



3.3 SIGNAL TO NOISE MEASUREMENT OF THE CALIBRATION SYSTEM

The T-coil probe was positioned within the Helmholtz coil in axial orientation. The audio generator connected to the input of the Helmholtz coil was adjusted to obtain a field of -50 dB A/m. The T-coil reading was recorded. The audio generator is then turned off and the T-coil reading recorded.

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 T-coil probe calibration					
Uncertainty Component	Tol. ($\pm$ dB)	Prob. Dist.	Div.	Uncertainty (dB)	Uncertainty (%)
Current/Voltage Accuracy	0.224	R	$\sqrt{3}$	0.13	
Acoustic/ Signal Source drift	0.008	R	$\sqrt{3}$	0.00	
Probe coil sensitivity	0.2	R	$\sqrt{3}$	0.12	
Positioning accuracy	0.4	R	$\sqrt{3}$	0.23	
Acoustic Signal Receive Accuracy	0.03	R	$\sqrt{3}$	0.02	
Acoustic Signal Receive Linearity	0.006	R	$\sqrt{3}$	0.00	
System repeatability	0.4	N	1	0.40	
Combined Standard Uncertainty		N	1	0.49	
Expanded uncertainty (confidence level of 95%, $k = 2$)		N	$k=2$	1.00	12.0

5 CALIBRATION MEASUREMENT RESULTS

Calibration Parameters	
Lab Temperature	21°C
Lab Humidity	45%

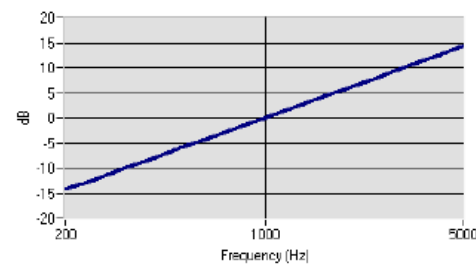
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5.1 SENSITIVITY

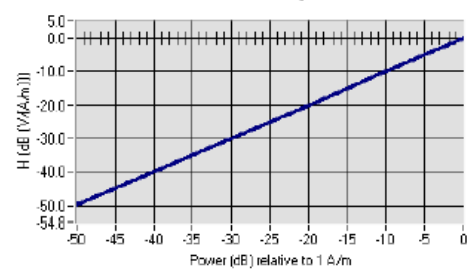
Probe coil sensitivity relative to sensitivity at 1000 Hz



	Measured	Required
Sensitivity at 1 kHz	-60.20 dB (V/A/m)	-60.5 +/- 0.5 dB (V/A/m)
Max. deviation from Sensitivity	0.40 dB	+/- 0.5 dB

5.2 LINEARITY

Linearity



	Measured	Required
Linearity Slope	0.16 dB	+/- 0.5 dB

5.3 SIGNAL TO NOISE MEASUREMENT OF THE CALIBRATION SYSTEM

	Measured	Required
Signal to Noise	-64.23 dB A/m	'Reading with -50 dB A/m in coil' – 'no signal applied' > 10 dB

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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.
Audio Generator	National Instruments	15222AE	01/2011	01/2014
Reference Probe	Satimo	TCP 18 SN 47/10	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Multimeter	Keithley 2000	1188656	11/2010	11/2013
Helmholtz Coil	Satimo	HC07 SN47/10	Validated. No cal required.	Validated. No cal required.
Temperature / Humidity Sensor	Control Company	11-661-9	3/2012	3/2014

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SIDB835 Dipole Calibration Certificate**HAC Reference Dipole Calibration Report**

Ref: ACR.96.13.13.SATU.A

**CCIC SOUTHERN ELECTRONIC PRODUCT TESTING
(SHENZHEN) CO.,LTD**

**ELECTRONIC TESTING BUILDING,SHAHE ROAD, XILI
TOWN SHENZHEN,P.R.CHINA**

**SATIMO COMOHAC REFERENCE DIPOLE
FREQUENCY: 800-950MHZ**

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

**04/05/13***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.



HAC REFERENCE DIPOLE CALIBRATION REPORT

Ref ACR.96.13.13.SATU.A

	<i>Name</i>	<i>Function</i>	<i>Date</i>	<i>Signature</i>
<i>Prepared by :</i>	Jérôme LUC	Product Manager	4/5/2013	<i>JS</i>
<i>Checked by :</i>	Jérôme LUC	Product Manager	4/5/2013	<i>JS</i>
<i>Approved by :</i>	Kim RUTKOWSKI	Quality Manager	4/5/2013	<i>Kim Rutkowski</i>

	<i>Customer Name</i>
<i>Distribution :</i>	Shenzhen EMC-united Co., Ltd

<i>Issue</i>	<i>Date</i>	<i>Modifications</i>
A	4/5/2013	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	Satimo
Model	SIDB835
Serial Number	SN 18/12 DHA37
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.

