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## COMOHAC H-FIELD PROBE CALIBRATION REPORT

Ref. ACR.96.11.13.SATU.A

## 1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOHAC H FIELD PROBE
Manufacturer	Satimo
Model	SCH
Serial Number	SN 02/12 HPH45
Product Condition (new / used)	New
Frequency Range of Probe	0.7GHz-2.5GHz
Resistance of Three Loops at Connector	Loop 1: R1=0.296 MΩ Loop 2: R2=0.459 MΩ Loop 3: R3=0.271 MΩ

A yearly calibration interval is recommended.

## 2 PRODUCT DESCRIPTION

2.1 GENERAL INFORMATION

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



Figure 1 – Satimo COMOHAC H field Probe

Probe Length	330 mm
Dimension of one loop	3.3 mm
Maximum external diameter	8 mm
Probe Tip External Diameter	5 mm
Distance between loops / 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 0.01A/m to 2A/m).



## COMOHAC H-FIELD PROBE CALIBRATION REPORT

Ref. ACR.96.11.13.SATU.A

**3.2 SENSITIVITY**

The sensitivity factors of the three loops 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 H-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> <b>95 % confidence level <math>k = 2</math></b>					9.0%

**5 CALIBRATION MEASUREMENT RESULTS**

Calibration Parameters	
Lab Temperature	21 °C
Lab Humidity	45 %

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## COMOHAC H-FIELD PROBE CALIBRATION REPORT

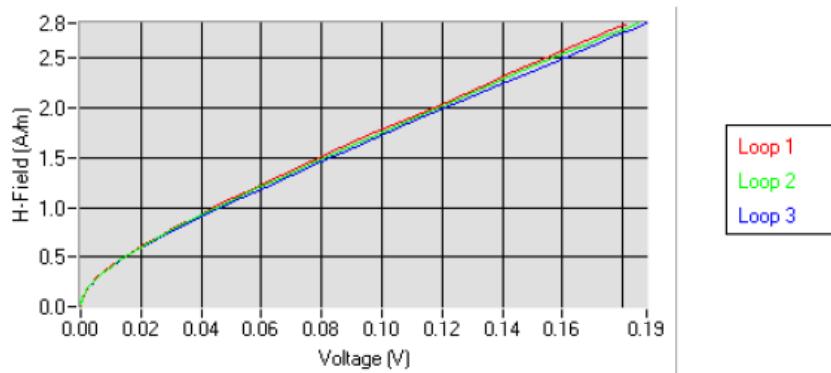
Ref ACR.96.11.13.SATU.A

5.1 SENSITIVITY IN AIR

Frequency	Normx loop 1 (mV/(A/m) <sup>2</sup> )	Normy loop 2 (mV/(A/m) <sup>2</sup> )	Normz loop 3 (mV/(A/m) <sup>2</sup> )
0.7-1.0 GHz	63.05	68.42	66.05
1.7-2.0 GHz	368.87	389.77	391.32

