



## COMOHAC E-Field Probe Calibration Report

Ref : ACR.262.14.14.SATU.A

**SHENZHEN STS TEST SERVICES CO., LTD.**  
**1/F, BUILDING 2, ZHUOKE SCIENCE PARK, CHONGQING**  
**ROAD**  
**FUYONG, BAO' AN DISTRICT, SHENZHEN, CHINA**  
**SATIMO COMOHAC E-FIELD PROBE**  
**SERIAL NO.: SN 06/14 EPH42**

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



**09/01/2015**

### *Summary:*

This document presents the method and results from an accredited COMOHAC E-Field Probe calibration performed in SATIMO USA using the CALIBAIR test bench, for use with a SATIMO COMOHAC system only. All calibration results are traceable to national metrology institutions.

	<i>Name</i>	<i>Function</i>	<i>Date</i>	<i>Signature</i>
<i>Prepared by :</i>	Jérôme LUC	Product Manager	9/19/2014	<i>JS</i>
<i>Checked by :</i>	Jérôme LUC	Product Manager	9/19/2014	<i>JS</i>
<i>Approved by :</i>	Kim RUTKOWSKI	Quality Manager	9/19/2014	<i>Kim Rutkowski</i>

	<i>Customer Name</i>
<i>Distribution :</i>	Shenzhen STS Test Services Co., Ltd.

<i>Issue</i>	<i>Date</i>	<i>Modifications</i>
A	9/19/2014	Initial release

---

## 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 .....	4
3.3	Isotropy .....	5
3.4	Probe Modulation Response .....	5
4	Measurement Uncertainty .....	5
5	Calibration Measurement Results .....	5
5.1	Sensitivity in air .....	6
5.2	Linearity .....	7
5.3	Isotropy .....	7
6	List of Equipment .....	8

## 1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOHAC E FIELD PROBE
Manufacturer	Satimo
Model	SCE
Serial Number	SN 06/14 EPH42
Product Condition (new / used)	new
Frequency Range of Probe	0.7GHz-2.5GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.214 MΩ Dipole 2: R2=0.213 MΩ Dipole 3: R3=0.204 MΩ

A yearly calibration interval is recommended.

## 2 PRODUCT DESCRIPTION

### 2.1 GENERAL INFORMATION

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



**Figure 1 – Satimo 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 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).

### 3.2 SENSITIVITY

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

### 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.

### 3.4 PROBE MODULATION RESPONSE

The modulation factor was determined by illuminating the probe with a reference wave from a standard dipole 10 mm away, applying first a CW signal and then a modulated signal (both at same power level). The modulation factor is the ratio, in linear units, of the CW to modulated signal reading.

## 4 MEASUREMENT UNCERTAINTY

The guidelines outlined in the IEEE 1528 and IEC/CEI 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 (%)
Incident or forward power	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Reflected power	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Field homogeneity	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Field probe positioning	5.00%	Rectangular	$\sqrt{3}$	1	2.887%
Field probe linearity	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
<b>Combined standard uncertainty</b>					4.509%
<b>Expanded uncertainty</b> 95 % confidence level k = 2					9.0%

## 5 CALIBRATION MEASUREMENT RESULTS

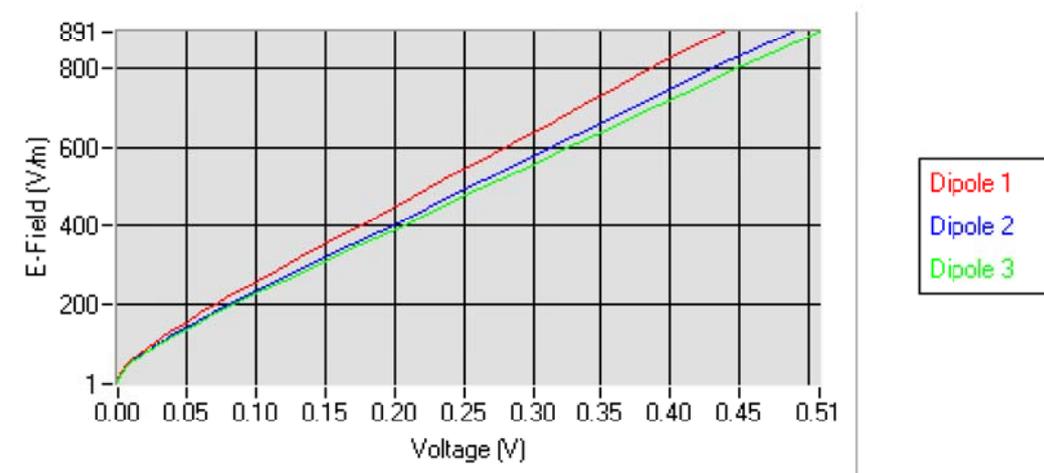
Calibration Parameters	
Lab Temperature	21 °C
Lab Humidity	45 %

