COMOHAC E-Field Probe Calibration Report

Ref : ACR.41.4.25.BES.A

BTF TESTING LAB (SHENZHEN) CO., LTD.

F101,201 AND 301, BUILDING 1, BLOCK 2, TANTOU INDUSTRIAL PARK, TANTOU COMMUNITY SONGGANG STREET, BAO'AN DISTRICT, SHENZHEN, CHINA

MVG COMOHAC E-FIELD PROBE

SERIAL NO.: SN 07/22-EPH-50

Calibrated at MVG

Z.I. de la pointe du diable

Technopôle Brest Iroise – 295 avenue Alexis de Rochon

29280 PLOUZANE - FRANCE

Calibration date: 02/05/2025

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

Summary:

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

	Name	*Function*	*Date*	*Signature*
Prepared by :	Pedro Ruiz	Technical Manager	2/10/2025	
Checked & approved by:	Pedro Ruiz	Technical Manager	2/10/2025	
Authorized by:	Geraldine Toutain	Quality Manager	2/10/2025	DocuSigned by: Géraldine TOUTAIN A1C9AC91CB5441A...

	Customer Name
Distribution :	BTF Testing Lab (Shenzhen) Co., Ltd.

Issue	*Name*	*Date*	*Modifications*
A	Pedro Ruiz	2/10/2025	Initial release

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1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOHAC E FIELD PROBE
Manufacturer	MVG
Model	SCE
Serial Number	0722-EPH-50
Product Condition (new / used)	Used
Frequency Range of Probe	0.7GHz-2.5GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.208 MΩ Dipole 2: R2=0.212 MΩ Dipole 3: R3=0.213 MΩ

2 PRODUCT DESCRIPTION

2.1 GENERAL INFORMATION

MVG's COMOHAC E field Probes are built in accordance to the ANSI C63.19 and IEEE 1309 standards.

Figure 1 – *MVG COMOHAC E field Probe*

Probe Length	330 mm
Length of Individual Dipoles	3.3 mm
Maximum external diameter	8 mm
Probe Tip External Diameter	5 mm
Distance between dipoles / probe extremity	3 mm

3 MEASUREMENT METHOD

All methods used to perform the measurements and calibrations comply with the ANSI C63.19 and IEEE 1309 standards.

3.1 SENSITIVITY

The sensitivity factors of the three dipoles were determined using the waveguide method outlined in the fore mentioned standards.

3.2 LINEARITY

The linearity was determined using a standard dipole with the probe positioned 10 mm above the dipole. The input power of the dipole was adjusted from -15 to 36 dBm using a 1dB step (to cover the range 2V/m to 1000A/m).

3.3 ISOTROPY

The axial isotropy was evaluated by exposing the probe to a reference wave from a standard dipole. The probe was rotated along its main axis from 0 - 360 degrees in 15 degree steps.

4 MEASUREMENT UNCERTAINTY

The guidelines outlined in the ANSI C63.19 and IEEE 1309 standards were followed to generate the measurement uncertainty associated with an E-field probe calibration using the waveguide technique.

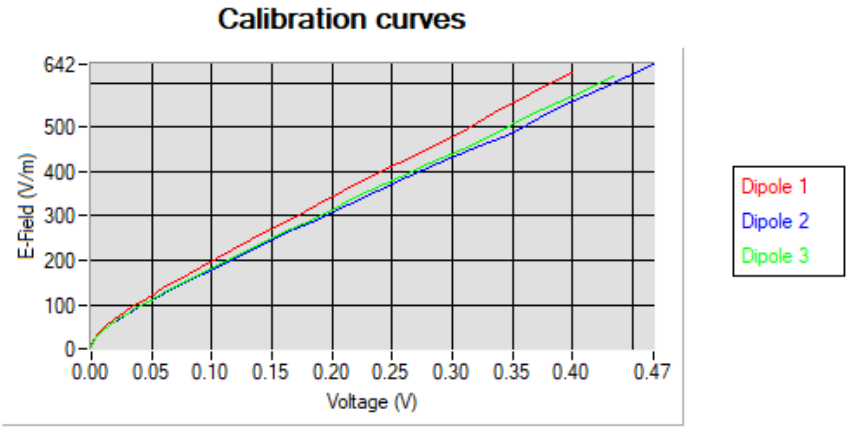
The estimated expanded uncertainty (k=2) in calibration for E-Field (V/m) is +/-9.6% with respect to measurement conditions.

