

Annex B: Probe and dipole description and calibration certificates

B.1 Probe, measurement chain description, specification and calibration certificate



Annex B to Hearing Aid Compatibility RF Emissions Test Report for the BlackBerry® Smartphone model RFQ111LW

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Author Data

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Feb. 17-29, June 28, 2012 April 24-26, 2013 Report No RTS-6026-1304-52 FCC ID L6ARFQ110LW

DASY Dosimetric Assessment System by Schmid & Partner Engineering AG



ER3DV6 ISOTROPIC E-FIELD PROBE FOR GENERAL NEAR-FIELD Applications MEASUREMENTS Support & Downloads Download Product Flyer (PDF, 192kB) Products DASY4 Packages ■ EASY4 Construction One dipole parallel, two dipoles normal to probe axis Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., ET3DV6 - Isotropic Dos-Probe glycolether) ES3DV3 - Isotropic Dos-Probe EX3DV4 - Isotropic Dos-Probe Calibration In air from 100 MHz to 3.0 GHz (absolute accuracy ±6.0%, k=2) 100 MHz to > 6 GHz; Linearity: ± 0.2 dB (100 MHz to 3 GHz) Frequency EUV3 - Universal Vector E-Probe H3DV6 - Isotropic H-Probe Directivity ± 0.2 dB in air (rotation around probe axis) HUV4 - Universal Vector H-Probe ± 0.4 dB in air (rotation normal to probe axis) T1V3 - Temp-Probe DP1 - Dummy-Probe Data Acquisition System Dynamic Range 2 V/m to > 1000 V/m; Linearity: ± 0.2 dB Overall length: 330 mm (Tip: 16 mm) Dimensions Phantoms Tip diameter: 8 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.5 mm Validation Kits & Calibration Dipoles General near-field measurements up to 6 GHz Application • Hearing Aid Compatibility (HAC) Ext Field component measurements Tissue Simulating Liquids Fast automatic scanning in phantoms SPEAG Home

http://www.dasy4.com/er3.htm



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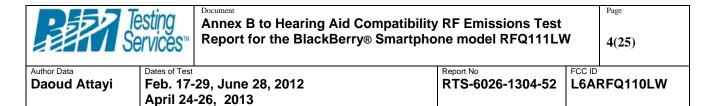
FCC ID L6ARFQ110LW

DASY Dosimetric Assessment System by Schmid & Partner Engineering AG



Applications	H3DV6 3-DIMENSIONAL H-FIELD PROBE FOR SMALL BAND APPLICATIONS			
Products • DASY4 Packages	Download Product Fly	<u>ver</u> (PDF, 192kB)		
Probes ET3DV6 - Isotropic Dos-Probe ES3DV3 - Isotropic Dos-Probe EX3DV4 - Isotropic Dos-Probe	Construction	Three concentric loop sensors with 3.8 mm loop diameters Resistively loaded detector diodes for linear response Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., glycolether)		
ET1DV3 - D-Probe ER3DV6 - Iso tr opic E-Probe	Frequency 200 MHz to 3 GHz (absolute accuracy ± 6.0%, Output linearized			
EUV3 - Universal Vector E-Probe	Directivity	± 0.25 dB (spherical isotropy error)		
HUV4 - Universal Vector H-Probe	Dynamic Range	10 mA/m to 2 A/m at 1 GHz		
T1V3 - Temp-Probe DP1 - Dummy-Probe	E-Field Interference	< 10% at 3 GHz (for plane wave)		
Data Acquisition System Software	Dimensions	Overall length: 330 mm (Tip: 40 mm) Tip diameter: 6 mm (Body: 12 mm) Distance from probe tip to dipole centers: 3 mm		
Phantoms Robots Validation Kits & Calibration Dipoles Hearing Aid Compatibility (HAC) Ext Tissue Simulating Liquids	Application	General magnetic near-field measurements up to 3 GHz Field component measurements Surface current measurements Measurements in air or liquids Low interaction with the measured field		
SPEAG Home				