5.1 SENSITIVITY IN AIR

Normx dipole 1 ( $\mu\text{V}/(\text{V}/\text{m})^2$ )	Normy dipole 2 ( $\mu\text{V}/(\text{V}/\text{m})^2$ )	Normz dipole 3 ( $\mu\text{V}/(\text{V}/\text{m})^2$ )
3.06	3.86	4.00

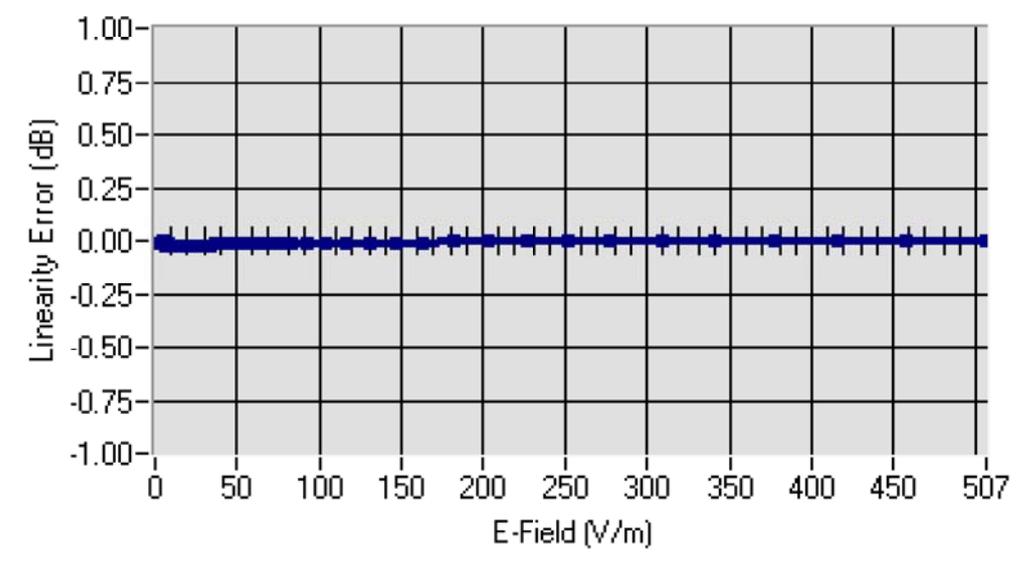
DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
96	92	96

Calibration curves



5.2 LINEARITY

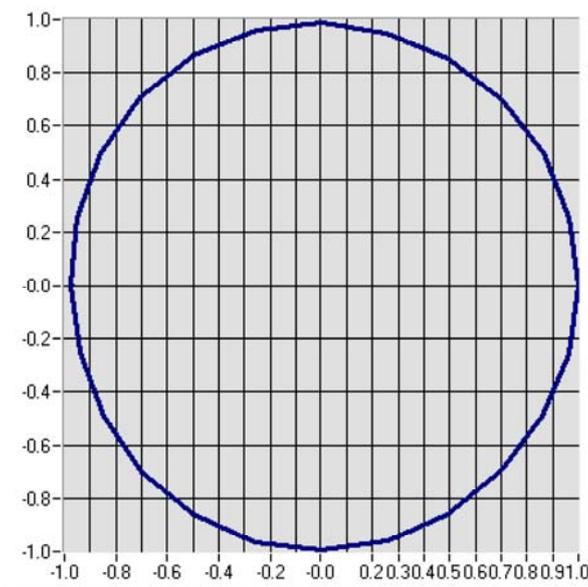
Linearity



Linearity: ±0.68% (±0.03dB)

5.3 ISOTROPY

Isotropy curve



Isotropy: ±1.32% (±0.06dB)

**6 LIST OF EQUIPMENT**

Equipment Summary Sheet				
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
HAC positioning ruler	Satimo	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	Rhode & Schwarz ZVA	SN100132	02/2014	02/2017
Reference Probe	Satimo	EPH28 SN 08/11	10/2014	10/2015
Reference Probe	Satimo	HPH38 SN31/10	10/2014	10/2015
Multimeter	Keithley 2000	1188656	12/2014	12/2017
Signal Generator	Agilent E4438C	MY49070581	12/2014	12/2017
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	12/2014	12/2017
Power Sensor	HP ECP-E26A	US37181460	12/2014	12/2017
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	Control Company	11-661-9	8/2013	8/2016



## HAC Reference Dipole Calibration Report

Ref : ACR.262.17.14.SATU.A

**SHENZHEN STS TEST SERVICES CO., LTD.**  
**1/F, BUILDING 2, ZHUOKE SCIENCE PARK, CHONGQING**  
**ROAD**  
**FUYONG, BAO' AN DISTRICT, SHENZHEN, CHINA**  
**SATIMO COMOHAC REFERENCE DIPOLE**  
**FREQUENCY: 800-950MHZ**  
**SERIAL NO.: SN 13/14 DHA55**

