

Ref: ACR.287.3.14.SATU.A

7 VALIDATION MEASUREMENT

The IEEE Std. 1528, OET 65 Bulletin C and CEI/IEC 62209 standards state that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards. Per the standards, the dipole shall be positioned below the bottom of the phantom, with the dipole length centered and parallel to the longest dimension of the flat phantom, with the top surface of the dipole at the described distance from the bottom surface of the phantom.

7.1 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative per	mittivity (ε _r ')	Conductiv	ity (σ) S/m
	required	measured	required	measured
300	45.3 ±5 %		0.87 ±5 %	
450	43.5 ±5 %		0.87 ±5 %	
750	41.9 ±5 %	PASS	0.89 ±5 %	PASS
835	41.5 ±5 %		0.90 ±5 %	
900	41.5 ±5 %		0.97 ±5 %	
1450	40.5 ±5 %		1.20 ±5 %	
1500	40.4 ±5 %		1.23 ±5 %	
1640	40.2 ±5 %		1.31 ±5 %	
1750	40.1 ±5 %		1.37 ±5 %	
1800	40.0 ±5 %		1.40 ±5 %	
1900	40.0 ±5 %		1.40 ±5 %	
1950	40.0 ±5 %		1.40 ±5 %	
2000	40.0 ±5 %		1.40 ±5 %	
2100	39.8 ±5 %	5	1.49 ±5 %	
2300	39.5 ±5 %		1.67 ±5 %	
2450	39.2 ±5 %		1.80 ±5 %	
2600	39.0 ±5 %		1.96 ±5 %	
3000	38.5 ±5 %		2.40 ±5 %	
3500	37.9 ±5 %		2.91 ±5 %	

7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is given with the used input power.

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: eps': 42.1 sigma: 0.89
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm

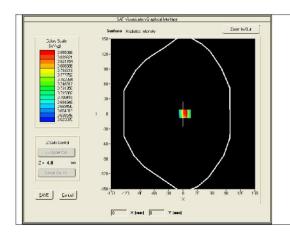
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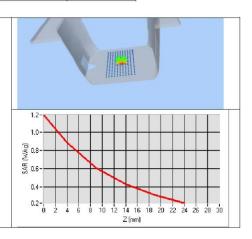


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Zoon Scan Resolution	dx=8mm/dy=8m/dz=5mm
Frequency	750 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)	10 g SAR	(W/kg/W)
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49	8.38 (0.84)	5.55	5.53 (0.55)
835	9.56		6.22	
900	10.9		6.99	
1450	29		16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4		19.3	
1800	38.4		20.1	
1900	39.7		20.5	
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7		23.3	
2450	52.4		24	
2600	55.3		24.6	
3000	63.8		25.7	
3500	67.1		25	





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7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative per	mittivity (ε,')	Conductiv	ity (σ) S/m
	required	measured	required	measured
150	61.9 ±5 %		0.80 ±5 %	
300	58.2 ±5 %		0.92 ±5 %	
450	56.7 ±5 %		0.94 ±5 %	
750	55.5 ±5 %	PASS	0.96 ±5 %	PASS
835	55.2 ±5 %		0.97 ±5 %	
900	55.0 ±5 %		1.05 ±5 %	
915	55.0 ±5 %		1.06 ±5 %	
1450	54.0 ±5 %		1.30 ±5 %	
1610	53.8 ±5 %		1.40 ±5 %	
1800	53.3 ±5 %		1.52 ±5 %	
1900	53.3 ±5 %		1.52 ±5 %	
2000	53.3 ±5 %		1.52 ±5 %	
2100	53.2 ±5 %		1.62 ±5 %	
2450	52.7 ±5 %		1.95 ±5 %	
2600	52.5 ±5 %		2.16 ±5 %	
3000	52.0 ±5 %		2.73 ±5 %	
3500	51.3 ±5 %		3.31 ±5 %	
5200	49.0 ±10 %		5.30 ±10 %	
5300	48.9 ±10 %		5.42 ±10 %	
5400	48.7 ±10 %		5.53 ±10 %	
5500	48.6 ±10 %		5.65 ±10 %	
5600	48.5 ±10 %		5.77 ±10 %	
5800	48.2 ±10 %		6.00 ±10 %	

7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

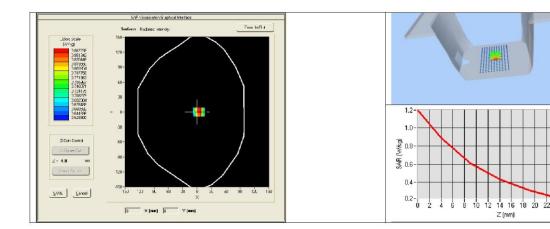
Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Body Liquid Values: eps': 56.6 sigma: 0.99
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8m/dz=5mm
Frequency	750 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

