The sensitivity factors of the three dipoles were determined using a two step calibration method (air and tissue simulating liquid) using waveguides as outlined in the standards.

3.3 LOWER DETECTION LIMIT

The lower detection limit was assessed using the same measurement set up as used for the linearity measurement. The required lower detection limit is 10 mW/kg.

3.4 ISOTROPY

The axial isotropy was evaluated by exposing the probe to a reference wave from a standard dipole with the dipole mounted under the flat phantom in the test configuration suggested for system validations and checks. The probe was rotated along its main axis from 0 to 360 degrees in 15-degree steps. The hemispherical isotropy is determined by inserting the probe in a thin plastic box filled with tissue-equivalent liquid, with the plastic box illuminated with the fields from a half wave dipole. The dipole is rotated about its axis (0°–180°) in 15° increments. At each step the probe is rotated about its axis (0°–360°).

3.1 BOUNDARY EFFECT

The boundary effect is defined as the deviation between the SAR measured data and the expected exponential decay in the liquid when the probe is oriented normal to the interface. To evaluate this effect, the liquid filled flat phantom is exposed to fields from either a reference dipole or waveguide. With the probe normal to the phantom surface, the peak spatial average SAR is measured and compared to the analytical value at the surface.

The boundary effect uncertainty can be estimated according to the following uncertainty approximation formula based on linear and exponential extrapolations between the surface and $d_{be} + d_{step}$ along lines that are approximately normal to the surface:

$$SAR_{uncertainty} [\%] = \Delta SAR_{be} \frac{(d_{be} + d_{step})^2 (e^{-d_{be}/\delta/2})}{2d_{step} \delta/2} \quad \text{for } (d_{be} + d_{step}) < 10 \text{ mm}$$

where

$SAR_{uncertainty}$	is the uncertainty in percent of the probe boundary effect
d_{be}	is the distance between the surface and the closest zoom-scan measurement point, in millimetre
Δ_{step}	is the separation distance between the first and second measurement points that are closest to the phantom surface, in millimetre, assuming the boundary effect at the second location is negligible
δ	is the minimum penetration depth in millimetres of the head tissue-equivalent liquids defined in this standard, i.e., $\delta \approx 14$ mm at 3 GHz;
ΔSAR_{be}	in percent of SAR is the deviation between the measured SAR value, at the distance d_{be} from the boundary, and the analytical SAR value.



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.297.1.20.MVGB.A

The measured worst case boundary effect SARuncertainty[%] for scanning distances larger than 4mm is 1.0% Limit ,2%).

4 MEASUREMENT UNCERTAINTY

The guidelines outlined in the IEEE 1528, OET 65 Bulletin C, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty associated with an E-field probe calibration using the waveguide technique. All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

Uncertainty analysis of the probe calibration in waveguide					
ERROR SOURCES	Uncertainty value (%)	Probability Distribution	Divisor	ci	Standard Uncertainty (%)
Expanded uncertainty 95 % confidence level k = 2					14 %

5 CALIBRATION MEASUREMENT RESULTS

Calibration Parameters	
Liquid Temperature	20 +/- 1 °C
Lab Temperature	20 +/- 1 °C
Lab Humidity	30-80 %

5.1 SENSITIVITY IN AIR

Normx dipole 1 (μV/(V/m) ²)	Normy dipole 2 (μV/(V/m) ²)	Normz dipole 3 (μV/(V/m) ²)
0.81	0.71	0.80

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
115	112	112

Calibration curves $e_i=f(V)$ ($i=1,2,3$) allow to obtain E-field value using the formula:

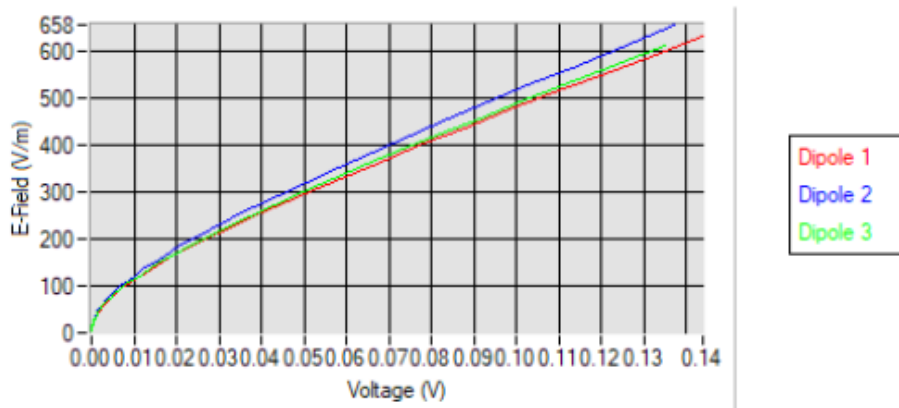
$$E = \sqrt{E_1^2 + E_2^2 + E_3^2}$$



COMOSAR E-FIELD PROBE CALIBRATION REPORT

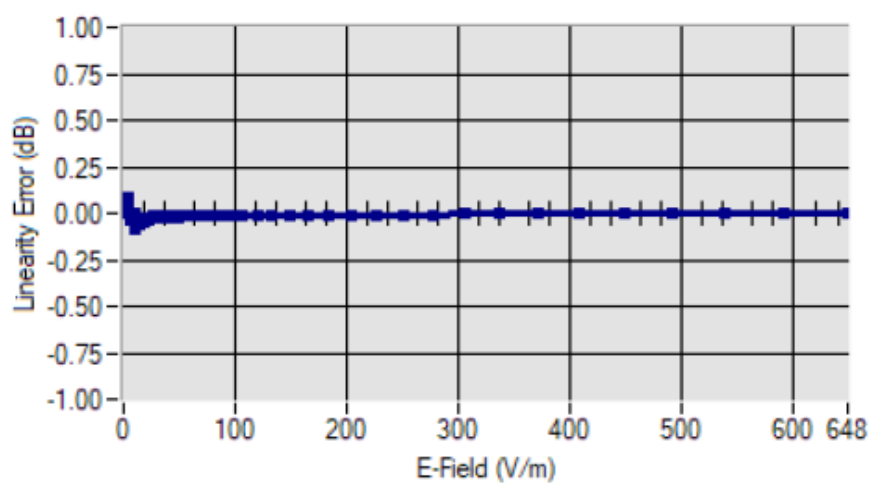
Ref: ACR.297.1.20.MVGB.A

Calibration curves



5.2 LINEARITY

Linearity



Linearity: $\pm 1.97\%$ ($\pm 0.09\text{dB}$)



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.297.1.20.MVGB.A

5.3 SENSITIVITY IN LIQUID

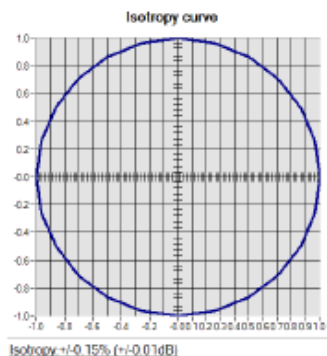
Liquid	Frequency (MHz +/- 100MHz)	ConvF	Epsilon (S/m)	Permittivity
HL750	750	1.71	0.93	40.76
BL750	750	1.78	0.98	56.70
HL900	900	1.91	0.93	41.94
BL900	900	1.96	0.98	54.62
HL1800	1800	2.08	1.29	40.86
BL1800	1800	2.16	1.47	52.27
HL2000	2000	2.03	1.42	38.37
BL2000	2000	2.10	1.52	52.03
HL2450	2450	2.31	1.80	38.72
BL2450	2450	2.37	1.97	54.91
HL2600	2600	2.16	1.89	39.98
BL2600	2600	2.23	2.18	54.42
HL5200	5200	2.01	4.45	36.68
BL5200	5200	2.08	5.46	49.02
HL5800	5800	2.06	5.08	34.81
BL5800	5800	2.13	6.12	47.81

LOWER DETECTION LIMIT: 8mW/kg



5.4 ISOTROPY

HL1800 MHz





COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.297.1.20.MVGB.A

6 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
Flat Phantom	MVG	SN-20/09-SAM71	Validated. No cal required.	Validated. No cal required.
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rohde & Schwarz ZVM	100203	05/2019	05/2022
Network Analyzer – Calibration kit	Rohde & Schwarz ZV-Z235	101223	05/2019	05/2022
Multimeter	Keithley 2000	1160271	02/2020	02/2023
Signal Generator	Rohde & Schwarz SMB	106589	04/2019	04/2022
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	NI-USB 5680	170100013	05/2019	05/2022
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Waveguide	Mega Industries	069Y7-158-13-712	Validated. No cal required.	Validated. No cal required.
Waveguide Transition	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Waveguide Termination	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Temperature / Humidity Sensor	Testo 184 H1	44220687	05/2020	05/2023

Page: 10/10

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Page 88 of 152

Dielectric Probe Calibration



Dielectric Probe Calibration Report

Ref : ACR.138.4.33.SATU.A

SHENZHEN TONGCE TESTING LAB.
TCT TESTING INDUSTRIAL PARK, FUQIAO 5TH INDUSTRIAL
ZONE, FUHAI STREET, BAOAN DISTRICT, SHENZHEN CHINA
MVG COMOSAR DOSIMETRIC E-FIELD PROBE

FREQUENCY: 0.3-6 GHZ
SERIAL NO.: SN 19/15 OCPG 71

Calibrated at MVG US
2105 Barrett Park Dr. - Kennesaw, GA 30144



Calibration Date: 06/05/2018

Summary:

This document presents the method and results from an accredited Dielectric Probe calibration performed in MVG USA using the LIMESAR test bench. All calibration results are traceable to national metrology institutions.