5 CALIBRATION RESULTS

Calibration Parameters	
Lab Temperature	20 +/-1 °C
Lab Humidity	30-70 %

5.1 CALIBRATION IN AIR

The following curve represents the measurement in waveguide of the voltage picked up by the probe toward the E-field generated inside the waveguide.



From this curve, the sensitivity in air is calculated using the below formula.

$$E^2 = \sum_{i=1}^{3} \frac{V_i \left(1 + {}^{V_i}/_{DCP_i}\right)}{Norm_i}$$

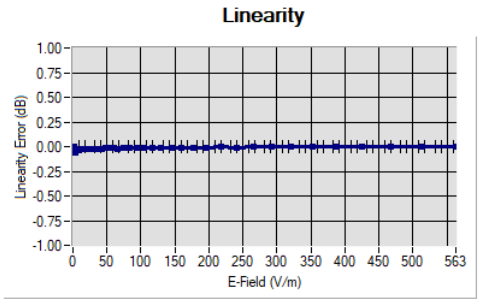
Vi=voltage readings on the 3 channels of the probe
DCPi=diode compression point given below for the 3 channels of the probe
Normi=dipole sensitivity given below for the 3 channels of the probe

Normx dipole 1 ($\mu V/(V/m)^2$)	Normy dipole 2 ($\mu V/(V/m)^2$)	Normz dipole 3 ($\mu V/(V/m)^2$)
5.00	5.96	5.85

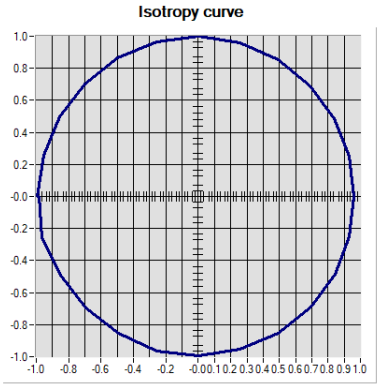
DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
104	110	106

6 VERIFICATION RESULTS

The figures below represent the measured linearity and axial isotropy for this probe. The probe specification is +/-0.2 dB for linearity and +/-0.15 dB for axial isotropy.



Linearity:+/-1.34% (+/-0.06dB)



Isotropy:+/-1.96% (+/-0.09dB)

7 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	**Manufacturer / Model**	**Identification No.**	**Current Calibration Date**	**Next Calibration Date**
HAC positioning ruler	MVG	TABH12 SN 42/09	Validated. No cal required.	Validated. No cal required.
COMOHAC Test Bench	Version 2	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rohde & Schwarz ZVM	100203	08/2021	08/2026
Network Analyzer – Calibration kit	Rohde & Schwarz ZV-Z235	101223	07/2022	07/2027
Multimeter	Keithley 2000	4013982	02/2023	02/2026
Signal Generator	Rohde & Schwarz SMB	183277	05/2022	05/2025
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	06/2026
Power Meter	Keysight U2000A	SN: MY62340002	10/2024	10/2027
Directional Coupler	Krytar 158020	131467	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Waveguide	MVG	SN 32/16 WG8_1	Validated. No cal required.	Validated. No cal required.
Temperature / Humidity Sensor	Testo 184 H1	44235403	02/2024	02/2027

HAC Reference Dipole Calibration Report

Ref : ACR.148.21.25.BES.A

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MVG COMOHAC REFERENCE DIPOLE

FREQUENCY: 800-950MHZ

SERIAL NO.: 0722-DHA69

Calibrated at MVG

Z.I. de la pointe du diable

Technopôle Brest Iroise – 295 avenue Alexis de Rochon

29280 PLOUZANE - FRANCE

Calibration date: 05/27/2025

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

Summary:

This document presents the method and results from an accredited HAC reference dipole calibration performed at MVG, using the COMOHAC test bench. The test results covered by accreditation are traceable to the International System of Units (SI).