http://www.dasy4.com/h3d.htm

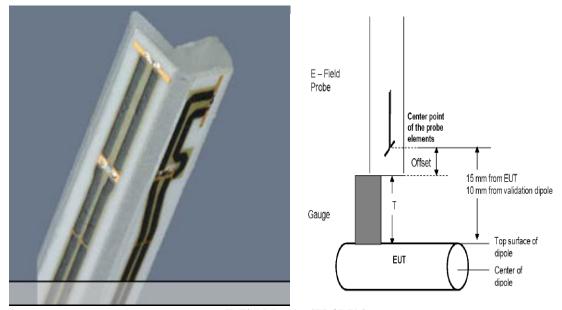


All measurements were performed to the nearest element point as per the C63.19 standard. Offset distances were entered in the DASY5 software so that the measurement was to the nearest element.

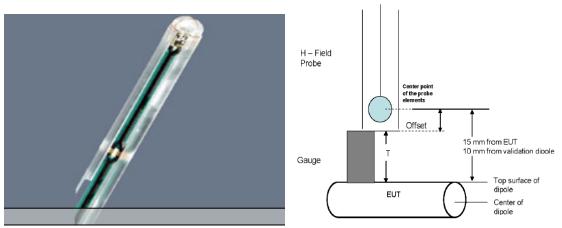
Figures 1 and 2, provided by the manufacturer, illustrate detail of the probe tip and its dimensions.

ER3DV6 E-Field probe: The distances from the probe tip to the closest points on the dipole sensors are 1.45mm for X and Y and 1.25mm for Z. From the probe tip to the center of the sensors is 2.5mm.

H3DV6 H-Field probe: The distance from the probe tip to the closest point of the X, Y and Z loop sensors is 1.1mm. From the probe tip to the center of the sensor is 3.00mm.



E-Field Probe (ER3DV6)



H-Field Probe (H3DV6)



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The following information is from the system manufacturer user manual describing the process chain:

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$
(20.1)

with V_i = compensated signal of channel i (i = x, y, z) U_i = input signal of channel i (i = x, y, z) cf = crest factor of exciting field (DASY parameter) dcp_i = diode compression point (DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

E – field
probes :
$$E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

$${\rm H-field probes:} \qquad H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1}f + a_{i2}f^2}{f}$$

with V_i = compensated signal of channel i (i = x, y, z) $Norm_i$ = sensor sensitivity of channel i (i = x, y, z)

 $\mu V/(V/m)^2$ for E-field Probes

ConvF = sensitivity enhancement in solution a_{ij} = sensor sensitivity factors for H-field probes

f = carrier frequency [GHz]

 E_i = electric field strength of channel i in V/m H_i = magnetic field strength of channel i in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$
(20.2)

The measurement / integration time per point is > 500 ms, as per the system manufacturer:

The time response of the field probes has been assessed by exposing the probe to a well-controlled field producing signals larger than HAC E- and H-fields of class M4. The signal response time is evaluated as the time required by the system to reach 90% of the expected final value after an on/off switch of the power source with an integration time of 500 ms and a probe response time of <5 ms. In the current implementation, DASY4 waits longer than 100 ms after having reached the grid point before starting a measurement, i.e., the response time uncertainty is negligible.

If the device under test does not emit a CW signal, the integration time applied to measure the electric field at a specific point may introduce additional uncertainties due to the discretization. The tolerances for the different systems had the worst-case of 2.6%.