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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	
Combined standard uncertainty				0.52	
Expanded uncertainty 95 % confidence level $k = 2$				1.00	13.0

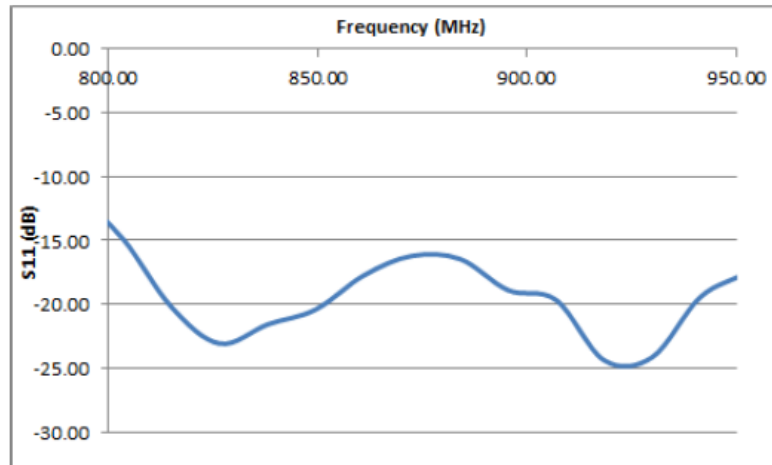
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6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS



Frequency (MHz)	Worst Case Return Loss (dB)	Requirement (dB)
800-950 MHz	-14.85	-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%

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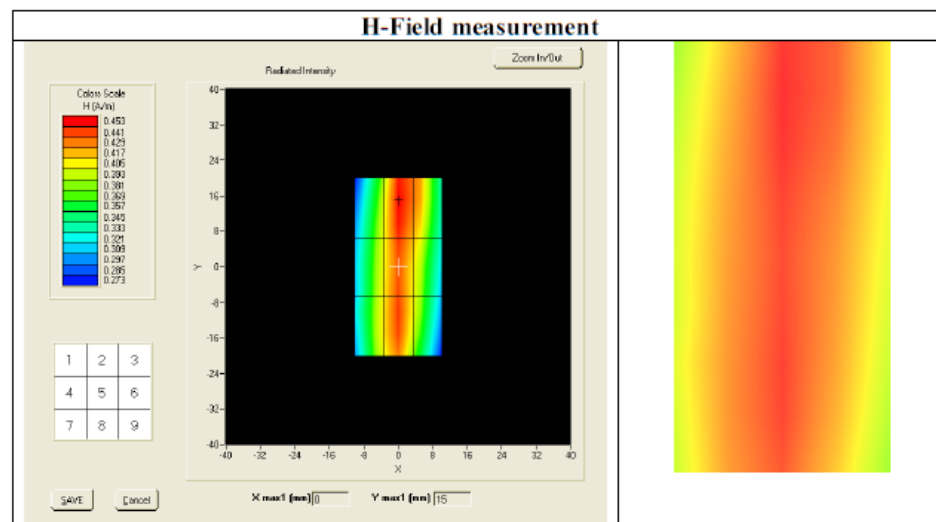
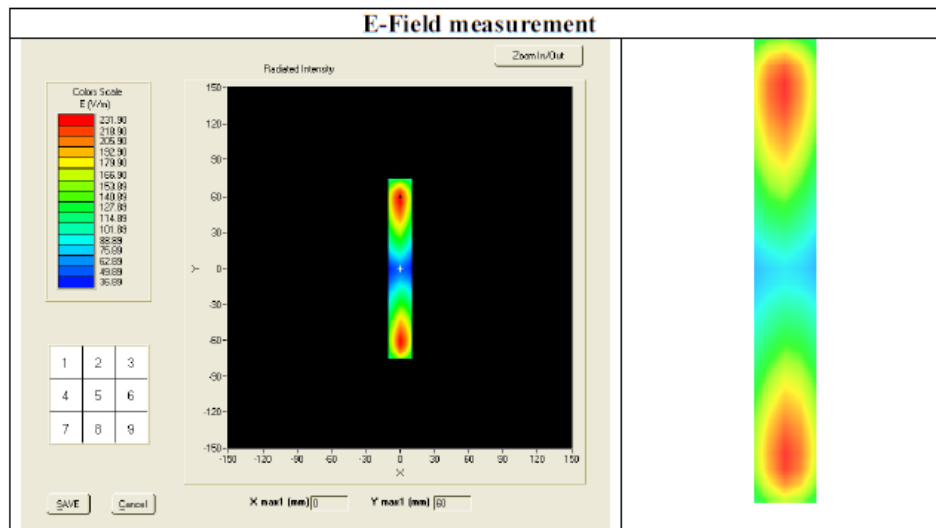


