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Report On

EMC Evaluation of
Hughes Network Systems
Thuraya IP+ Broadband Satellite IP Modem

FCC Part 15 Subpart B

Report No. SC1410492A **November 2014**

TÜV SÜD America Inc., 10040 Mesa Rim Road, San Diego, CA 92121
Tel: (858) 678-1400. Website: www.TUVamerica.com

REPORT ON	Radio Testing of the Hughes Network Systems Thuraya IP+ Broadband Satellite IP Modem
TEST REPORT NUMBER	SC1410492A
PREPARED FOR	Hughes Network Systems 9605 Scranton Road, Suite 500 San Diego, CA 92121
CONTACT PERSON	David Couchman Principal Engineer (858) 452-4648 Dave.Couchman@hughes.com
PREPARED BY	Alex Chang Name Title: EMC/Wireless Test Engineer
APPROVED BY	Ferdinand S. Custodio Name Authorized Signatory Title: EMC/Senior Wireless Test Engineer
DATED	November 20, 2014

TÜV SÜD America Inc., 10040 Mesa Rim Road, San Diego, CA 92121
Tel: (858) 678-1400. Website: www.TUVamerica.com

Revision History

SC1410492A Hughes Network Systems Thuraya IP+ Broadband Satellite IP Modem					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
11/20/2014	Initial Release				Ferdinand Custodio

CONTENTS

SECTION 1

REPORT SUMMARY

EMC Evaluation of the
Hughes Network Systems
Thuraya IP+ Broadband Satellite IP Modem

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Thuraya IP+ Broadband Satellite IP Modem to the requirements of FCC Part 15 Subpart B.

Objective	To perform EMC Evaluation to determine the Equipment Under Test's (EUT's) compliance with the Test Specification, for the series of tests carried out.
Manufacturer	Hughes Network Systems
Model Name	Thuraya IP+
Model Number(s)	9104
Serial Number(s)	EUT#3-EMC
Number of Samples Tested	1
Highest Frequency Generated or Used	2462 MHz
Test Specification/Issue/Date	FCC Part 15 Subpart B (October 1, 2013)
Start of Test	October 30, 2014
Finish of Test	October 31, 2014
Name of Engineer(s)	Alex Chang
Related Document(s)	None

1.2 BRIEF SUMMARY OF RESULTS

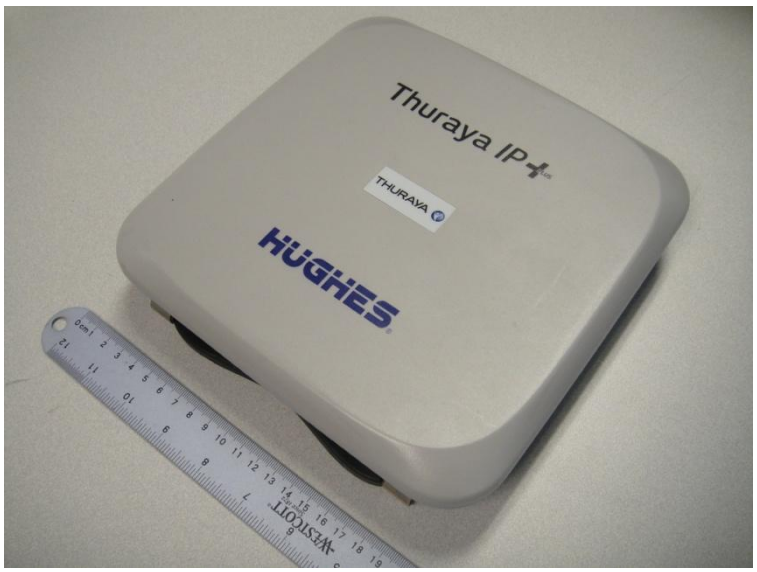
A brief summary of the tests carried out in accordance with FCC Part 15 Subpart B is shown below.