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Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





Schweizerischer Kalibrierdienst Service suisse d'étalonnage Servizio svizzero di taratura Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

RTS (RIM Testing Services)

S

Certificate No: ER3-2286_Jan13

CALIBRATION CERTIFICATE

ER3DV6 - SN:2286 Object

QA CAL-02.v6, QA CAL-25.v4 Calibration procedure(s)

Calibration procedure for E-field probes optimized for close near field

evaluations in air

January 11, 2013

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Catibration
Power meter £44198	GB41293874	29-Mar-12 (No. 217-01508)	Apr-13
Power sensor E4412A	MY41498087	29-Mar-12 (No. 217-01508)	Apr-13
Reference 3 dB Attenuator	SN: S5054 (3c)	27-Mar-12 (No. 217-01531)	Apr-13
Reference 20 dB Attenuator	SN: S5086 (20b)	27-Mar-12 (No. 217-01529)	Apr-13
Reference 30 dB Attenuator	SN: S5129 (30b)	27-Mar-12 (No. 217-01532)	Apr-13
Reference Probe ER3DV6	SN: 2328	12-Oct-12 (No. ER3-2328_Oct12)	Oct-13
DAE4	SN: 789	18-Sep-12 (No. DAE4-789_Sep12)	Sep-13
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-11)	in house check: Apr-13
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12)	In house check: Oct-13

Function Signature Jeton Kastrati Laboratory Technician Calibrated by: Katja Pokovic Technical Manager Approved by: Issued: January 11, 2013 This calibration certificate shall not be reproduced except in full without written approval of the laboratory

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Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland





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Accreditation No.: SCS 108

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Glossary:

NORMx,y,z DCP sensitivity in free space diode compression point

CF CF

crest factor (1/duty_cycle) of the RF signal

A, B, C, D

modulation dependent linearization parameters

Polarization φ

φ rotation around probe axis

Polarization 8

9 rotation around an axis that is in the plane normal to probe axis (at measurement center),

i.e., 9 = 0 is normal to probe axis

Connector Angle

information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1309-2005, "IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", December 2005
- b) CTIA Test Plan for Hearing Aid Compatibility, April 2010.

Methods Applied and Interpretation of Parameters:

- NORMx,y,z: Assessed for E-field polarization 9 = 0 for XY sensors and 9 = 90 for Z sensor (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide).
- NORM(f)x,y,z = NORMx,y,z * frequency_response (see Frequency Response Chart).
- DCPx,y,z: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z; A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- Spherical isotropy (3D deviation from isotropy): in a locally homogeneous field realized using an open waveguide setup.
- Sensor Offset: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle: The angle is assessed using the information gained by determining the NORMx (no uncertainty required).

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Report No

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ER3DV6 - SN:2286

January 11, 2013

Probe ER3DV6

SN:2286

Manufactured: Calibrated:

September 18, 2002 January 11, 2013

Calibrated for DASY/EASY Systems (Note: non-compatible with DASY2 system!)

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ER3DV6- SN:2286

January 11, 2013

DASY/EASY - Parameters of Probe: ER3DV6 - SN:2286

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm $(\mu V/(V/m)^2)$	2.20	1.47	1.51	± 10.1 %
DCP (mV) ⁸	98.4	100.5	99.6	

Modulation Calibration Parameters

UID	Communication System Name		Α	В	£	D	VR	Unc
			άB	dB√μV		₫B	mV	(k=2)
0	CW	X	0.0	0.0	1.0	0.00	194.1	±2.5 %
		Υ	0.0	0.0	1.0		197.9	
		Z	0.0	0.0	1.0		176.0	

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

B Numerical linearization parameter: uncertainty not required.
E Uncertainty is determined using the max, deviation from linear response applying rectangular distribution and is expressed for the square of the



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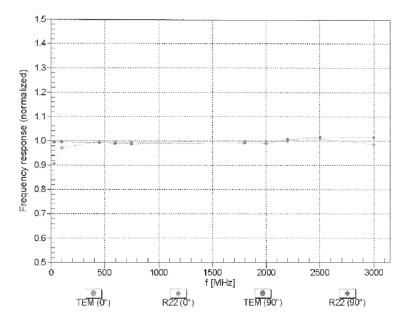
FCC ID L6ARFQ110LW

ER3DV6- SN:2286

January 11, 2013

Frequency Response of E-Field

(TEM-Cell:ifi110 EXX, Waveguide: R22)



Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

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L6ARFQ110LW

ER3DV6-- SN:2286

January 11, 2013

Receiving Pattern (ϕ), $9 = 0^{\circ}$

f=600 MHz,TEM,0° f=2500 MHz,R22,0°

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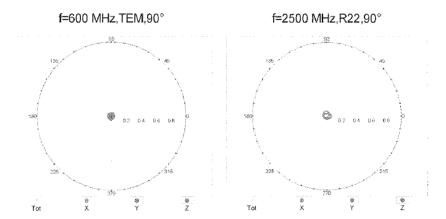
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Receiving Pattern (ϕ), $9 = 90^{\circ}$



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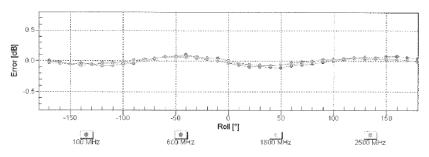
Report No

L6ARFQ110LW

ER3DV6-- SN:2286

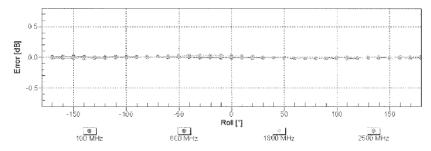
January 11, 2013

Receiving Pattern (ϕ), $9 = 0^{\circ}$



Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Receiving Pattern (ϕ), $\vartheta = 90^{\circ}$



Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

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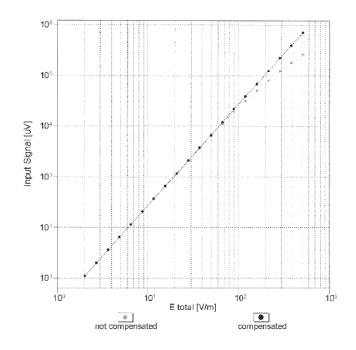
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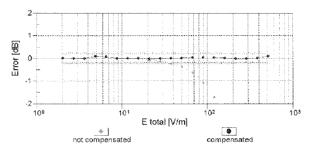
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Dynamic Range f(E-field) (TEM cell , f = 900 MHz)





Uncertainty of Linearity Assessment: ± 0.6% (k=2)

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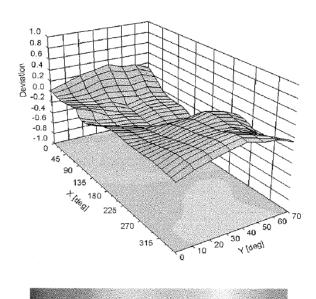
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ER3DV6-SN:2286

January 11, 2013

Deviation from Isotropy in Air

Error (¢, 9), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

0.2

0.6 0.8

-0.4 -0.2 8.0

~0.6

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ER3DV6-- SN:2286

January 11, 2013

DASY/EASY - Parameters of Probe: ER3DV6 - SN:2286

Other Probe Parameters

Sensor Arrangement	Rectangular
Connector Angle (°)	-10.1
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	8 mm
Probe Tip to Sensor X Calibration Point	2.5 mm
Probe Tip to Sensor Y Calibration Point	2.5 mm
Probe Tip to Sensor Z Calibration Point	2.5 mm

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Multilateral Agreement for the recognition of calibration certificates

Client

RTS (RIM Testing Services)

Accreditation No.: SCS 108

C

S

Certificate No: H3-6105_Nov12

CALIBRATION CERTIFICATE

Object H3DV6 - SN:6105

Calibration procedure(s) QA CAL-03.v6, QA CAL-25.v4

Calibration procedure for H-field probes optimized for close near field

evaluations in air

Calibration date: November 9, 2012

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

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Power sensor E4412A	MY41498087	29-Mar-12 (No. 217-01508)	Apr-13
Reference 3 dB Attenuator	SN: S5054 (3c)	27-Mar-12 (No. 217-01531)	Apr-13
Reference 20 dB Attenuator	SN: S5086 (20b)	27-Mar-12 (No. 217-01529)	Apr-13
Reference 30 dB Attenuator	SN: S5129 (30b)	27-Mar-12 (No. 217-01532)	Apr-13
Reference Probe H3DV6	SN: 6182	12-Oct-12 (No. H3-6182_Oct12)	Oct-13
DAE4	SN: 789	18-Sep-12 (No. DAE4-789_Sep12)	Sep-13
Secondary Standards	ID GI	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-11)	In house check: Apr-13
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-12) In house check: Oct	

