



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.199.1.23.BES.A

## 7 LIST OF EQUIPMENT

	Equi	pment Summary S	Sheet		
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date	
CALIPROBE Test Bench	Version 2	NA	Validated. No cal required.	Validated. No ca required.	
Network Analyzer	Rohde & Schwarz ZVM	100203	08/2021	08/2024	
Network Analyzer	Agilent 8753ES	MY40003210	10/2019	10/2023	
Network Analyzer – Calibration kit	HP 85033D	3423A08186	06/2021	06/2027	
Network Analyzer – Calibration kit	Rohde & Schwarz ZV-Z235	101223	07/2022	07/2025	
Multimeter	Keithley 2000	4013982	02/2023	02/2026	
Signal Generator	Rohde & Schwarz SMB	106589	03/2022	03/2025	
Amplifier	MVG	MODU-023-C-0002	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.	
Power Meter	NI-USB 5680	170100013	06/2021	06/2024	
Power Meter	Keysight U2000A	SN: MY62340002	10/2022	10/2025	
Directional Coupler	Krytar 158020	131467	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.	
Fluoroptic Thermometer	LumaSense Luxtron 812	94264	09/2022	09/2025	
Coaxial cell	MVG	SN 32/16 COAXCELL_1	Validated. No cal required.	Validated. No cal required.	
Wa∨eguide	MVG	SN 32/16 WG2_1	Validated. No cal required.	Validated. No cal required.	
Liquid transition	MVG	SN 32/16 WGLIQ_0G600_1	Validated. No cal required.	Validated. No cal required.	
Wa∨eguide	MVG	SN 32/16 WG4_1	Validated. No cal required.	Validated. No cal required.	
Liquid transition	MVG	SN 32/16 WGLIQ_0G900_1	Validated. No cal required.	Validated. No cal required.	
Wa∨eguide	MVG	SN 32/16 WG6_1	Validated. No cal required.	Validated. No cal required.	
Liquid transition	MVG	SN 32/16 WGLIQ_1G500_1	Validated. No cal required.	Validated. No cal required.	
Wa∨eguide	MVG	SN 32/16 WG8_1	Validated. No cal required.	Validated. No cal required.	

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Liquid transition	MVG	SN 32/16 WGLIQ_1G800B_1	Validated. No cal required.	Validated. No cal required.
Liquid transition	MVG	SN 32/16 WGLIQ_1G800H_1	Validated. No cal required.	Validated. No cal required.
Wa∨eguide	MVG	SN 32/16 WG10_1	Validated. No cal required.	Validated. No cal required.
Liquid transition	MVG	SN 32/16 WGLIQ_3G500_1	Validated. No cal required.	Validated. No cal required.
Wa∨eguide	MVG	SN 32/16 WG12_1	Validated. No cal required.	Validated. No cal required.
Liquid transition	MVG	SN 32/16 WGLIQ_5G000_1	Validated. No cal required.	Validated. No cal required.
Wa∨eguide	MVG	SN 32/16 WG14_1	Validated. No cal required.	Validated. No cal required.
Liquid transition	MVG	SN 32/16 WGLIQ_7G000_1	Validated. No cal required.	Validated. No cal required.
emperature / Humidity Sensor	Testo 184 H1	44225320	06/2021	06/2024

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# **SAR Reference Dipole Calibration Report**

Ref: ACR.329.15.21.BES.A

# SHENZHEN BCTC TECHNOLOGY CO., LTD.

1~2/ F, NO. B FACTORY BUILDING, PENGZHOU INDUSTRIAL PARK, FUYUAN 1ST ROAD, TANGWEI COMMUNITY, FUHAI STREET, BAO'AN DISTRICT, SHENZHEN, GUANGDONG, CHINA MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 2450 MHZ

SERIAL NO.: SN 47/21 DIP 2G450-627

Calibrated at MVG

Z.I. de la pointe du diable

Technopôle Brest Iroise – 295 avenue Alexis de Rochon 29280 PLOUZANE - FRANCE

Calibration date: 11/25/2021



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

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## Summary:

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

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No.: BCTC/RF-EMC-005

#### SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR 329.15.21.BES.A

	Name	Function	Date	Signature
Prepared by:	Jérôme Luc	Technical Manager	11/25/2021	JES
Checked by :	Jérôme Luc	Technical Manager	11/25/2021	25
Approved by :	Yann Toutain	Laboratory Director	11/25/2021	Gann TOUTAN.