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



09/01/2015

### *Summary:*

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

	<i>Name</i>	<i>Function</i>	<i>Date</i>	<i>Signature</i>
<i>Prepared by :</i>	Jérôme LUC	Product Manager	9/19/2014	<i>JL</i>
<i>Checked by :</i>	Jérôme LUC	Product Manager	9/19/2014	<i>JL</i>
<i>Approved by :</i>	Kim RUTKOWSKI	Quality Manager	9/19/2014	<i>Kim Rutkowski</i>

	<i>Customer Name</i>
<i>Distribution :</i>	Shenzhen STS Test Services Co., Ltd.

<i>Issue</i>	<i>Date</i>	<i>Modifications</i>
A	9/19/2014	Initial release

**TABLE OF CONTENTS**

1	Introduction.....	4
2	Device Under TEst.....	4
3	Product Description .....	4
3.1	General Information _____	4
4	Measurement Method .....	4
4.1	Return Loss Requirements _____	5
4.2	Reference Dipole Calibration _____	5
5	Measurement Uncertainty.....	5
5.1	Return Loss _____	5
5.2	Validation Measurement _____	5
6	Calibration Measurement Results.....	6
6.1	Return Loss _____	6
6.2	Validation measurement _____	6
7	List of Equipment .....	8

## 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

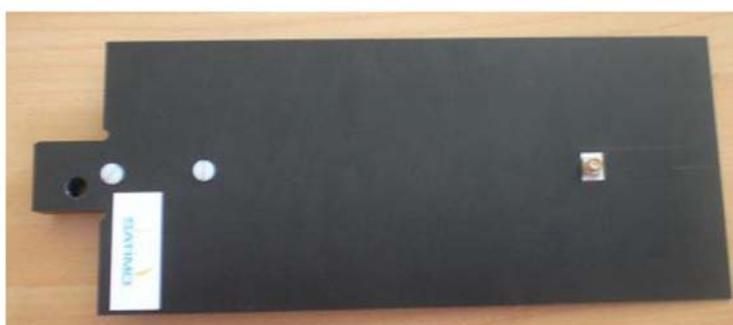
Device Under Test	
Device Type	COMOHAC 800-950 MHz REFERENCE DIPOLE
Manufacturer	Satimo
Model	SIDB835
Serial Number	SN 13/14 DHA55
Product Condition (new / used)	New

A yearly calibration interval is recommended.

## 3 PRODUCT DESCRIPTION

### 3.1 GENERAL INFORMATION

Satimo’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 – Satimo 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.