	Name	*Function*	*Date*	*Signature*
Prepared by :	Pedro Ruiz	Technical Manager	5/28/2025	
Checked & approved by:	Pedro Ruiz	Technical Manager	5/28/2025	
Authorized by:	Kim Rutkowski	Quality Manager	6/4/2025	Signed by: Kimberley RUTKOWSKI 2B689547AD17461...

	Customer Name
Distribution :	BTF Testing Lab (Shenzhen) Co., Ltd.

Issue	*Name*	*Date*	*Modifications*
A	Pedro Ruiz	5/28/2025	Initial release

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1 INTRODUCTION

This document contains a summary of the requirements set forth by the ANSI C63.19 standard for reference dipoles used for HAC 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	COMOHAC 800-950 MHz REFERENCE DIPOLE
Manufacturer	MVG
Model	SIDB835
Serial Number	0722-DHA69
Product Condition (new / used)	Used

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

MVG's COMOHAC Validation Dipoles are built in accordance to the ANSI C63.19 standard. The product is designed for use with the COMOHAC system only.

Figure 1 – *MVG COMOHAC Validation Dipole*

4 MEASUREMENT METHOD

The ANSI C63.19 standard outlines the requirements for reference dipoles to be used for system validation measurements. The following measurements were performed to verify that the product complies with the fore mentioned standard.

The ANSI C63.19 standard outlines the requirements for reference dipoles to be used for system validation measurements. The following measurements were performed to verify that the product complies with the fore mentioned standard.

4.1 S11 PARAMETER REQUIREMENTS

The dipole used for HAC system validation measurements and checks must have a return loss of -10 dB or better. The return loss measurement shall be performed in free space. A direct method is used with a network analyser and its calibration kit, both with a valid ISO17025 calibration.

4.2 E-FIELD REQUIREMENTS

The IEEE ANSI C63-19 standard states that the dipole used for validation measurements and checks must be scanned with the E field probe, with the dipole 10 mm below the probe. The E field strength plots are compared to the simulation results obtained by MVG.

5 MEASUREMENT UNCERTAINTY

5.1 S11 PARAMETER

The estimated expanded uncertainty (k=2) in calibration for the S11 parameter in linear is +/-0.08 with respect to measurement conditions.

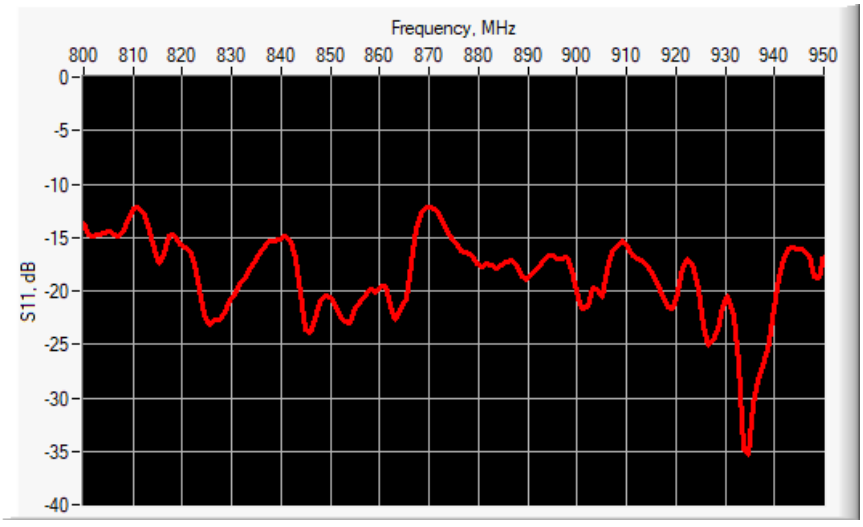
5.2 E-FIELD

The guideline outlined in the IEEE ANSI C63.19 standard was followed to generate the measurement uncertainty for validation measurements.

The estimated expanded uncertainty (k=2) in calibration for the E-Field measurement in V/m is +/-14% with respect to measurement conditions.