Part 15	Test Description	Result	Comments/Base Standard
§15.107	Conducted Emission	Compliant	Class B requirement
§15.109	Radiated Emission	Compliant	Class B requirement

1.3 PRODUCT INFORMATION

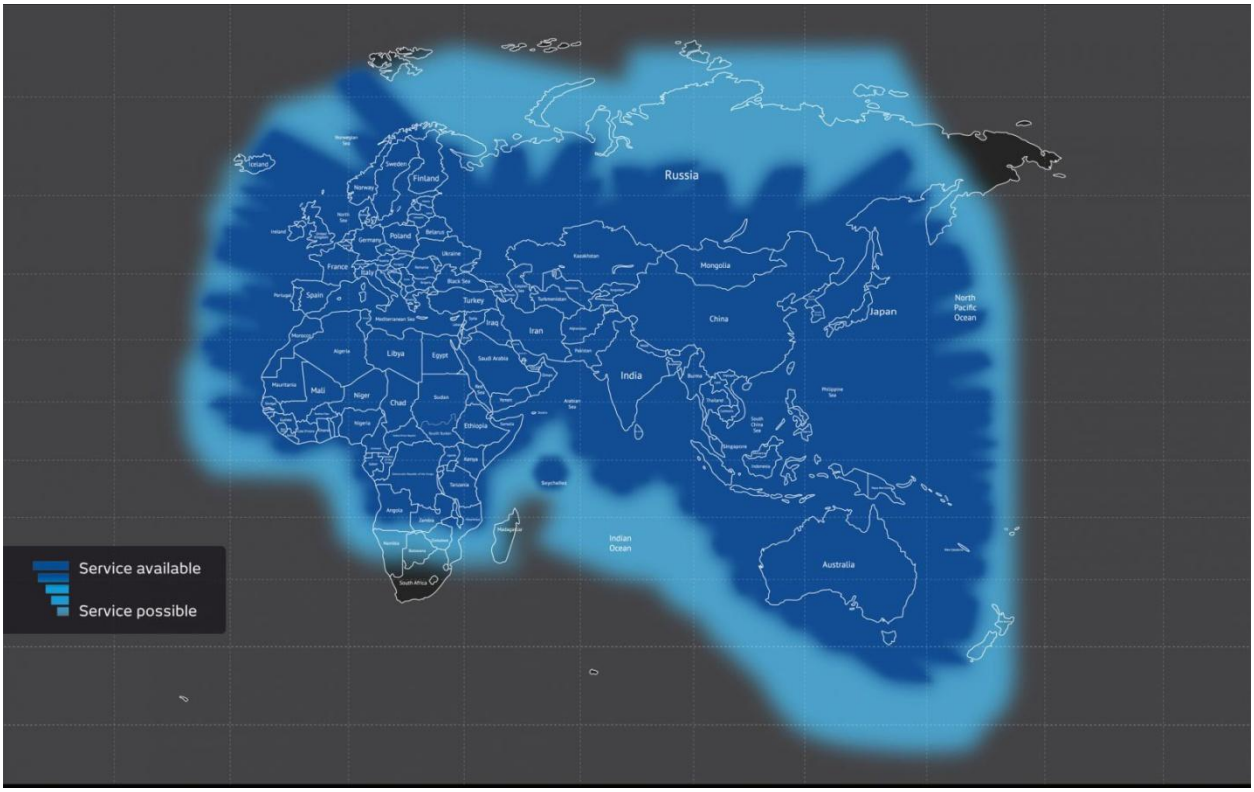
1.3.1 Technical Description

The Equipment Under Test (EUT) was a Hughes Network Systems Thuraya IP+ Broadband Satellite IP Modem model 9104 as shown in the photograph below. The EUT is a broadband satellite IP modem and Wi-Fi Access Point. It is a self-contained communications system designed to provide users with IP network access via satellite. It can use Ethernet or Wi-Fi interfaces for network access. The 9104 allows you to simultaneously send and receive IP packet data via Ethernet and Wi-Fi interfaces over the Thuraya satellite network– see Section 1.3.2 for map coverage.



Equipment Under Test

1.3.2 Thuraya Satellite Coverage Map



1.3.3 Labelling Requirement for Part 15 (Verification) Device

See FCC Publication Number: 784748 for details:

https://apps.fcc.gov/oetcf/kdb/forms/FTSSearchResultPage.cfm?id=27980&switch=P

1.1 EUT TEST CONFIGURATION

1.1.1 Test Configuration Description

Test Configuration	Description
Default	All radio of the EUT in standby (receive) mode. Satellite and GPS ports were in non active mode; no cable(s) or 50Ω termination connected during evaluation.