#### 4.1 RETURN LOSS 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.

#### 4.2 REFERENCE DIPOLE CALIBRATION

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

### 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 Gain
400-6000MHz	0.1 dB

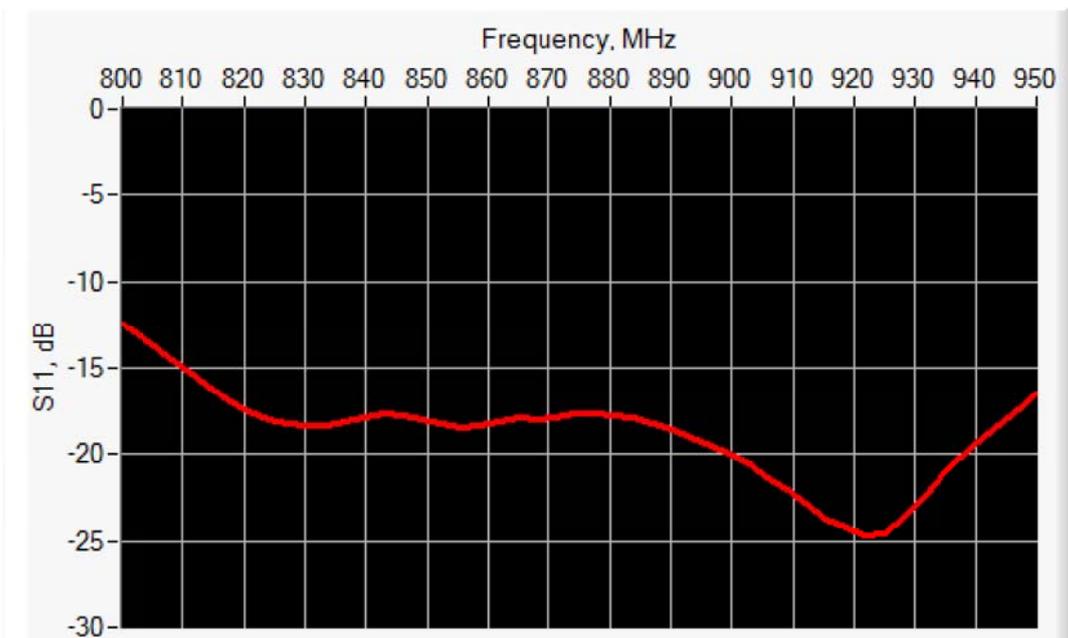
#### 5.2 VALIDATION MEASUREMENT

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

Uncertainty analysis of the probe calibration in waveguide					
ERROR SOURCES	Uncertainty value (%)	Probability Distribution	Divisor	Uncertainty (dB)	Standard Uncertainty (%)
RF reflections	0.1	R	$\sqrt{3}$	0.06	
Field probe conv. Factor	0.4	R	$\sqrt{3}$	0.23	
Field probe anisotropy	0.25	R	$\sqrt{3}$	0.14	
Positioning accuracy	0.2	R	$\sqrt{3}$	0.12	
Probe cable placement	0.1	R	$\sqrt{3}$	0.06	
System repeatability	0.2	R	$\sqrt{3}$	0.12	
EUT repeatability	0.4	N	1	0.40	
<b>Combined standard uncertainty</b>				0.52	
<b>Expanded uncertainty</b> 95 % confidence level k = 2				1.00	13.0

## 6 CALIBRATION MEASUREMENT RESULTS

### 6.1 RETURN LOSS



Frequency (MHz)	Worst Case Return Loss (dB)	Requirement (dB)
800-950 MHz	-12.94	-10

### 6.2 VALIDATION MEASUREMENT

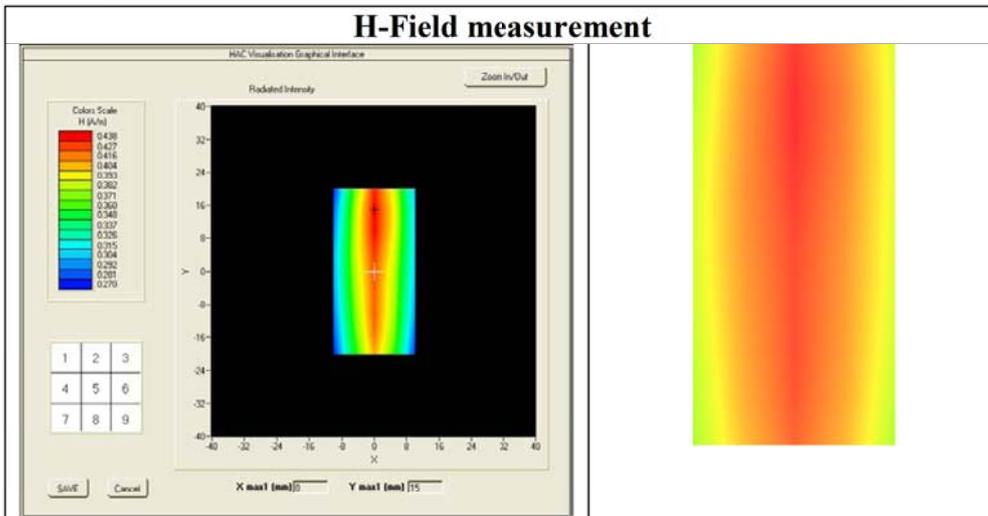
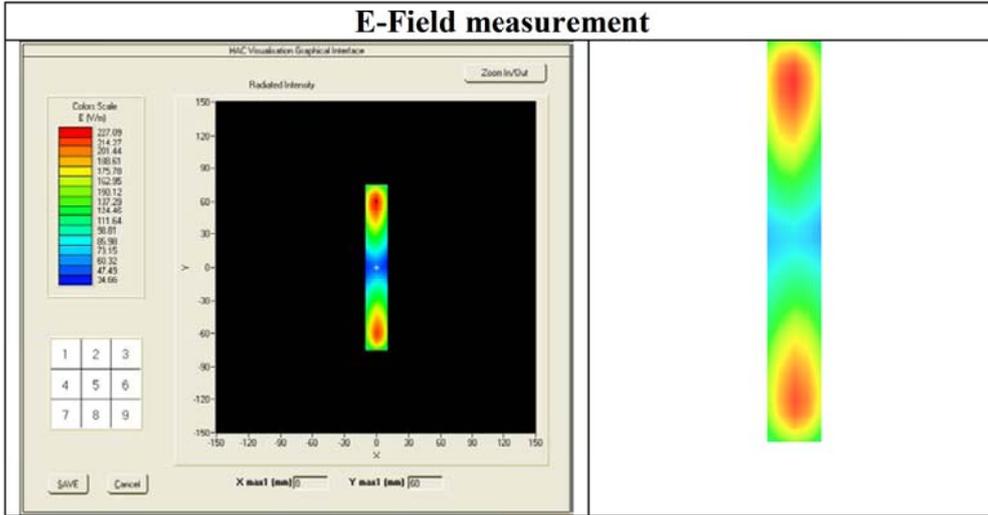
The IEEE ANSI C63.19 standard states that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss requirements. The system validations measurement results are then compared to SATIMO’s simulated results.