HAC REFERENCE DIPOLE CALIBRATION REPORT

Ref. ACR.96.13.13.SATU.A

Measurement Result

	Measured	Internal Requirement
E field (V/m)	231.90	220.4
H field (A/m)	0.45	0.445



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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	02/2013	02/2016
Reference Probe	Satimo	EPH28 SN 08/11	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Reference Probe	Satimo	HPH38 SN31/10	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Multimeter	Keithley 2000	1188656	11/2010	11/2013
Signal Generator	Agilent E4438C	MY49070581	12/2010	12/2013
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	11/2010	11/2013
Power Sensor	HP ECP-E26A	US37181460	11/2010	11/2013
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	3/2012	3/2014

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SIDB1900 Dipole Calibration Certificate**HAC Reference Dipole Calibration Report**

Ref: ACR.96.14.13.SATU.A

**CCIC SOUTHERN ELECTRONIC PRODUCT TESTING
(SHENZHEN) CO.,LTD
ELECTRONIC TESTING BUILDING,SHAHE ROAD, XILI
TOWN SHENZHEN,P.R.CHINA
SATIMO COMOHAC REFERENCE DIPOLE
FREQUENCY: 1700-2000MHZ**

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

**04/05/13***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.



HAC REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.96.14.13.SATU.A

	<i>Name</i>	<i>Function</i>	<i>Date</i>	<i>Signature</i>
<i>Prepared by :</i>	Jérôme LUC	Product Manager	4/5/2013	<i>JS</i>
<i>Checked by :</i>	Jérôme LUC	Product Manager	4/5/2013	<i>JS</i>
<i>Approved by :</i>	Kim RUTKOWSKI	Quality Manager	4/5/2013	<i>Kim Rutkowski</i>

	<i>Customer Name</i>
<i>Distribution :</i>	Shenzhen EMC-united Co., Ltd

<i>Issue</i>	<i>Date</i>	<i>Modifications</i>
A	4/5/2013	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 1700-2000 MHz REFERENCE DIPOLE
Manufacturer	Satimo
Model	SIDB1900
Serial Number	SN 18/12 DHB42
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.

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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	
Combined standard uncertainty				0.52	
Expanded uncertainty 95 % confidence level $k = 2$				1.00	13.0

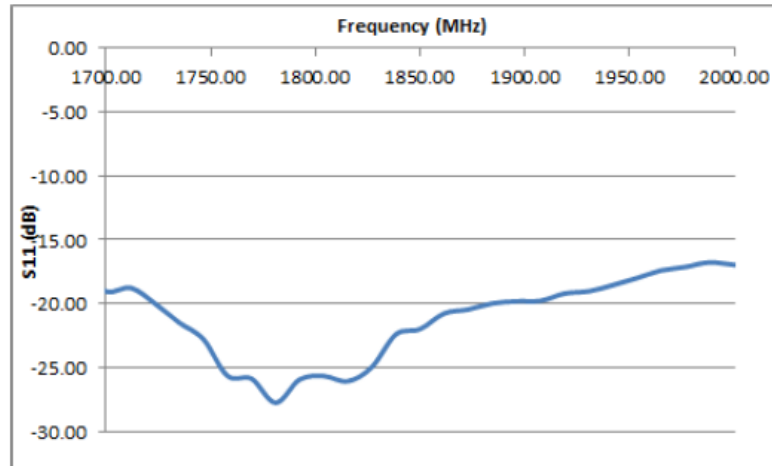
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6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS



Frequency (MHz)	Worst Case Return Loss (dB)	Requirement (dB)
1700-2000 MHz	-16.77	-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%

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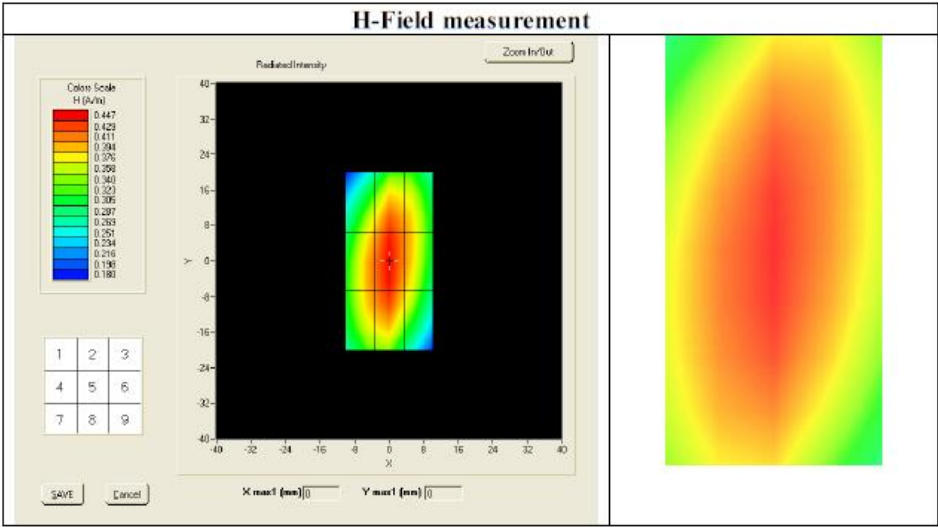
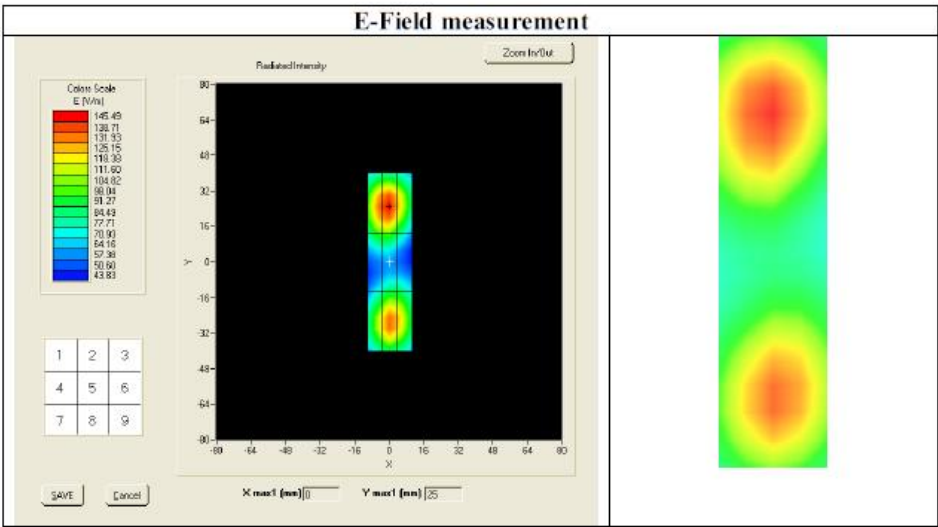


HAC REFERENCE DIPOLE CALIBRATION REPORT

Ref. ACR.96.14.13.SAT.U.A

Measurement Result

	Measured	Internal Requirement
E field (V/m)	145.49	153.4
H field (A/m)	0.45	0.445