2021.11.25 11:56:55 +01'00'

	Customer Name
Distribution :	Shenzhen BCTC Technology Co., Ltd.

Name	Date	Modifications	
Jérôme Luc	11/25/2021	Initial release	
	ADSCRETS RESIDENCES	10.000.000.000.000.000.000.000.000.000.	

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## INTRODUCTION

This document contains a summary of the requirements set forth by the IEC/IEEE 62209-1528 and FCC KDB865664 D01 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.

#### DEVICE UNDER TEST 2

Device Under Test			
Device Type COMOSAR 2450 MHz REFERENCE DIPO			
Manufacturer	MVG		
Model	SID2450		
Serial Number	SN 47/21 DIP 2G450-627		
Product Condition (new / used)	New		

#### PRODUCT DESCRIPTION 3

#### **GENERAL INFORMATION** 3.1

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MVG's COMOSAR Validation Dipoles are built in accordance to the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards. The product is designed for use with the COMOSAR test bench only.



Figure 1 - MVG COMOSAR Validation Dipole

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#### MEASUREMENT METHOD

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 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.

## 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 constructed as outlined in the fore mentioned standards. A direct method is used with a network analyser and its calibration kit, both with a valid ISO17025 calibration.

## 4.2 MECHANICAL REQUIREMENTS

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards specify the mechanical components and dimensions of the validation dipoles, with the dimension's 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. A direct method is used with a ISO17025 calibrated caliper.

#### 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	0.08 LIN		

## DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

Length (mm)	Expanded Uncertainty on Length
0 - 300	0.20 mm
300 - 450	0.44 mm

## 5.3 VALIDATION MEASUREMENT

The guidelines outlined in the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards were followed to generate the measurement uncertainty for validation measurements.

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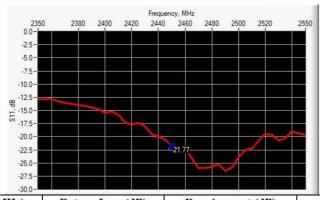
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Scan Volume	Expanded Uncertainty		
1 g	19 % (SAR)		
10 g	19 % (SAR)		

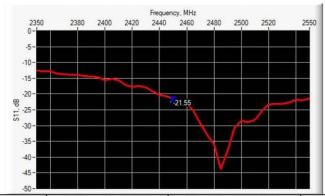
## 6 CALIBRATION MEASUREMENT RESULTS

## 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz) Return Loss (dB) Requirement (dB) Impedance 2450 -21.77  $49.1 \Omega + 8.1 j\Omega$ 

## 6.2 <u>RETURN LOSS AND IMPEDANCE IN BODY LIQUID</u>



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
2450	-21.55	-20	$54.7 \Omega + 6.8 i\Omega$