1.1.2 EUT Exercise Software

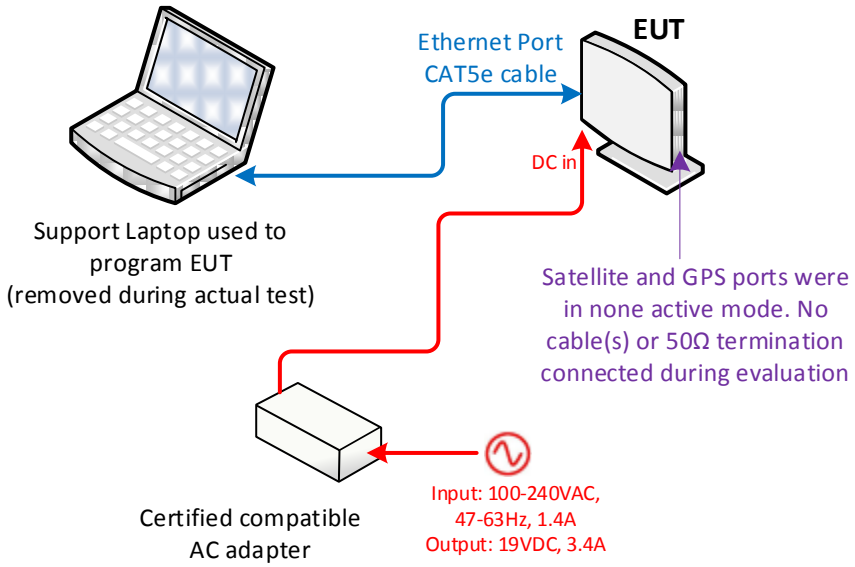
None. No special software used to exercise the EUT.

1.1.3 Support Equipment and I/O cables

Manufacturer	Equipment/Cable	Description
Hughes	AC Adapter for EUT	Model: STD-1934PA
Toshiba	Laptop	Model Satellite Pro 4600 S/N 91225670PU
Toshiba	Laptop External PSU	Model PA3049U-1ACA S/N 0008A0184957G
HP	Mouse for Laptop	Model M-UD43 S/N LZA03401471
-	CAT5e (Laptop to EUT)	2.1m unshielded RJ45 connector

1.1.4 Simplified Test Configuration Diagram

Emission Test Setup



1.2 DEVIATIONS FROM THE STANDARD

No deviations from the applicable test standards or test plan were made during testing.

1.3 MODIFICATION RECORD

Description of Modification	Modification Fitted By	Date Modification Fitted
Serial Number: EUT#3-EMC		
N/A	—	—

The table above details modifications made to the EUT during the test programme. The modifications incorporated during each test (if relevant) are recorded on the appropriate test pages.

1.4 TEST METHODOLOGY

All measurements contained in this report were conducted with ANSI C63.4-2009, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz.
For radiated emissions the equipment under test (EUT) was configured to measure its highest possible emission level. This level was based on the maximized cable configuration from exploratory testing per ANSI C63.4-2009. The test modes were adapted according to the Operating Instructions provided by the manufacturer/client.

1.5 TEST FACILITY LOCATION

1.5.1 TÜV SÜD America Inc. (Mira Mesa)

10040 Mesa Rim Road, San Diego, CA 92121-2912 (32.901268,-117.177681). Phone: 858 678 1400 Fax: 858 546 0364.

1.5.2 TÜV SÜD America Inc. (Rancho Bernardo)

Sony Electronics Inc., Building #8, 16530 Via Esprillo, San Diego, CA 92127-1708 (33.018644,-117.092409). Phone: 858 942 5542 Fax: 858 546 0364.

1.6 TEST FACILITY REGISTRATION

1.6.1 FCC – Registration No.: US1146

TUV SUD America Inc. (San Diego), is an accredited test facility with the site description report on file and has met all the requirements specified in §2.948 of the FCC rules. The acceptance letter from the FCC is maintained in our files and the Registration is US1146.