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
112	102	106

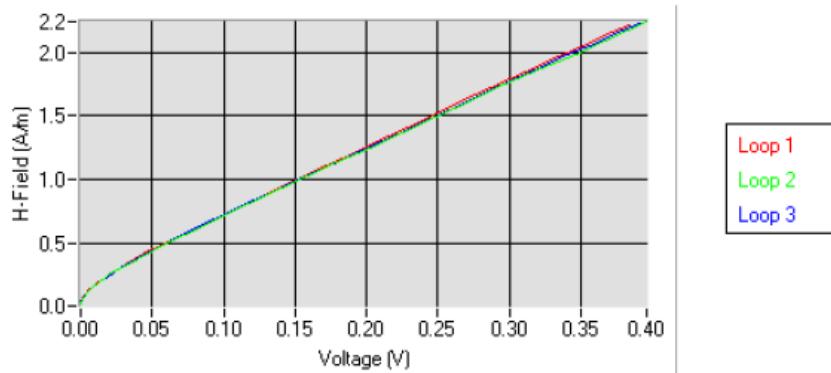
## Calibration curves



Calibration curves at 835 MHz

Loop 1  
Loop 2  
Loop 3

## Calibration curves



Loop 1  
Loop 2  
Loop 3

Calibration curves at 1900 MHz

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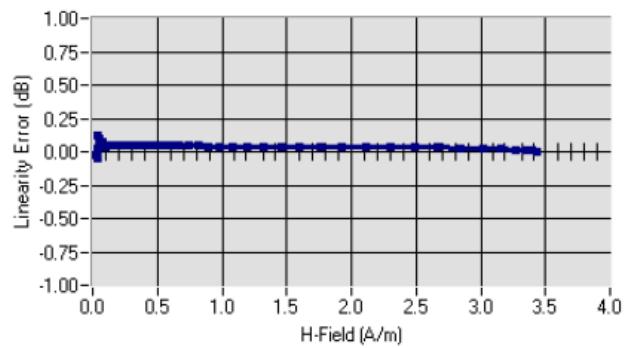


## COMOHAC H-FIELD PROBE CALIBRATION REPORT

Ref. ACR.96.11.13.SAT.U.A

5.2 LINEARITY

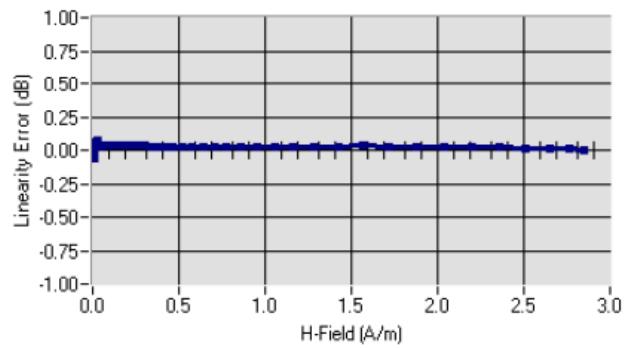
Linearity



Linearity: +/- 2.92% (+/- 0.13dB)

Linearity at 835 MHz

Linearity



Linearity: +/- 1.64% (+/- 0.07dB)

Linearity at 1900 MHz

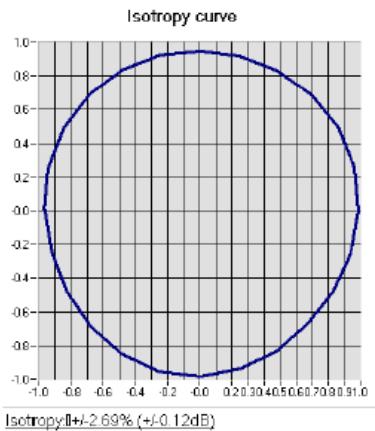
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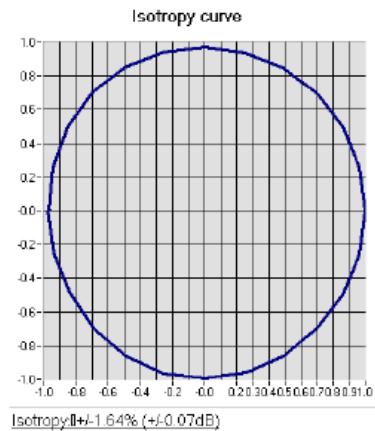


## COMOHAC H-FIELD PROBE CALIBRATION REPORT

Ref. ACR.96.11.13.SAT.U.A

5.3 ISOTROPY

Isotropy at 835 MHz



Isotropy at 1900 MHz



## 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	02/2013	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.
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	3/2012	3/2014

**T-Coil Probe Calibration Certificate**



**COMOHAC T-coil Probe Calibration Report**

Ref : ACR.96.12.13.SATU.A

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

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

**SATIMO COMOHAC T-COIL PROBE  
SERIAL NO.: SN 24/11 TCP23**

**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 T-coil Probe 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.