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	416
			ing Agent (New York and Agent Ag
Approved by:	Katja Pokovic	Technical Manager	
			John Lagra
			Issued: November 13, 2012
This calibration certificate	shall not be reproduced except in	full without written approval of the labo	oratory.

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Author Data

Daoud Attayi

Dates of Test

Feb. 17-29, June 28, 2012 April 24-26, 2013 RTS-6026-1304-52

Report No

FCC ID L6ARFQ110LW

Calibration Laboratory of

Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
Servizio svizzero di taratura
Swiss Calibration Service

Accreditation No.: SCS 108

Accredited by the Swiss Accreditation Service (SAS)

The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Glossary:

NORMx,y,z DCP

sensitivity in free space diode compression point

CF A, B, C crest factor (1/duty_cycle) of the RF signal modulation dependent linearization parameters

Polarization φ

φ rotation around probe axis

Polarization 9

9 rotation around an axis that is in the plane normal to probe axis (at measurement center),

i.e., $\theta = 0$ is normal to probe axis

Connector Angle

information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1309-2005, "IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", December 2005.
- b) CTIA Test Plan for Hearing Aid Compatibility, April 2010.

Methods Applied and Interpretation of Parameters:

- NORMx,y,z: Assessed for E-field polarization 9 = 0 for XY sensors and 9 = 90 for Z sensor (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide).
- X,Y,Z(f)_a0a1a2= X,Y,Z_a0a1a2* frequency_response (see Frequency Response Chart).
- DCPx,y,z: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- Ax,y,z; Bx,y,z; Cx,y,z, VRx,y,z: A, B, C are numerical linearization parameters assessed based on the data of
 power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the
 maximum calibration range expressed in RMS voltage across the diode.
- Spherical isotropy (3D deviation from isotropy): in a locally homogeneous field realized using an open waveguide setup.
- Sensor Offset: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle: The angle is assessed using the information gained by determining the X_a0a1a2 (no
 uncertainty required).

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FCC ID L6ARFQ110LW

H3DV6 - SN:6105

November 9, 2012

Probe H3DV6

SN:6105

Manufactured: Calibrated:

January 5, 2002 November 9, 2012

Calibrated for DASY/EASY Systems (Note: non-compatible with DASY2 system!)

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Report No RTS-6026-1304-52 FCC ID L6ARFQ110LW

H3DV6- SN:6105

November 9, 2012

DASY/EASY - Parameters of Probe: H3DV6 - SN:6105

Basic Calibration Parameters

		Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (A/m / √(mV))	a0	2.92E-003	2.69E-003	2.98E-003	± 5.1 %
Norm (A/m / √(mV))	a1	4.61E-005	4.09E-005	-6.60E-005	± 5.1 %
Norm (A/m / √(mV))	a2	-8.67E-006	3.24E-006	4.02E-006	± 5.1 %
DCP (mV) ^B		93.7	97.1	88.7	

Modulation Calibration Parameters

UID	Communication System Name	PAR	1	A dB	B dB	C dB	VR mV	Unc ^E (k=2)
0	CW	0.00	X	0.0	0.0	1.0	118.6	±3.3 %
			Υ	0.0	0.0	1.0	130.1	
***************************************			Z	0.0	0.0	1.0	135.8	

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

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⁸ Numerical linearization parameter: uncertainty not required.
⁶ Uncertainty is determined using the max, deviation from linear response applying rectangular distribution and is expressed for the square of the