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## MECHANICAL DIMENSIONS

Frequency MHz	Ln	ım	hm	m	d r	nm
	required	measured	required	measured	required	m easured
300	420.0 <b>±1 %.</b>		250.0 <b>±1 %.</b>		6.35 <b>±1 %.</b>	
450	290.0 <b>±1 %.</b>		166.7 ±1 %.		6.35 <b>±1 %</b> .	
750	176.0 ±1 %.		100.0 <b>±1 %.</b>		6.35 <b>±1 %</b> .	
835	161.0 ±1 %.		89.8 <b>±1 %.</b>		3.6 <b>±1 %.</b>	
900	149.0 <b>±1 %.</b>		83.3 <b>±1 %.</b>		3.6 <b>±1 %.</b>	
1450	89.1 <b>±1 %.</b>		51.7 <b>±1 %.</b>		3.6 <b>±1 %.</b>	
1500	86.2 <b>±1 %.</b>		50.0 <b>±1 %.</b>		3.6 <b>±1 %.</b>	
1640	79.0 <b>±1 %.</b>		45.7 ±1 %.		3.6 <b>±1 %.</b>	
1750	75.2 ±1 %.		42.9 <b>±1 %.</b>		3.6 <b>±1 %.</b>	
1800	72.0 <b>±1 %.</b>		41.7 <b>±1 %.</b>		3.6 <b>±1 %.</b>	
1900	68.0 <b>±1 %.</b>		39.5 <b>±1 %.</b>		3.6 <b>±1 %.</b>	
1950	66.3 <b>±1 %.</b>		38.5 <b>±1 %.</b>		3.6 <b>±1 %</b> .	
2000	64.5 <b>±1 %.</b>	5	37.5 <b>±1 %.</b>		3.6 <b>±1 %.</b>	
2100	61.0 <b>±1 %</b> .		35.7 <b>±1 %</b> .		3.6 <b>±1 %.</b>	
2300	55.5 <b>±1 %.</b>		32.6 <b>±1</b> %.		3.6 <b>±1 %.</b>	
2450	51.5 <b>±1 %.</b>	51.37	30.4 <b>±1 %.</b>	30.45	3.6 <b>±1 %.</b>	3.60
2600	48.5 <b>±1 %.</b>	9	28.8 <b>±1 %.</b>		3.6 <b>±1 %.</b>	
3000	41.5 <b>±1 %.</b>		25.0 <b>±1 %.</b>		3.6 <b>±1 %.</b>	
3300	a		a		15	
3500	37.0 <b>±1 %.</b>		26.4 <b>±1 %.</b>		3.6 <b>±1 %.</b>	
3700	34.7 <b>±1 %</b> .		26.4 ±1 %.		3.6 <b>±1</b> %.	
3900	8		8		22	
4200			ā		, ,-	
4600			*		æ	
4900	P	9	E		6	

## 7 VALIDATION MEASUREMENT

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 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.

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## 7.1 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative permittivity $(\mathbf{s}_{r}')$		Conductivity (σ) S/m	
	required	measured	required	measured
300	45.3 <b>±10</b> %		0.87 <b>±</b> 10 %	
450	43.5 <b>±</b> 10 %		0.87 <b>±</b> 10 %	
750	41.9 <b>±</b> 10 %		0.89 <b>±</b> 10 %	
835	41.5 ±10 %		0.90 ±10 %	
900	41.5 <b>±</b> 10 %		0.97 <b>±</b> 10 %	
1450	40.5 <b>±</b> 10 %		1.20 <b>±</b> 10 %	
1500	40.4 <b>±</b> 10 %		1.23 <b>±</b> 10 %	
1640	40.2 <b>±10</b> %		1.31 <b>±</b> 10 %	
1750	40.1 <b>±</b> 10 %		1.37 <b>±</b> 10 %	
1800	40.0 <b>±10</b> %	10	1.40 ±10 %	
1900	40.0 <b>±10</b> %		1.40 ±10 %	
1950	40.0 <b>±</b> 10 %		1.40 ±10 %	
2000	40.0 ±10 %		1.40 ±10 %	
2100	39.8 <b>±10</b> %		1.49 <b>±</b> 10 %	
2300	39.5 <b>±10</b> %		1.67 <b>±</b> 10 %	
2450	39.2 <b>±10</b> %	36.4	1.80 ±10 %	1.96
2600	39.0 <b>±10</b> %		1.96 ±10 %	
3000	38.5 <b>±1</b> 0 %		2.40 <b>±</b> 10 %	
3300	38.2 <b>±10</b> %	0	2.71 <b>±</b> 10 %	
3500	37.9 <b>±10</b> %		2.91 <b>±</b> 10 %	
3700	37.7 <b>±10</b> %		3.12 <b>±</b> 10 %	
3900	37.5 <b>±10</b> %	2	3.32 <b>±10</b> %	
4200	37.1 <b>±</b> 10 %		3.63 <b>±10</b> %	
4600	36.7 <b>±10</b> %		4.04 <b>±</b> 10 %	
4900	36.3 <b>±10</b> %		4.35 <b>±</b> 10 %	

## 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 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.

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Software	OPENSAR V5	
Phantom	SN 13/09 SAM68	
Probe	SN 41/18 EPGO333	
Liquid	Head Liquid Values: eps': 36.4 sigma: 1.96	
Distance between dipole center and liquid	10.0 mm	
Area scan resolution	dx=8mm/dy=8mm	
Zoon Scan Resolution	dx=5mm/dy=5mm/dz=5mm	
Frequency	2450 MHz	
Input power	20 dBm	
Liquid Temperature	20 +/- 1 °C	
Lab Temperature	20 +/- 1 °C	
Lab Humidity 30-70 %		