#### Measurement Condition

Software Version	OpenHAC V2
HAC positioning ruler	SN 42/09 TABH12
E-Field probe	SN 08/11 EPH28
H-Field probe	SN 31/10 HPH38
Distance between dipole and sensor center	10 mm
E-field scan size	X=150mm/Y=20mm
H-field scan size	X=40mm/Y=20mm
Scan resolution	dx=5mm/dy=5mm
Frequency	835 MHz
Input power	20 dBm
Lab Temperature	21°C
Lab Humidity	45%

**Measurement Result**

	Measured	Internal Requirement
<b>E field (V/m)</b>	227.09	220.4
<b>H field (A/m)</b>	0.44	0.445



7 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
HAC positioning ruler	Satimo	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	Rhode & Schwarz ZVA	SN100132	02/2014	02/2017
Reference Probe	Satimo	EPH28 SN 08/11	10/2014	10/2015
Reference Probe	Satimo	HPH38 SN31/10	10/2014	10/2015
Multimeter	Keithley 2000	1188656	12/2014	12/2017
Signal Generator	Agilent E4438C	MY49070581	12/2014	12/2017
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	12/2014	12/2016
Power Sensor	HP ECP-E26A	US37181460	12/2014	12/2016
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	8/2013	8/2015



## HAC Reference Dipole Calibration Report

Ref : ACR.262.18.14.SATU.A

**SHENZHEN STS TEST SERVICES CO., LTD.**  
**1/F, BUILDING 2, ZHUOKE SCIENCE PARK, CHONGQING**  
**ROAD**  
**FUYONG, BAO' AN DISTRICT, SHENZHEN, CHINA**  
**SATIMO COMOHAC REFERENCE DIPOLE**  
**FREQUENCY: 1700-2000MHZ**  
**SERIAL NO.: SN 13/14 DHB59**

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



09/01/2015

### *Summary:*

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

	<i>Name</i>	<i>Function</i>	<i>Date</i>	<i>Signature</i>
<i>Prepared by :</i>	Jérôme LUC	Product Manager	9/19/2014	<i>JL</i>
<i>Checked by :</i>	Jérôme LUC	Product Manager	9/19/2014	<i>JL</i>
<i>Approved by :</i>	Kim RUTKOWSKI	Quality Manager	9/19/2014	<i>Kim Rutkowski</i>

	<i>Customer Name</i>
<i>Distribution :</i>	Shenzhen STS Test Services Co., Ltd.

<i>Issue</i>	<i>Date</i>	<i>Modifications</i>
A	9/19/2014	Initial release

---

## TABLE OF CONTENTS

1	Introduction.....	4
2	Device Under TEst.....	4
3	Product Description .....	4
3.1	General Information _____	4
4	Measurement Method .....	4
4.1	Return Loss Requirements _____	5
4.2	Reference Dipole Calibration _____	5
5	Measurement Uncertainty.....	5
5.1	Return Loss _____	5
5.2	Validation Measurement _____	5
6	Calibration Measurement Results.....	6
6.1	Return Loss _____	6
6.2	Validation measurement _____	6
7	List of Equipment .....	8

## 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 1700-2000 MHz REFERENCE DIPOLE
Manufacturer	Satimo
Model	SIDB1900
Serial Number	SN 13/14 DHB59
Product Condition (new / used)	New

A yearly calibration interval is recommended.

## 3 PRODUCT DESCRIPTION

### 3.1 GENERAL INFORMATION

Satimo'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** – Satimo 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.