## COMOHACT-COIL PROBE CALIBRATION REPORT

Ref. ACR.96.12.13.SATU.A

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

	Customer Name
Distribution :	Shenzhen EMC-united Co., Ltd

Issue	Date	Modifications
A	4/5/2013	Initial release

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## 1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOHAC T-COIL PROBE
Manufacturer	Satimo
Model	STCOIL
Serial Number	SN 24/11 TCP23
Product Condition (new / used)	New
Frequency Range of Probe	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 IEEE 1027 standards.

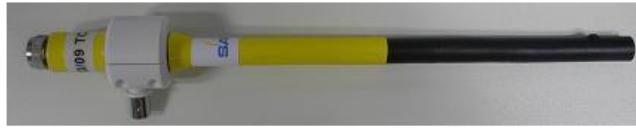


Figure 1 – Satimo COMOHAC T-coil Probe

Coil Dimension	6.55 mm length * 2.29 mm diameter
DC resistance	860.6 $\Omega$
Wire size	51AWG
Inductance at 1 kHz	132.1 mH at 1 kHz

## 3 MEASUREMENT METHOD

All methods used to perform the measurements and calibrations comply with the ANSI C63.19 and IEEE 1027 standards. All measurements were performed using a Helmholtz coil built according to the specifications outlined in ANSI C63.19 and IEEE 1027.

### 3.1 SENSITIVITY

The T-coil was positioned within the Helmholtz coil in axial orientation. Using an audio generator connected to the input of the Helmholtz coil, a known field (1 A/m) was generated within the coil and the T-coil probe reading recorded over the frequency range of 100 Hz to 1000 Hz.

### 3.2 LINEARITY

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 within the coil from 0 dB A/m to -50 dB A/m and the T-coil reading recorded at each power level (10 dB steps).



## COMOHACT T-COIL PROBE CALIBRATION REPORT

Ref. ACR.96.12.13.SATU.A

**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	
<b>Combined Standard Uncertainty</b>		N	1	0.49	
<b>Expanded uncertainty (confidence level of 95%, <math>k = 2</math>)</b>		N	$k=2$	1.00	12.0

**5 CALIBRATION MEASUREMENT RESULTS**

Calibration Parameters	
Lab Temperature	21°C
Lab Humidity	45%

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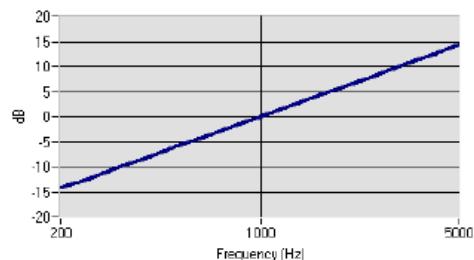


## COMOHACT-COIL PROBE CALIBRATION REPORT

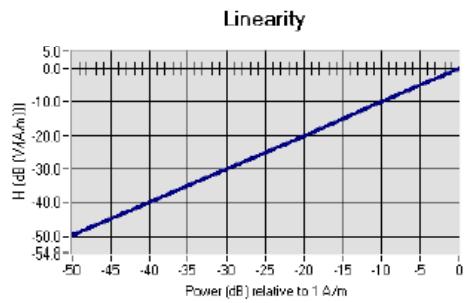
Ref ACR.96.12.13.SATU.A

**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**

	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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## COMOHAC T-COIL PROBE CALIBRATION REPORT

Ref ACR.96.12.13.SAT.U.A

## 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 Ceriticate



**HAC Reference Dipole Calibration Report**

Ref: ACR.96.13.13.SATU.A

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(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

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

	Customer Name
Distribution :	Shenzhen EMC-united Co., Ltd

Issue	Date	Modifications
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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## HAC REFERENCE DIPOLE CALIBRATION REPORT