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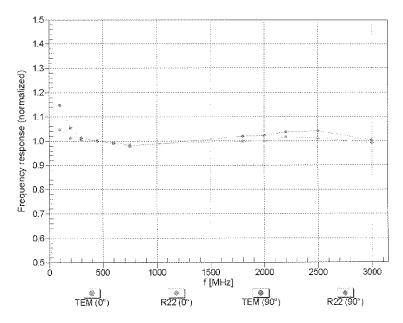
FCC ID L6ARFQ110LW

H3DV6~ SN:6105

November 9, 2012

Frequency Response of H-Field

(TEM-Cell:ifi110 EXX, Waveguide: R22)



Uncertainty of Frequency Response of H-field: ± 6.3% (k=2)



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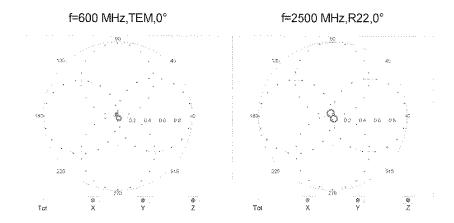
Feb. 17-29, June 28, 2012 April 24-26, 2013 Report No RTS-6026-1304-52

FCC ID L6ARFQ110LW

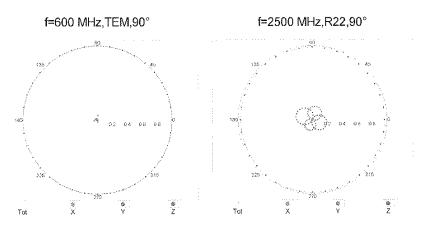
H3DV6-- SN:6105

November 9, 2012

Receiving Pattern (ϕ), $9 = 0^{\circ}$



Receiving Pattern (ϕ), $9 = 90^{\circ}$



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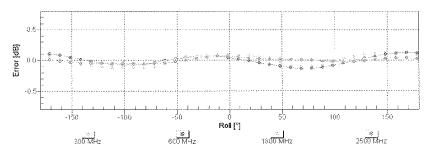
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H3DV6-- SN:6105

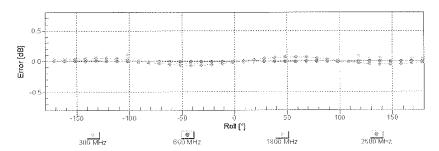
November 9, 2012

Receiving Pattern (ϕ), $9 = 0^{\circ}$



Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Receiving Pattern (ϕ), $9 = 90^{\circ}$



Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)



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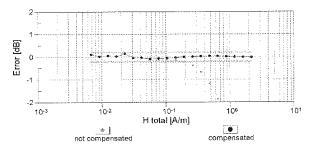
Feb. 17-29, June 28, 2012 April 24-26, 2013 Report No **RTS-6026-1304-52**

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November 9, 2012

Dynamic Range f(H-field) (TEM cell, f = 900 MHz)



Uncertainty of Linearity Assessment: ± 0.6% (k=2)

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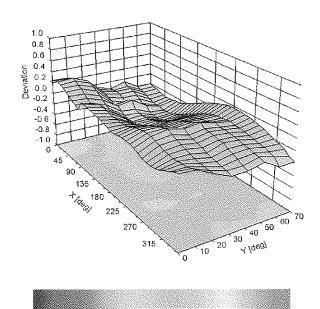
FCC ID L6ARFQ110LW

H3DV6- SN:6105

November 9, 2012

Deviation from Isotropy in Air

Error (\$\phi\$, \$), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

0.2 0.4

0.6 0.8

-0.2 0.0

-0.8 -0.6 -0.4

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H3DV6- SN:6105

November 9, 2012

DASY/EASY - Parameters of Probe: H3DV6 - SN:6105

Other Probe Parameters

Sensor Arrangement	Rectangular
Connector Angle (°)	-61.6
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	20 mm
Tip Diameter	6 mm
Probe Tip to Sensor X Calibration Point	3 mm
Probe Tip to Sensor Y Calibration Point	3 mm
Probe Tip to Sensor Z Calibration Point	3 mm

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