4.1 RETURN LOSS 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.

4.2 REFERENCE DIPOLE CALIBRATION

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

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 Gain
400-6000MHz	0.1 dB

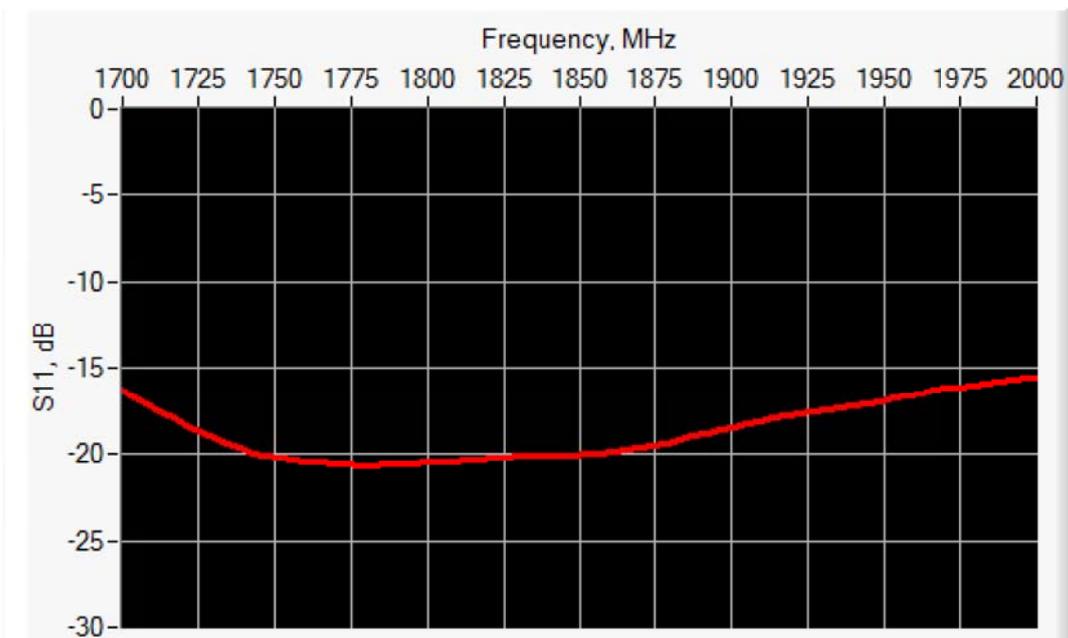
5.2 VALIDATION MEASUREMENT

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

Uncertainty analysis of the probe calibration in waveguide					
ERROR SOURCES	Uncertainty value (%)	Probability Distribution	Divisor	Uncertainty (dB)	Standard Uncertainty (%)
RF reflections	0.1	R	$\sqrt{3}$	0.06	
Field probe conv. Factor	0.4	R	$\sqrt{3}$	0.23	
Field probe anisotropy	0.25	R	$\sqrt{3}$	0.14	
Positioning accuracy	0.2	R	$\sqrt{3}$	0.12	
Probe cable placement	0.1	R	$\sqrt{3}$	0.06	
System repeatability	0.2	R	$\sqrt{3}$	0.12	
EUT repeatability	0.4	N	1	0.40	
<b>Combined standard uncertainty</b>				0.52	
<b>Expanded uncertainty</b> 95 % confidence level k = 2				1.00	13.0

## 6 CALIBRATION MEASUREMENT RESULTS

### 6.1 RETURN LOSS



Frequency (MHz)	Worst Case Return Loss (dB)	Requirement (dB)
1700-2000 MHz	-15.74	-10

### 6.2 VALIDATION MEASUREMENT

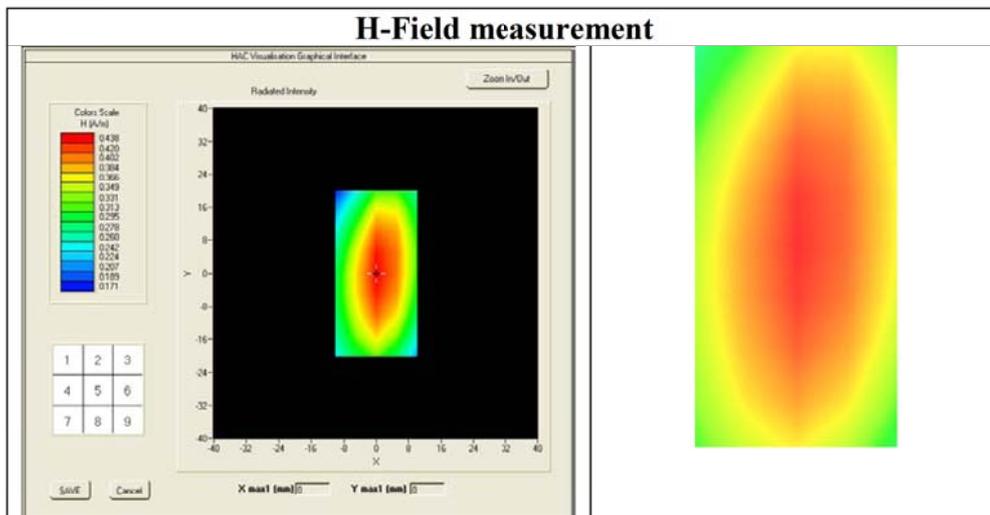
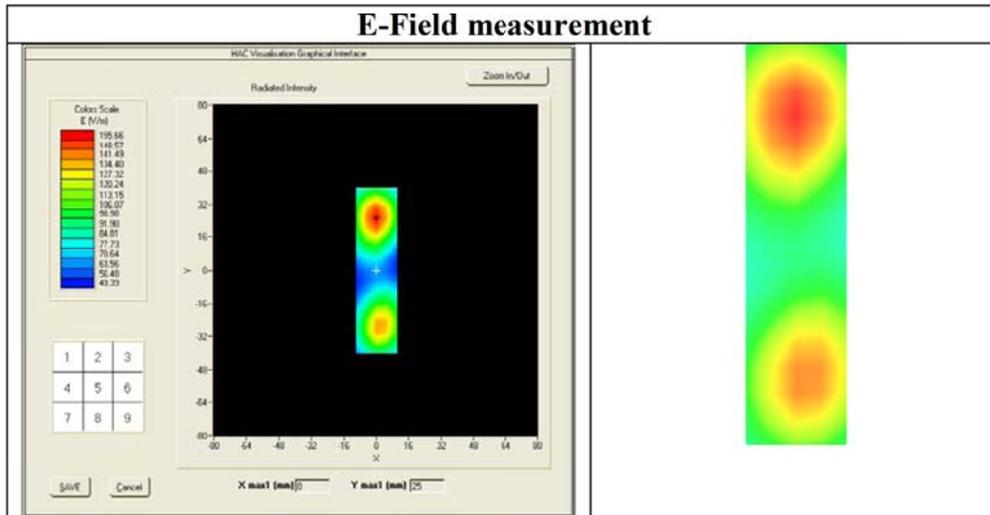
The IEEE ANSI C63.19 standard states that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss requirements. The system validations measurement results are then compared to SATIMO’s simulated results.