6 CALIBRATION RESULTS

6.1 S11 PARAMETER



Frequency (MHz)	Worst Case S11 parameter (dB)	Requirement (dB)
800-950 MHz	-12.13	-10

6.2 E-FIELD

The IEEE ANSI C63.19 standard states that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss requirements. The system validations measurement results are then compared to MVG's simulated results.

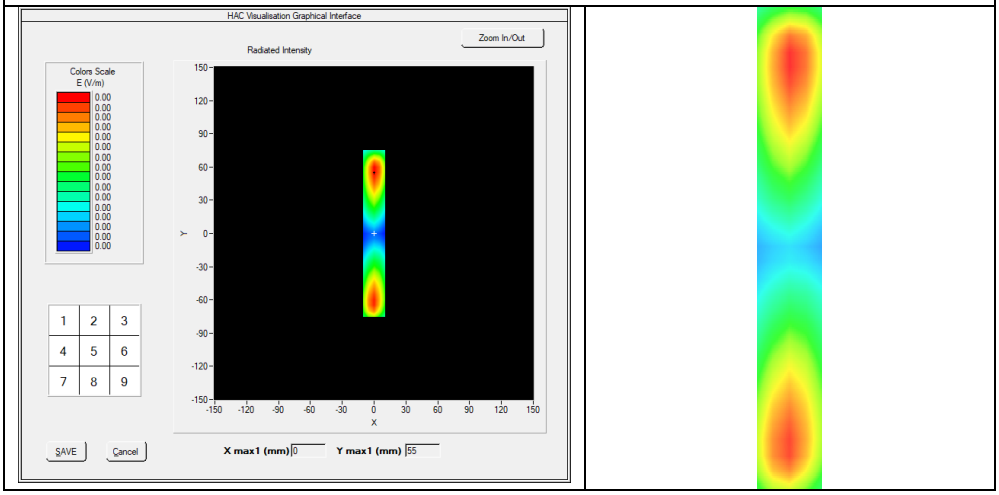
Measurement Condition

Software Version	OpenHAC V2
HAC positioning ruler	SN 42/09 TABH12
E-Field probe	SN 26/11 EPH32
Distance between dipole and sensor center	10 mm
E-field scan size	X=150mm/Y=20mm
Scan resolution	dx=5mm/dy=5mm
Frequency	835 MHz
Input power	20 dBm
Lab Temperature	20 +/- 1°C
Lab Humidity	30-70%

Measurement Result

	Measured	Internal Requirement
E field (V/m)	223.21	210.0

E-Field measurement



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HAC positioning ruler	MVG	TABH12 SN 42/09	Validated. No cal required.	Validated. No cal required.
COMOHAC Test Bench	Version 2	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rohde & Schwarz ZVM	100203	08/2021	08/2026
Network Analyzer – Calibration kit	Rohde & Schwarz ZV-Z235	101223	07/2022	07/2027
Reference Probe	MVG	EPH32 SN 26/11	02/2025	02/2026
Multimeter	Keithley 2000	4013982	02/2023	02/2026
Signal Generator	Rohde & Schwarz SMB	183277	05/2022	05/2026
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	06/2026
Power Meter	Keysight U2000A	SN: MY62340002	10/2024	10/2027
Directional Coupler	Krytar 158020	131467	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Temperature and Humidity Sensor	Testo 184 H1	44235403	02/2024	02/2027

HAC Reference Dipole Calibration Report

Ref : ACR.148.22.25.BES.A

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MVG COMOHAC REFERENCE DIPOLE

FREQUENCY: 1700-2000MHZ

SERIAL NO.: 0722-DHB70

Calibrated at MVG

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2 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOHAC 1700-2000 MHz REFERENCE DIPOLE
Manufacturer	MVG
Model	SIDB1900
Serial Number	0722-DHB70
Product Condition (new / used)	Used