1.6.2 Industry Canada (IC) Registration No.: 3067A

The 10m Semi-anechoic chamber of TUV SUD America Inc. (San Diego) has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No. 3067A.

1.6.3 BSMI – Laboratory Code: SL2-IN-E-028R (US0102)

TUV Product Service Inc. (San Diego) is a recognized EMC testing laboratory by the BSMI under the MRA (Mutual Recognition Arrangement) with the United States. Accreditation includes CNS 13438 up to 6GHz.

1.6.4 VCCI – Registration No. A-0132

TUV SUD America Inc. (San Diego) is a VCCI registered measurement facility which includes radiated field strength measurement, radiated field strength measurement above 1GHz, mains port interference measurement and telecommunication port interference measurement.

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SECTION 2

TEST DETAILS

EMC Evaluation of the
Hughes Network Systems
Thuraya IP+ Broadband Satellite IP Modem

2.1 CONDUCTED EMISSION

2.1.1 Specification Reference

Part 15 Subpart B §15.107(a)

2.1.2 Standard Applicable

Except for Class A digital devices, for equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the band edges

Frequency of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

**Decreases with the logarithm of the frequency.*

2.1.3 Equipment Under Test and Modification State

Serial No: EUT#3-EMC / Default Test Configuration

2.1.4 Date of Test/Initial of test personnel who performed the test

October 31, 2014 / AC

2.1.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.1.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility.

Ambient Temperature	25.0 °C
Relative Humidity	54.1 %
ATM Pressure	99.0 kPa

2.1.7 Additional Observations

Measurement was done using EMC32 V8.53 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.1.8 for sample computation.

2.1.8 Sample Computation (Conducted Emission – Quasi Peak)

Measuring equipment raw measurement (dbµV) @ 150kHz			5.5
Correction Factor (dB)	Asset# 8607 (20 dB attenuator)	19.9	20.7
	Asset# 1177 (cable)	0.15	
	Asset# 1176 (cable)	0.35	
	Asset# 7568 (LISN)	0.30	
Reported QuasiPeak Final Measurement (dbµV) @ 150kHz			**26.2**

2.1.9 Test Results

Compliant. See attached plots and tables.

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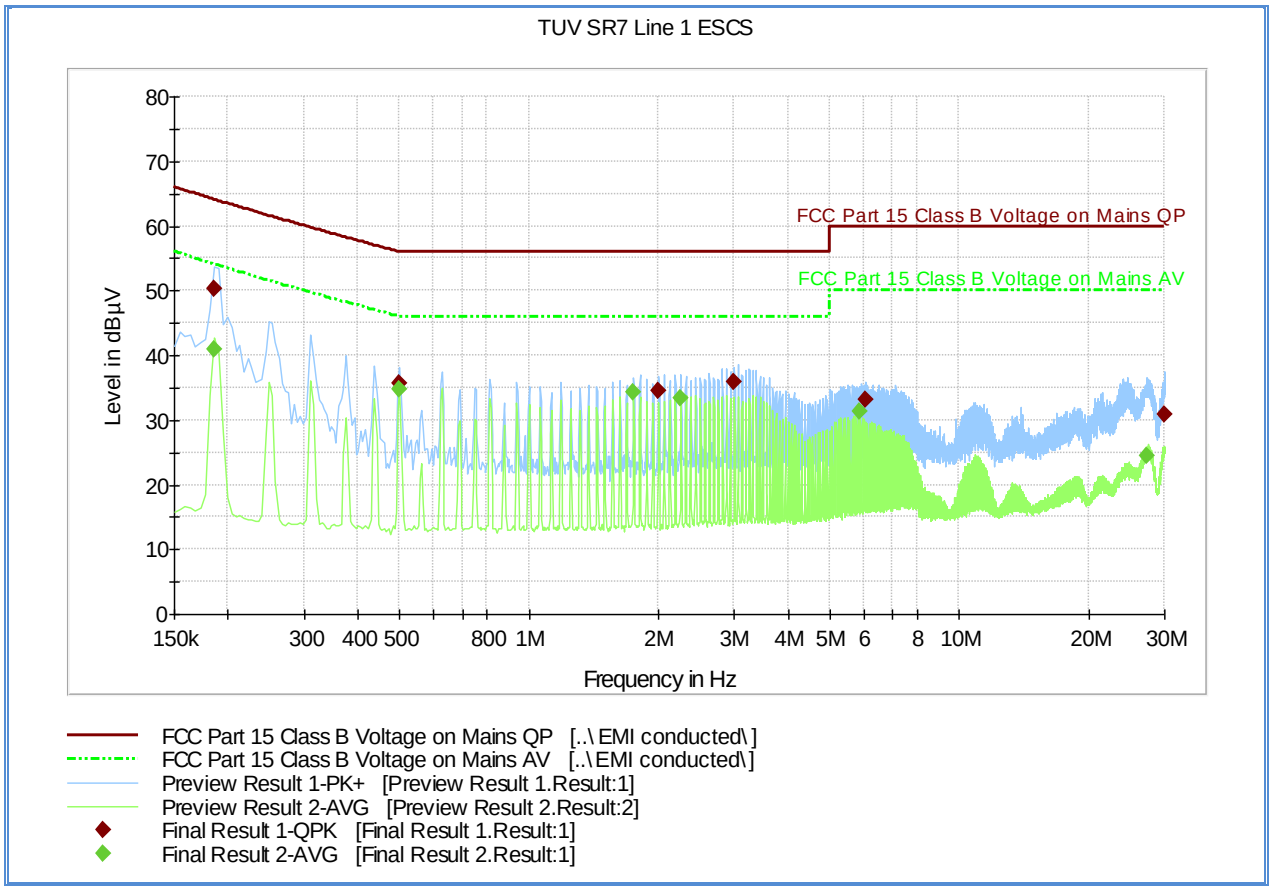
2.1.10 FCC Class B 120VAC 60Hz (Line 1)