#### Measurement Condition

Software Version	OpenHAC V2
HAC positioning ruler	SN 42/09 TABH12
E-Field probe	SN 08/11 EPH28
H-Field probe	SN 31/10 HPH38
Distance between dipole and sensor center	10 mm
E-field scan size	X=150mm/Y=20mm
H-field scan size	X=40mm/Y=20mm
Scan resolution	dx=5mm/dy=5mm
Frequency	1900 MHz
Input power	20 dBm
Lab Temperature	21°C
Lab Humidity	45%

**Measurement Result**

	Measured	Internal Requirement
<b>E field (V/m)</b>	155.66	153.4
<b>H field (A/m)</b>	0.44	0.445



7 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
HAC positioning ruler	Satimo	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	Rhode & Schwarz ZVA	SN100132	02/2014	02/2017
Reference Probe	Satimo	EPH28 SN 08/11	10/2014	10/2015
Reference Probe	Satimo	HPH38 SN31/10	10/2014	10/2015
Multimeter	Keithley 2000	1188656	12/2014	12/2017
Signal Generator	Agilent E4438C	MY49070581	12/2014	12/2017
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	12/2014	12/2017
Power Sensor	HP ECP-E26A	US37181460	12/2014	12/2017
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	8/2013	8/2016



## COMOHAC TMFS Calibration Report

Ref : ACR.262.19.14.SATU.A

**SHENZHEN STS TEST SERVICES CO., LTD.**  
**1/F, BUILDING 2, ZHUOKE SCIENCE PARK, CHONGQING**  
**ROAD**  
**FUYONG, BAO' AN DISTRICT, SHENZHEN, CHINA**  
**SATIMO COMOHAC MAGNETIC FIELD**  
**SIMULATOR**  
**SERIAL NO.: SN 07/14 TMFS24**

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



**09/01/2015**

### *Summary:*

This document presents the method and results from an accredited COMOHAC TMFS calibration performed in SATIMO USA using the COMOHAC test bench, for use with a SATIMO COMOHAC system only. All calibration results are traceable to national metrology institutions.

	<i>Name</i>	<i>Function</i>	<i>Date</i>	<i>Signature</i>
<i>Prepared by :</i>	Jérôme LUC	Product Manager	9/19/2014	<i>JLS</i>
<i>Checked by :</i>	Jérôme LUC	Product Manager	9/19/2014	<i>JLS</i>
<i>Approved by :</i>	Kim RUTKOWSKI	Quality Manager	9/19/2014	<i>Kim Rutkowski</i>

	<i>Customer Name</i>
<i>Distribution :</i>	Shenzhen STS Test Services Co., Ltd.

<i>Issue</i>	<i>Date</i>	<i>Modifications</i>
A	9/19/2014	Initial release

**TABLE OF CONTENTS**

1 Device Under Test ..... 4

2 Product Description ..... 4

    2.1 General Information ..... 4

3 Measurement Method ..... 4

    3.1 Maximum Axial and Radial Magnetic Field Values ..... 4

4 Measurement Uncertainty ..... 4

5 Calibration Measurement Results ..... 5

    5.1 Maximum Axial and Radial Magnetic Field Values ..... 5

6 List of Equipment ..... 7

## 1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOHAC Magnetic Field Simulator
Manufacturer	Satimo
Model	STMFS
Serial Number	SN 07/14 TMFS24
Product Condition (new / used)	New
Frequency Range	200-5000 Hz

A yearly calibration interval is recommended.