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Frequency MHz	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
750	8.77 (0.88)	5.78 (0.58)



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8 LIST OF EQUIPMENT

Equipment Summary Sheet					
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date	
SAM Phantom	Satimo	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	Rhode & Schwarz ZVA	SN100132	02/2018	02/20121	
Calipers	Carrera	CALIPER-01	12/2018	12/2021	
Reference Probe	Satimo	EPG122 SN 18/11	10/2018	10/2019	
Multimeter	Keithley 2000	1188656	12/2018	12/2021	
Signal Generator	Agilent E4438C	MY49070581	12/2018	12/2021	
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.	
Power Meter	HP E4418A	US38261498	12/2018	12/2021	
Power Sensor	HP ECP-E26A	US37181460	12/2018	12/2021	
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.	
Temperature and Humidity Sensor	Control Company	11-661-9	8/2018	8/2021	

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5.3 SID835Dipole Calibration Ceriticate



SAR Reference Dipole Calibration Report

Ref: ACR.287.4.14.SATU.A

SHENZHEN LCS COMPLIANCE TESTING LABORATORY LTD.

1F., XINGYUAN INDUSTRIAL PARK, TONGDA ROAD, BAO'AN BLVD BAO'AN DISTRICT, SHENZHEN, GUANGDONG, CHINA

BAO'AN DISTRICT, SHENZHEN, GUANGDONG, CHINA SATIMO COMOSAR REFERENCE DIPOLE

FREQUENCY: 835 MHZ

SERIAL NO.: SN 07/14 DIP 0G835-303

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





10/01/2018

Summary:

This document presents the method and results from an accredited SAR reference dipole calibration performed in SATIMO USA using the COMOSAR test bench. All calibration results are traceable to national metrology institutions.



Ref: ACR.287.4.14.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	10/14/2018	Jes
Checked by:	Jérôme LUC	Product Manager	10/14/2018	JES
Approved by:	Kim RUTKOWSKI	Quality Manager	10/14/2018	Jum Puthowski

	Customer Name
Distribution :	Shenzhen LCS Compliance Testing Laboratory Ltd.

Date	Modifications
10/14/2018	Initial release

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1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards for reference dipoles used for SAR measurement system validations and the measurements that were performed to verify that the product complies with the fore mentioned standards.

2 DEVICE UNDER TEST

Device Under Test		
Device Type	COMOSAR 835 MHz REFERENCE DIPOLE	
Manufacturer	Satimo	
Model SID835		
Serial Number	SN 07/14 DIP 0G835-303	
Product Condition (new / used)	New	

A yearly calibration interval is recommended.

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

Satimo's COMOSAR Validation Dipoles are built in accordance to the IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards. The product is designed for use with the COMOSAR test bench only.



Figure 1 – Satimo COMOSAR Validation Dipole

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4 MEASUREMENT METHOD

The IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards provide requirements for reference dipoles used for system validation measurements. The following measurements were performed to verify that the product complies with the fore mentioned standards.

4.1 RETURN LOSS REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a return loss of -20 dB or better. The return loss measurement shall be performed against a liquid filled flat phantom, with the phantom constucted as outlined in the fore mentioned standards.

4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/IEC 62209 standards specify the mechanical components and dimensions of the validation dipoles, with the dimensions frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness.

5 MEASUREMENT UNCERTAINTY

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.

5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

Frequency band	Expanded Uncertainty on Return Loss
400-6000MHz	0.1 dB

5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

Length (mm)	Expanded Uncertainty on Length
3 - 300	0.05 mm

5.3 VALIDATION MEASUREMENT

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 for validation measurements.

Scan Volume	Expanded Uncertainty
1 g	20.3 %
10 g	20.1 %

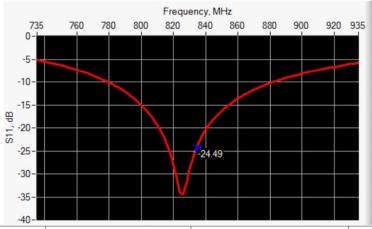
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6 CALIBRATION MEASUREMENT RESULTS

6.1 <u>RETURN LOSS AND IMPEDANCE</u>



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
835	-24.49	-20	$54.9 \Omega + 2.8 j\Omega$