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		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	55.16 (5.52)	24	24.15 (2.41)
2600	55.3		24.6	
3000	63.8		25.7	
3300	- 5		540	
3500	67.1		25	
3700	67.4		24.2	
3900	E-1			
4200	- 1		17.1	
4600			in:	
4900	-		380	

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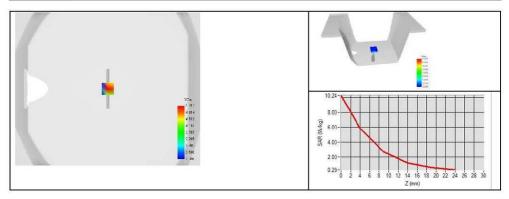






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## 7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity $(s_r')$		Conductivity (σ) S/m	
	required	measured	required	measured
150	61.9 <b>±</b> 10 %		0.80 ±10 %	
300	58.2 <b>±10</b> %		0.92 <b>±</b> 10 %	
450	56.7 <b>±10</b> %		0.94 ±10 %	
750	55.5 <b>±1</b> 0 %		0.96 <b>±</b> 10 %	
835	55.2 <b>±10</b> %		0.97 <b>±</b> 10 %	
900	55.0 <b>±10</b> %		1.05 <b>±</b> 10 %	
915	55.0 <b>±</b> 10 %		1.06 <b>±</b> 10 %	
1450	54.0 <b>±</b> 10 %		1.30 ±10 %	
1610	53.8 <b>±</b> 10 %		1.40 <b>±</b> 10 %	
1800	53.3 <b>±10</b> %		1.52 <b>±</b> 10 %	
1900	53.3 <b>±1</b> 0 %		1.52 <b>±</b> 10 %	
2000	53.3 <b>±10</b> %		1.52 <b>±</b> 10 %	
2100	53.2 <b>±10</b> %		1.62 ±10 %	
2300	52.9 <b>±10</b> %		1.81 ±10 %	
2450	52.7 <b>±1</b> 0 %	53.4	1.95 <b>±</b> 10 %	2.14
2600	52.5 <b>±10</b> %		2.16 <b>±</b> 10 %	
3000	52.0 <b>±10</b> %		2.73 <b>±</b> 10 %	
3300	51.6 <b>±</b> 10 %		3.08 <b>±</b> 10 %	
3500	51.3 <b>±</b> 10 %	5	3.31 <b>±</b> 10 %	
3700	51.0 <b>±</b> 10 %		3.55 <b>±</b> 10 %	
3900	50.8 <b>±1</b> 0 %		3.78 ±10 %	
4200	50.4 <b>±1</b> 0 %		4.13 ±10 %	
4600	49.8 <b>±</b> 10 %		4.60 ±10 %	
4900	49.4 <b>±</b> 10 %		4.95 <b>±</b> 10 %	
5200	49.0 <b>±10</b> %		5.30 <b>±10</b> %	
5300	48.9 <b>±10</b> %		5.42 <b>±10</b> %	
5400	48.7 <b>±10</b> %		5.53 <b>±10</b> %	
5500	48.6 <b>±10</b> %		5.65 <b>±10</b> %	
5600	48.5 <b>±10</b> %		5.77 <b>±10</b> %	
5800	48.2 <b>±10</b> %		6.00 <b>±10</b> %	

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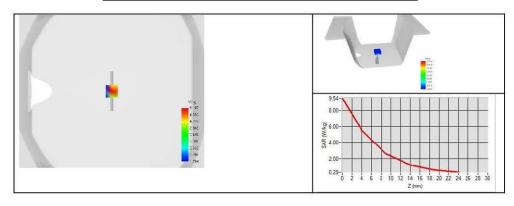
#### SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR 329.15.21.BES.A

## 7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

Software	OPENSAR V5	
Phantom	SN 13/09 SAM68	
Probe	SN 41/18 EPGO333	
Liquid	Body Liquid Values: eps': 53.4 sigma: 2.14	
Distance between dipole center and liquid	10.0 mm	
Area scan resolution	dx=8mm/dy=8mm	
Zoon Scan Resolution	dx=5mm/dy=5mm/dz=5mm	
Frequency	2450 MHz	
Input power	20 dBm	
Liquid Temperature	20 +/- 1 °C	
Lab Temperature	20 +/- 1 °C	
Lab Humidity	30-70 %	