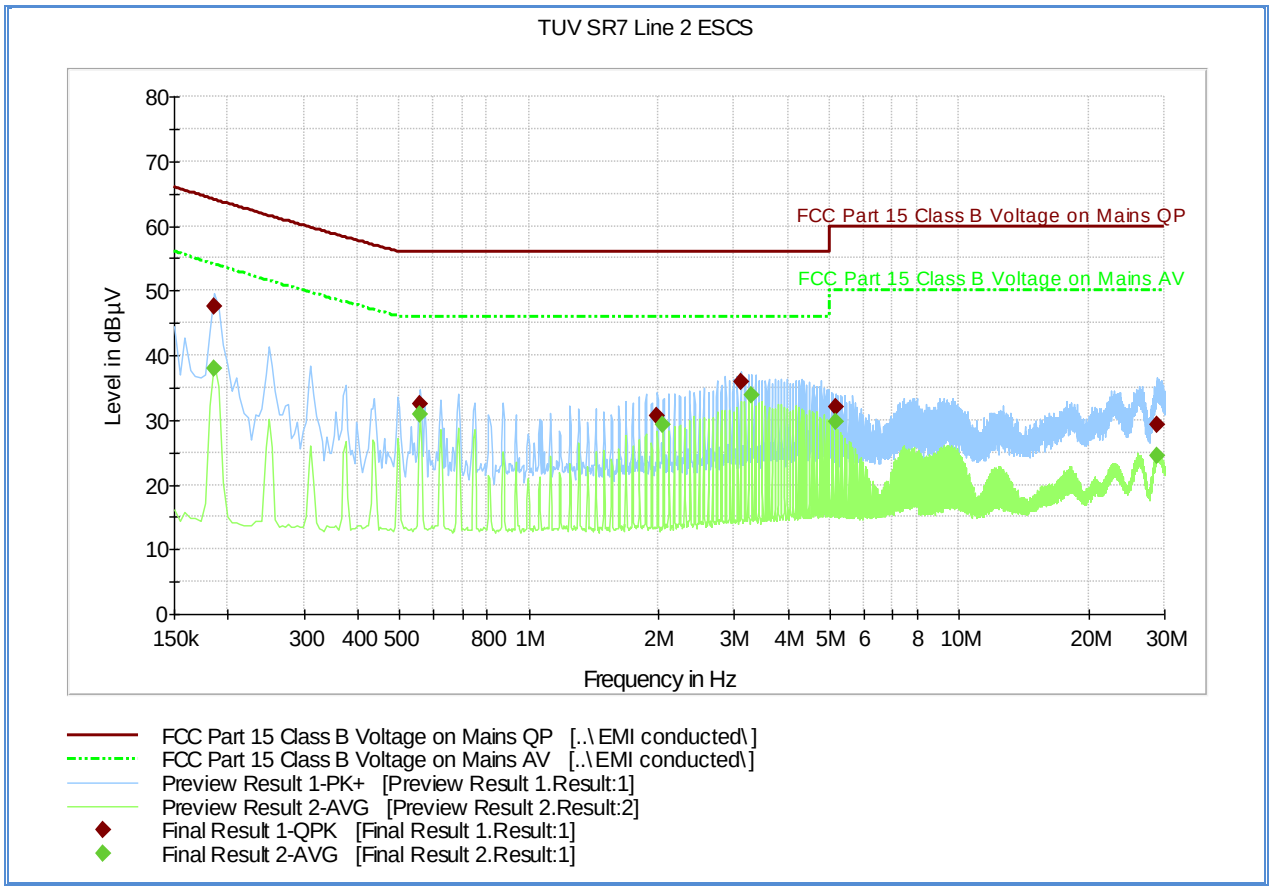
Quasi Peak

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBµV)
0.186000	50.3	1000.0	9.000	Off	L1	20.1	13.7	64.1
0.501000	35.6	1000.0	9.000	Off	L1	20.0	20.4	56.0
1.995000	34.5	1000.0	9.000	Off	L1	20.2	21.5	56.0
2.994000	35.8	1000.0	9.000	Off	L1	20.4	20.2	56.0
6.045000	33.0	1000.0	9.000	Off	L1	20.6	27.0	60.0
29.922000	30.8	1000.0	9.000	Off	L1	21.0	29.2	60.0

Average

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - Ave (dB)	Limit - Ave (dBµV)
0.186000	41.0	1000.0	9.000	Off	L1	20.1	13.0	54.1
0.501000	34.8	1000.0	9.000	Off	L1	20.0	11.2	46.0
1.747500	34.2	1000.0	9.000	Off	L1	20.1	11.8	46.0
2.247000	33.3	1000.0	9.000	Off	L1	20.4	12.7	46.0
5.860500	31.3	1000.0	9.000	Off	L1	20.6	18.7	50.0
27.357000	24.5	1000.0	9.000	Off	L1	20.9	25.5	50.0