6.2 MECHANICAL DIMENSIONS

Frequency MHz	L mm		h m	ım	d r	d mm	
	required	measured	required	measured	required	measured	
300	420.0 ±1 %.		250.0 ±1 %.		6.35 ±1 %.		
450	290.0 ±1 %.		166.7 ±1 %.		6.35 ±1 %.		
750	176.0 ±1 %.		100.0 ±1 %.		6.35 ±1 %.		
835	161.0 ±1 %.	PASS	89.8 ±1 %.	PASS	3.6 ±1 %.	PASS	
900	149.0 ±1 %.		83.3 ±1 %.		3.6 ±1 %.		
1450	89.1 ±1 %.		51.7 ±1 %.		3.6 ±1 %.		
1500	80.5 ±1 %.		50.0 ±1 %.		3.6 ±1 %.		
1640	79.0 ±1 %.		45.7 ±1 %.		3.6 ±1 %.		
1750	75.2 ±1 %.		42.9 ±1 %.		3.6 ±1 %.		
1800	72.0 ±1 %.		41.7 ±1 %.		3.6 ±1 %.		
1900	68.0 ±1 %.		39.5 ±1 %.		3.6 ±1 %.		
1950	66.3 ±1 %.		38.5 ±1 %.		3.6 ±1 %.		
2000	64.5 ±1 %.		37.5 ±1 %.		3.6 ±1 %.		
2100	61.0 ±1 %.		35.7 ±1 %.		3.6 ±1 %.		
2300	55.5 ±1 %.		32.6 ±1 %.		3.6 ±1 %.		
2450	51.5 ±1 %.		30.4 ±1 %.		3.6 ±1 %.		
2600	48.5 ±1 %.		28.8 ±1 %.		3.6 ±1 %.		
3000	41.5 ±1 %.		25.0 ±1 %.		3.6 ±1 %.		
3500	37.0±1 %.		26.4 ±1 %.		3.6 ±1 %.		
3700	34.7±1 %.		26.4 ±1 %.		3.6 ±1 %.		

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7 VALIDATION MEASUREMENT

The IEEE Std. 1528, OET 65 Bulletin C and CEI/IEC 62209 standards state that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards. Per the standards, the dipole shall be positioned below the bottom of the phantom, with the dipole length centered and parallel to the longest dimension of the flat phantom, with the top surface of the dipole at the described distance from the bottom surface of the phantom.

7.1 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative per	Relative permittivity (ϵ_r ')		ity (σ) S/m
	required	measured	required	measured
300	45.3 ±5 %		0.87 ±5 %	
450	43.5 ±5 %		0.87 ±5 %	
750	41.9 ±5 %		0.89 ±5 %	
835	41.5 ±5 %	PASS	0.90 ±5 %	PASS
900	41.5 ±5 %		0.97 ±5 %	
1450	40.5 ±5 %		1.20 ±5 %	
1500	40.4 ±5 %		1.23 ±5 %	
1640	40.2 ±5 %		1.31 ±5 %	
1750	40.1 ±5 %		1.37 ±5 %	
1800	40.0 ±5 %		1.40 ±5 %	
1900	40.0 ±5 %		1.40 ±5 %	
1950	40.0 ±5 %		1.40 ±5 %	
2000	40.0 ±5 %		1.40 ±5 %	
2100	39.8 ±5 %		1.49 ±5 %	
2300	39.5 ±5 %		1.67 ±5 %	
2450	39.2 ±5 %		1.80 ±5 %	
2600	39.0 ±5 %		1.96 ±5 %	
3000	38.5 ±5 %		2.40 ±5 %	
3500	37.9 ±5 %		2.91 ±5 %	

7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is given with the used input power.

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: eps': 42.3 sigma: 0.92
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm

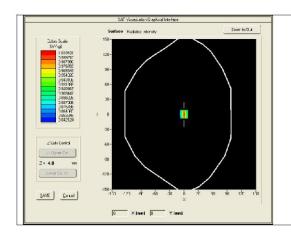
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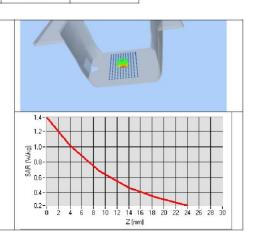


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Zoon Scan Resolution	dx=8mm/dy=8m/dz=5mm	
Frequency	835 MHz	
Input power	20 dBm	
Liquid Temperature	21 °C	
Lab Temperature	21 °C	
Lab Humidity	45 %	

Frequency MHz	1 g SAR ((W/kg/W)	10 g SAR	(W/kg/W)
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49		5.55	
835	9.56	9.60 (0.96)	6.22	6.20 (0.62)
900	10.9		6.99	
1450	29		16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4		19.3	
1800	38.4		20.1	
1900	39.7		20.5	
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7		23.3	
2450	52.4		24	
2600	55.3		24.6	
3000	63.8		25.7	
3500	67.1		25	