Frequency MHz	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)	
	measured	measured	
2450	52.28 (5.23)	22.68 (2.27)	



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#### SAR REFERENCE DIPOLE CALIBRATION REPORT

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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	MVG	SN 13/09 SAM68	Validated. No cal required.	Validated. No cal required.
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No ca required.
Network Analyzer	Rohde & Schwarz ZVM	100203	08/2021	08/2024
Network Analyzer	Agilent 8753ES	MY40003210	10/2019	10/2022
Network Analyzer – Calibration kit	Rohde & Schwarz ZV-Z235	101223	05/2019	05/2022
Network Analyzer – Calibration kit	HP 85033D	3423A08186	06/2021	06/2027
Calipers	Mitutoyo	SN 0009732	10/2019	10/2022
Reference Probe	MVG	SN 41/18 EPGO333	10/2021	10/2022
Multimeter	Keithley 2000	1160271	02/2020	02/2023
Signal Generator	Rohde & Schwarz SMB	106589	04/2019	04/2022
Amplifier	MVG	MODU-023-C-0002	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	NI-USB 5680	170100013	06/2021	06/2024
Power Meter	Rohde & Schwarz NRVD	832839-056	11/2019	11/2022
Directional Coupler	Krytar 158020	131467	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Temperature / Humidity Sensor	Testo 184 H1	44225320	06/2021	06/2024

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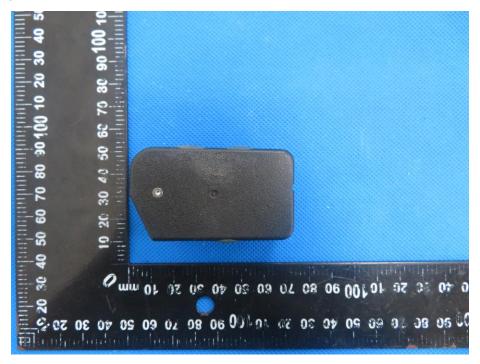
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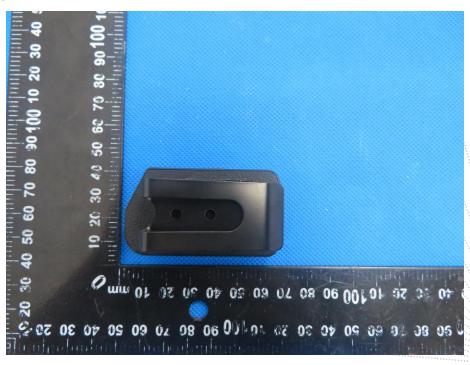


# 17. EUT Photographs

## **EUT Front View**



## **EUT Back View**



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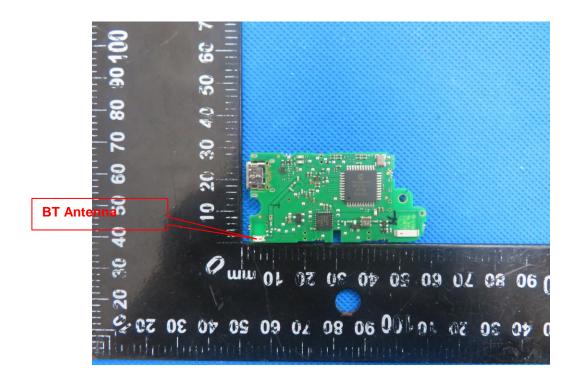
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## **Antenna View**





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ES

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# 18. EUT Test Setup Photographs

**Body mode Exposure Conditions Test distance: 0mm** 

Back



Front



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TIME D





# **STATEMENT**

- 1. The equipment lists are traceable to the national reference standards.
- 2. The test report can not be partially copied unless prior written approval is issued from our lab.
- 3. The test report is invalid without stamp of laboratory.
- 4. The test report is invalid without signature of person(s) testing and authorizing.
- 5. The test process and test result is only related to the Unit Under Test.
- 6. The quality system of our laboratory is in accordance with ISO/IEC17025.
- 7. If there is any objection to report, the client should inform issuing laboratory within 15 days from the date of receiving test report.

## Address:

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TEL: 400-788-9558

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FAX: 0755-33229357

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E-Mail: bctc@bctc-lab.com.cn

\*\*\*\* END \*\*\*\*

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