2.1.11 FCC Class B 120VAC 60Hz (Line 2)



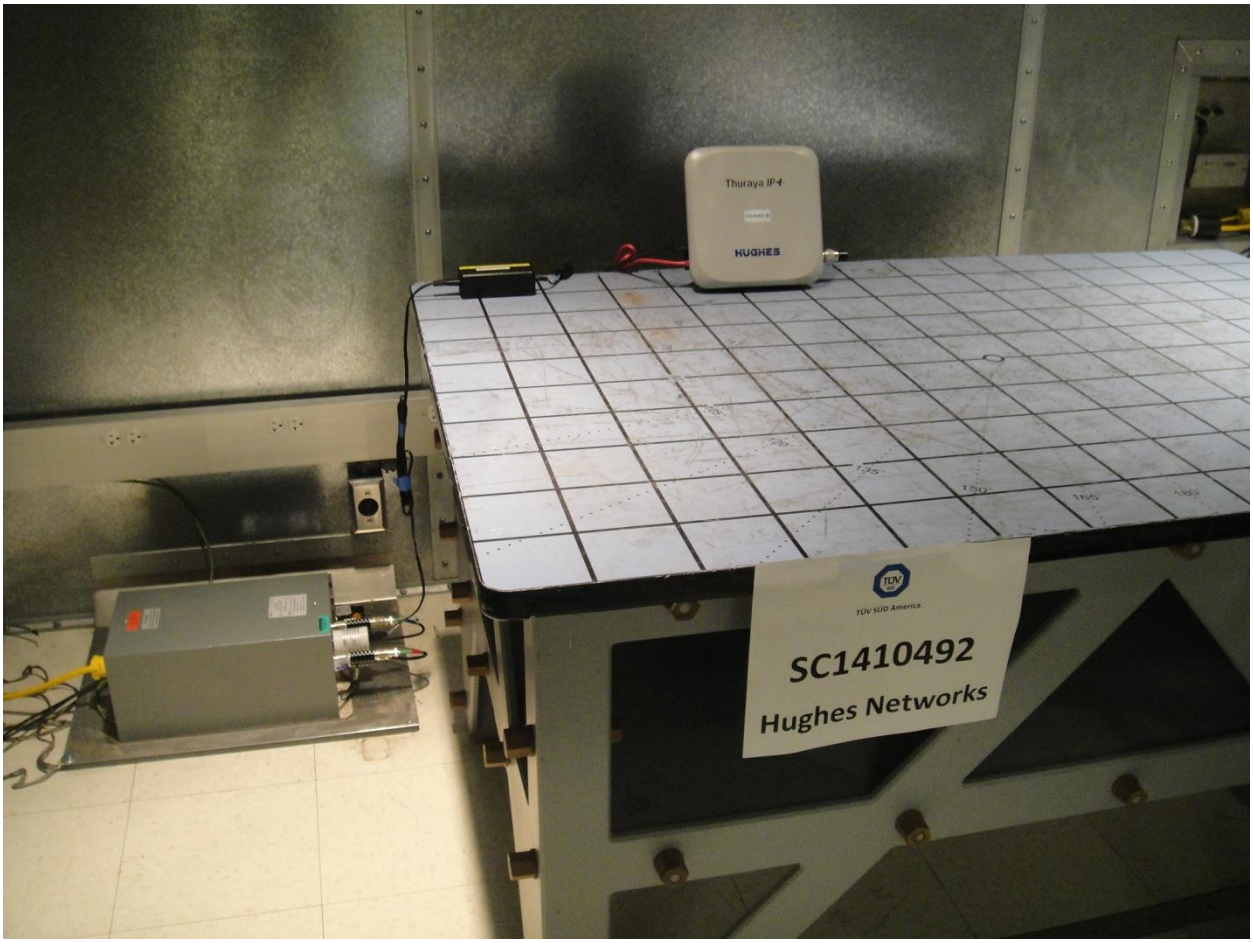
Quasi Peak

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBµV)
0.186000	47.6	1000.0	9.000	Off	N	20.1	16.5	64.1
0.559500	32.4	1000.0	9.000	Off	N	20.0	23.6	56.0
1.990500	30.7	1000.0	9.000	Off	N	20.1	25.3	56.0
3.106500	35.8	1000.0	9.000	Off	N	20.4	20.2	56.0
5.154000	32.1	1000.0	9.000	Off	N	20.5	27.9	60.0
28.900500	29.3	1000.0	9.000	Off	N	20.8	30.7	60.0