Ref. ACR.96.13.13.SATU.A

**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.

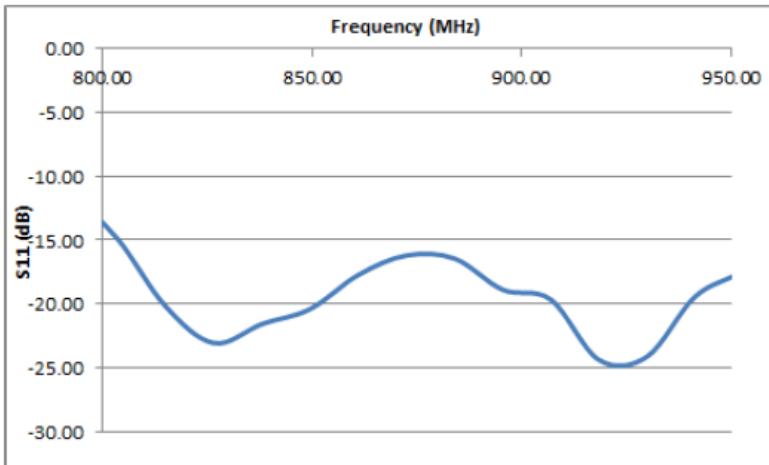
Uncertainty analysis of the probe calibration in waveguide					
ERROR SOURCES	Uncertainty value (%)	Probability Distribution	Divisor	Uncertainty (dB)	Standard Uncertainty (%)
RF reflections	0.1	R	$\sqrt{3}$	0.06	
Field probe conv. Factor	0.4	R	$\sqrt{3}$	0.23	
Field probe anisotropy	0.25	R	$\sqrt{3}$	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>				<b>0.52</b>	
<b>Expanded uncertainty</b> 95 % confidence level $k = 2$				<b>1.00</b>	<b>13.0</b>



## HAC REFERENCE DIPOLE CALIBRATION REPORT

Ref ACR.96.13.13.SATU.A

## 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%

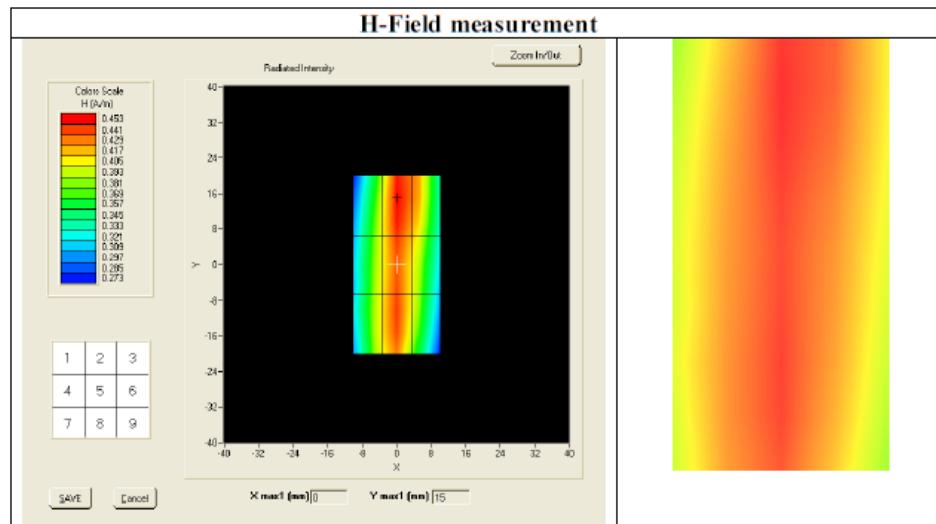
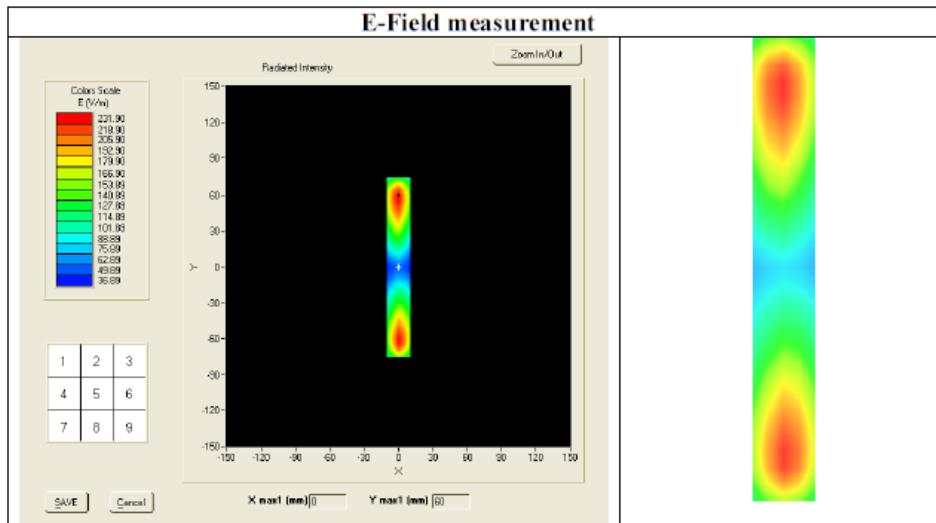