HAC REFERENCE DIPOLE CALIBRATION REPORT

Ref ACR.96.14.13.SATU.A

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	02/2013	02/2016
Reference Probe	Satimo	EPH28 SN 08/11	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Reference Probe	Satimo	HPH38 SN31/10	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Multimeter	Keithley 2000	1188656	11/2010	11/2013
Signal Generator	Agilent E4438C	MY49070581	12/2010	12/2013
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	11/2010	11/2013
Power Sensor	HP ECP-E26A	US37181460	11/2010	11/2013
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	3/2012	3/2014

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TMFS Calibration Certificate



COMOHAC TMFS Calibration Report

Ref: ACR.96.15.13.SATU.A

**CCIC SOUTHERN ELECTRONIC PRODUCT TESTING
(SHENZHEN) CO.,LTD
ELECTRONIC TESTING BUILDING,SHAHE ROAD, XILI
SHENZHEN,P.R.CHINA
SATIMO COMOHAC MAGNETIC FIELD
SIMULATOR
SERIAL NO.: SN 22/12 TMFS15**

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



04/05/13

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.



COMOHAC TMFS' PROBE CALIBRATION REPORT

Ref ACR.90.15.11.SATU.A

	<i>Name</i>	<i>Function</i>	<i>Date</i>	<i>Signature</i>
<i>Prepared by :</i>	Jérôme LUC	Product Manager	4/5/2013	
<i>Checked by :</i>	Jérôme LUC	Product Manager	4/5/2013	
<i>Approved by :</i>	Kim RUTKOWSKI	Quality Manager	4/5/2013	

	<i>Customer Name</i>
<i>Distribution :</i>	Shenzhen EMC-united Co., Ltd

<i>Issue</i>	<i>Date</i>	<i>Modifications</i>
A	4/5/2013	Initial release

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1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOHAC Magnetic Field Simulator
Manufacturer	Satimo
Model	TMFS
Serial Number	SN 22/12 TMFS15
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.

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COMOHACTMFS' PROBE CALIBRATION REPORT

Ref. ACR.90.15.11.SATU.A

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	
Combined standard uncertainty		N	1	0.43	
Expanded uncertainty 95 % confidence level k = 2		N	2	0.85	10.3%

5 CALIBRATION MEASUREMENT RESULTS

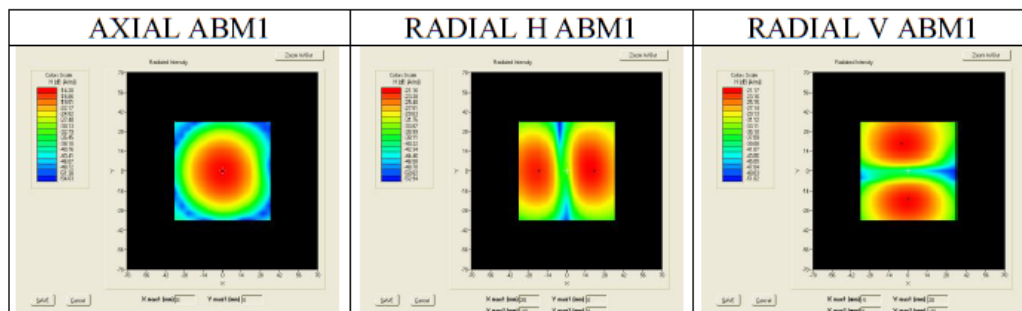
Calibration Parameters	
Software	OpenHAC V2
HAC positioning ruler	SN 42/09 TABH12
T-Coil probe	SN 47/10 TCP18
Distance between TMFS and coil center	10 mm
Frequency	1025 Hz
Scan Size	X=70mm/Y=70mm
Scan Resolution	dx=5mm/dy=5mm
Output level	0.5 VAC
Lab Temperature	21°C
Lab Humidity	45%

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5.1 MAXIMUM AXIAL AND RADIAL MAGNETIC FIELD VALUES

Test Description	Measured Magnetic Field	
	Location	Intensity (dB A/m)
Axial	Max	-13.99
Radial H	Right side	-20.94
	Left side	-21.85
Radial V	Upper side	-20.95
	Lower side	-21.00



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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	01/2011	01/2014
Reference Probe	Satimo	TCP 18 SN 47/10	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Multimeter	Keithley 2000	1188656	11/2010	11/2013
Temperature / Humidity Sensor	Control Company	11-661-9	3/2012	3/2014

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————End of the Report————