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

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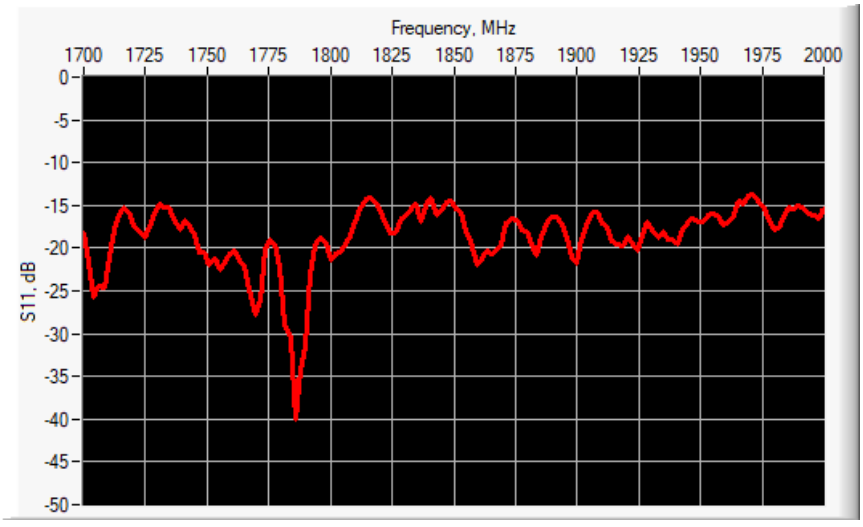
The guideline outlined in the IEEE ANSI C63.19 standard was followed to generate the measurement uncertainty for validation measurements.

The estimated expanded uncertainty (k=2) in calibration for the E-Field measurement in V/m is +/-14% with respect to measurement conditions.

6 CALIBRATION RESULTS

6.1 S11 PARAMETER



Frequency (MHz)	Worst Case S11 parameter (dB)	Requirement (dB)
1700-2000 MHz	-13.64	-10

6.2 E-FIELD

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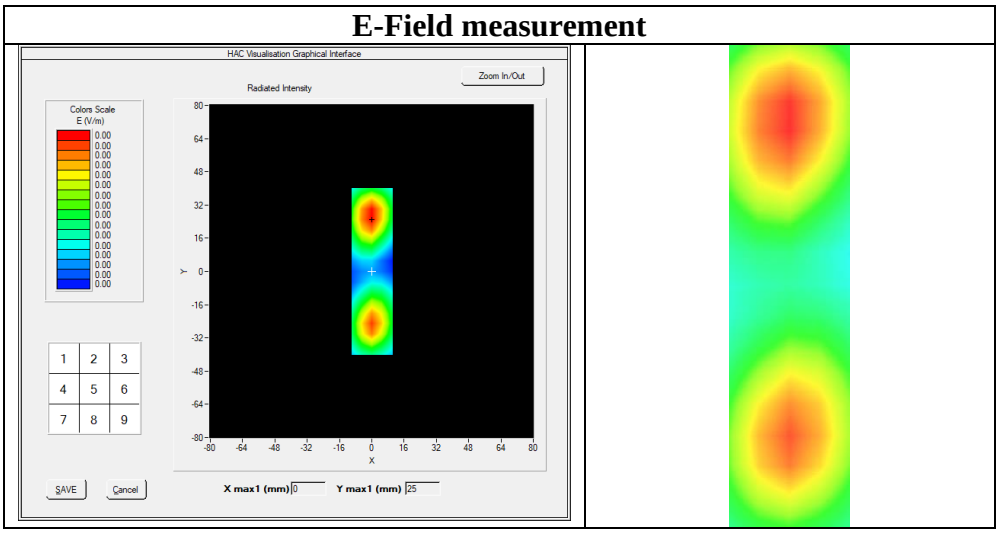
Measurement Condition

Software Version	OpenHAC V2
HAC positioning ruler	SN 42/09 TABH12
E-Field probe	SN 26/11 EPH32
Distance between dipole and sensor center	10 mm
E-field scan size	X=80mm/Y=20mm
Scan resolution	dx=5mm/dy=5mm
Frequency	1900 MHz
Input power	20 dBm
Lab Temperature	20 +/- 1°C
Lab Humidity	30-70%

Measurement Result

	Measured	Internal Requirement
E field (V/m)	151.75	146.1

E-Field measurement



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