## 2 PRODUCT DESCRIPTION

### 2.1 GENERAL INFORMATION

Satimo’s COMOHAC T-coil Probes are built in accordance to the ANSI C63.19 and ANSI S3.22-2003 standards.



**Figure 1** – *Satimo COMOHAC Magnetic Field Simulator*

## 3 MEASUREMENT METHOD

All methods used to perform the measurements and calibrations comply with the ANSI C63.19. All measurements were performed with the TMFS in the standard device test configuration, with the TMFS in free space, 10 mm below the coil center.

### 3.1 MAXIMUM AXIAL AND RADIAL MAGNETIC FIELD VALUES

An audio signal was fed into the TMFS and the magnetic field measured and recorded over an area scan with the T-coil probe in three orientations; axial and two radial. The maximum magnetic field is recorded for all three T-coil orientations.

## 4 MEASUREMENT UNCERTAINTY

The guideline outlined in the IEEE ANSI C63.19 standard was followed to generate the measurement uncertainty for validation measurements. 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 Helmholtz Coil					
Uncertainty Component	Tol. (± dB)	Prob. Dist.	Div.	Uncertainty (dB)	Uncertainty (%)
Reflections	0.1	R	$\sqrt{3}$	0.06	
Acoustic noise	0.1	R	$\sqrt{3}$	0.06	
Probe coil sensitivity	0.49	R	$\sqrt{3}$	0.28	
Reference signal level	0.25	R	$\sqrt{3}$	0.14	
Positioning accuracy	0.2	R	$\sqrt{3}$	0.12	
Cable loss	0.1	N	1	0.05	
Frequency analyzer	0.15	R	$\sqrt{3}$	0.09	
System repeatability	0.2	N	1	0.20	
Repeatability of the WD	0.1	N	1	0.10	
<b>Combined standard uncertainty</b>		N	1	0.43	
<b>Expanded uncertainty</b> 95 % confidence level k = 2		N	2	0.85	10.3%

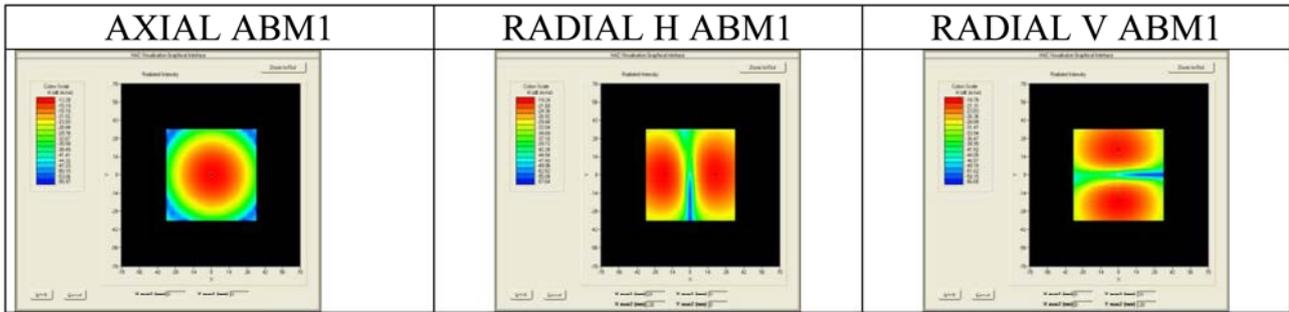
## 5 CALIBRATION MEASUREMENT RESULTS

Calibration Parameters	
Software	OpenHAC V2
HAC positioning ruler	SN 42/09 TABH12
T-Coil probe	SN 47/10 TCP18
Distance between TMFS and coil center	10 mm
Frequency	1025 Hz
Scan Size	X=70mm/Y=70mm
Scan Resolution	dx=5mm/dy=5mm
Output level	0.5 VAC
Lab Temperature	21°C
Lab Humidity	45%

### 5.1 MAXIMUM AXIAL AND RADIAL MAGNETIC FIELD VALUES

Test Description	Measured Magnetic Field	
	Location	Intensity (dB A/m)
Axial	Max	-12.06
Radial H	Right side	-19.27
	Left side	-19.03

Radial V	Upper side	-19.12
	Lower side	-18.56



**6 LIST OF EQUIPMENT**

Equipment Summary Sheet				
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
COMOHAC Test Bench	Version 2	NA	Validated. No cal required.	Validated. No cal required.
HAC positioning ruler	Satimo	TABH12 SN 42/09	Validated. No cal required.	Validated. No cal required.
Audio Generator	National Instruments	15222AE	01/2015	01/2018
Reference Probe	Satimo	TCP 18 SN 47/10	10/2014	10/2015
Multimeter	Keithley 2000	1188656	12/2014	12/2017
Temperature / Humidity Sensor	Control Company	11-661-9	8/2013	8/2016