## HAC REFERENCE DIPOLE CALIBRATION REPORT

Ref. ACR.96.13.13.SATUA

## 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

**SIDB1900 Dipole Calibration Cerificate**



**HAC Reference Dipole Calibration Report**

Ref: ACR.96.14.13.SATU.A

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**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

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

	Customer Name
Distribution :	Shenzhen EMC-united Co., Ltd

Issue	Date	Modifications
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

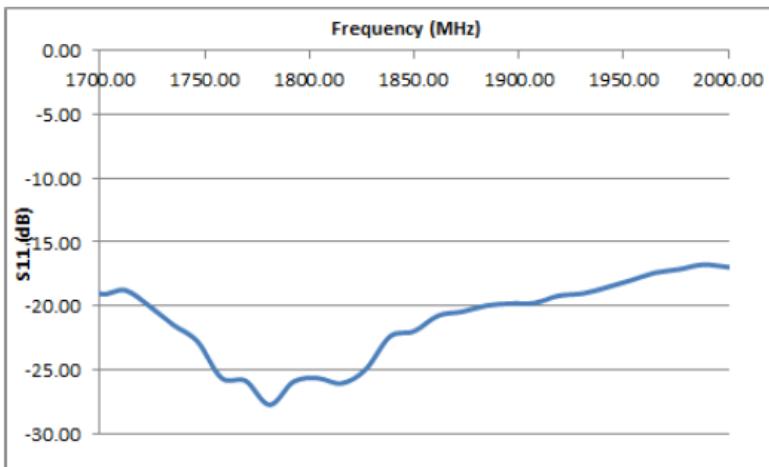
The guideline outlined in the IEEE ANSI C63.19 standard was followed to generate the measurement uncertainty for validation measurements.

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	
<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	-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%