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7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative per	mittivity (ε,')	Conductiv	ity (σ) S/m
	required	measured	required	measured
150	61.9 ±5 %		0.80 ±5 %	
300	58.2 ±5 %		0.92 ±5 %	
450	56.7 ±5 %		0.94 ±5 %	
750	55.5 ±5 %		0.96 ±5 %	
835	55.2 ±5 %	PASS	0.97 ±5 %	PASS
900	55.0 ±5 %		1.05 ±5 %	
915	55.0 ±5 %		1.06 ±5 %	
1450	54.0 ±5 %		1.30 ±5 %	
1610	53.8 ±5 %		1.40 ±5 %	
1800	53.3 ±5 %		1.52 ±5 %	
1900	53.3 ±5 %		1.52 ±5 %	
2000	53.3 ±5 %		1.52 ±5 %	
2100	53.2 ±5 %		1.62 ±5 %	
2450	52.7 ±5 %		1.95 ±5 %	
2600	52.5 ±5 %		2.16 ±5 %	
3000	52.0 ±5 %		2.73 ±5 %	
3500	51.3 ±5 %		3.31 ±5 %	
5200	49.0 ±10 %		5.30 ±10 %	
5300	48.9 ±10 %		5.42 ±10 %	
5400	48.7 ±10 %		5.53 ±10 %	
5500	48.6 ±10 %		5.65 ±10 %	
5600	48.5 ±10 %		5.77 ±10 %	
5800	48.2 ±10 %		6.00 ±10 %	

7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

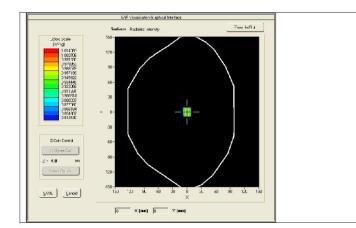
Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Body Liquid Values: eps': 54.1 sigma: 0.97
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8m/dz=5mm
Frequency	835 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

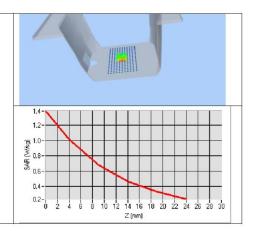
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Ref: ACR.287.4.14.SATU.A

Frequency MHz	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)	
	measured	measured	
835	9.90 (0.99)	6.39 (0.64)	





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Ref: ACR.287.4.14.SATU.A

8 LIST OF EQUIPMENT

Equipment Summary Sheet						
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date		
SAM Phantom	Satimo	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	Rhode & Schwarz ZVA	SN100132	02/2016	02/2019		
Calipers	Carrera	CALIPER-01	12/2016	12/2019		
Reference Probe	Satimo	EPG122 SN 18/11	10/2018	10/2019		
Multimeter	Keithley 2000	1188656	12/2016	12/2019		
Signal Generator	Agilent E4438C	MY49070581	12/2016	12/2019		
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.		
Power Meter	HP E4418A	US38261498	12/2016	12/2019		
Power Sensor	HP ECP-E26A	US37181460	12/2016	12/2019		
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.		
Temperature and Humidity Sensor	Control Company	11-661-9	8/2016	8/2019		

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5.4 SID1800 Dipole Calibration Certificate



SAR Reference Dipole Calibration Report

Ref: ACR.287.6.14.SATU.A

SHENZHEN LCS COMPLIANCE TESTING LABORATORY LTD.

1F., XINGYUAN INDUSTRIAL PARK, TONGDA ROAD,
BAO'AN BLVD
BAO'AN DISTRICT, SHENZHEN, GUANGDONG, CHINA
SATIMO COMOSAR REFERENCE DIPOLE

FREQUENCY: 1800 MHZ SERIAL NO.: SN 07/14 DIP 1G800-301

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



10/01/2018

Summary:

This document presents the method and results from an accredited SAR reference dipole calibration performed in SATIMO USA using the COMOSAR test bench. All calibration results are traceable to national metrology institutions.



Ref: ACR.287.6.14.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	10/14/2018	Jes
Checked by:	Jérôme LUC	Product Manager	10/14/2018	JES
Approved by:	Kim RUTKOWSKI	Quality Manager	10/14/2018	them Puthowski

	Customer Name	
Distribution :	Shenzhen LCS	
	Compliance Testing	
	Laboratory Ltd.	

Date	Modifications
10/14/2018	Initial release

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