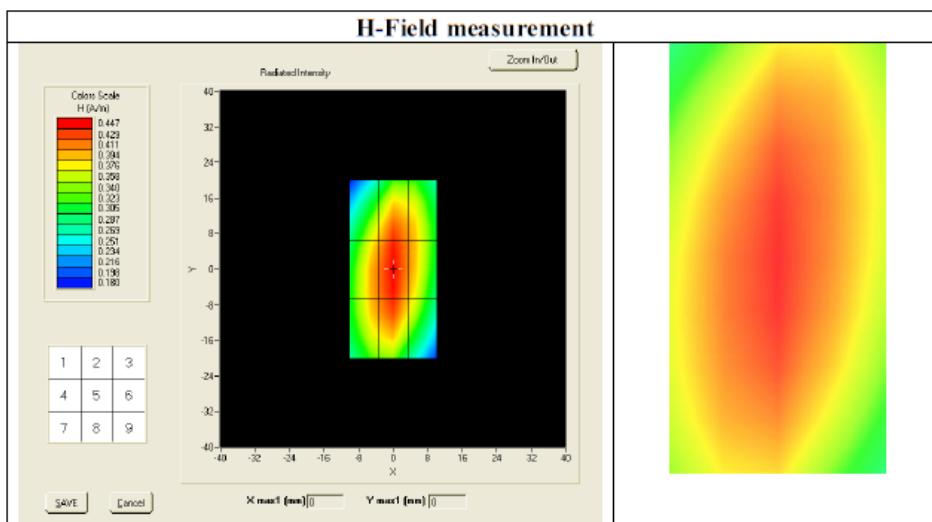
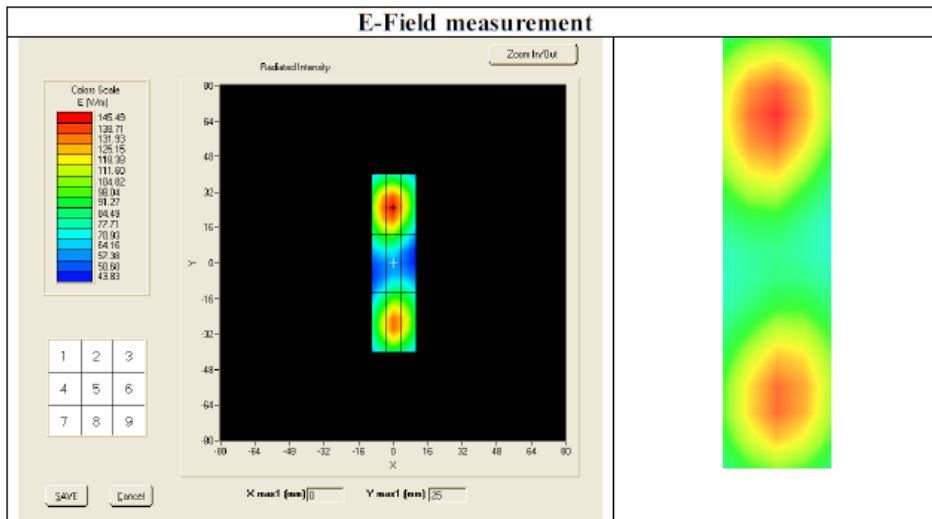


## HAC REFERENCE DIPOLE CALIBRATION REPORT

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



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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

**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

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

	Customer Name
Distribution :	Shenzhen EMC-united Co., Ltd

Issue	Date	Modifications
A	4/5/2013	Initial release

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## COMOHAC TMFS PROBE CALIBRATION REPORT

Ref. ACR.90.15.11.SAT.U.A

**1 DEVICE UNDER TEST**

Device Under Test	
Device Type	COMOHAC Magnetic Field Simulator
Manufacturer	Satimo
Model	STMFS
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. ( $\pm$ 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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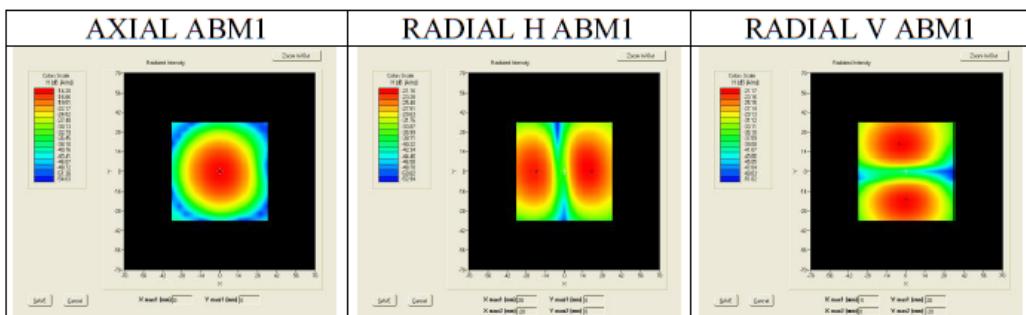


## COMOHACTMFS' PROBE CALIBRATION REPORT

Ref ACR.90.15.11.SATUA

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-----