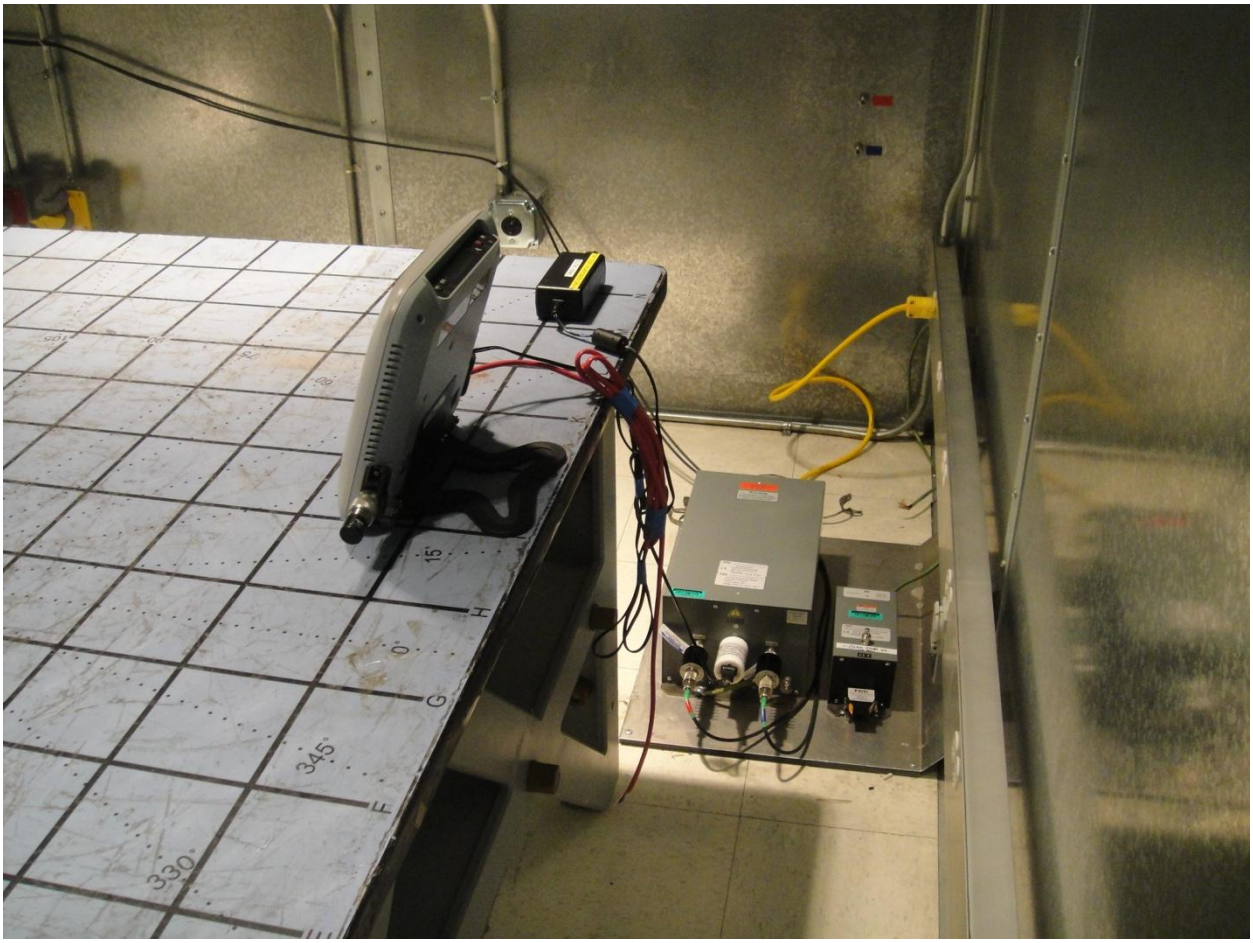
Average

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - Ave (dB)	Limit - Ave (dBµV)
0.186000	37.9	1000.0	9.000	Off	N	20.1	16.2	54.1
0.559500	30.9	1000.0	9.000	Off	N	20.0	15.1	46.0
2.049000	29.3	1000.0	9.000	Off	N	20.2	16.7	46.0
3.291000	33.8	1000.0	9.000	Off	N	20.3	12.2	46.0
5.154000	29.7	1000.0	9.000	Off	N	20.5	20.3	50.0
28.806000	24.4	1000.0	9.000	Off	N	20.8	25.6	50.0

2.1.12 Test Setup Photo (Front)



2.1.13 Test Setup Photo (Back)



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2.2 RADIATED EMISSION

2.2.1 Specification Reference

Part 15 Subpart B §15.109(a)

2.2.2 Standard Applicable

(a) Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency of emission (MHz)	Field Strength (microvolts/meter)
30-88	100
88-216	150
216-960	200
Above 960	500

2.2.3 Equipment Under Test and Modification State

Serial No: EUT#3-EMC / Default Test Configuration

2.2.4 Date of Test/Initial of test personnel who performed the test

October 30, 2014 / AC

2.2.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.2.6 Environmental Conditions

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility.

Ambient Temperature	23.1 °C
Relative Humidity	45.8 %
ATM Pressure	99.3 kPa

2.2.7 Additional Observations

- The spectrum was searched from 30MHz to the 5th harmonic (12.5GHz, up to 18GHz presented) and verified to Class B limits.
- Verification was performed at 3 meters.
- Measurement was done using EMC32 V8.53 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.2.8 for sample computation.

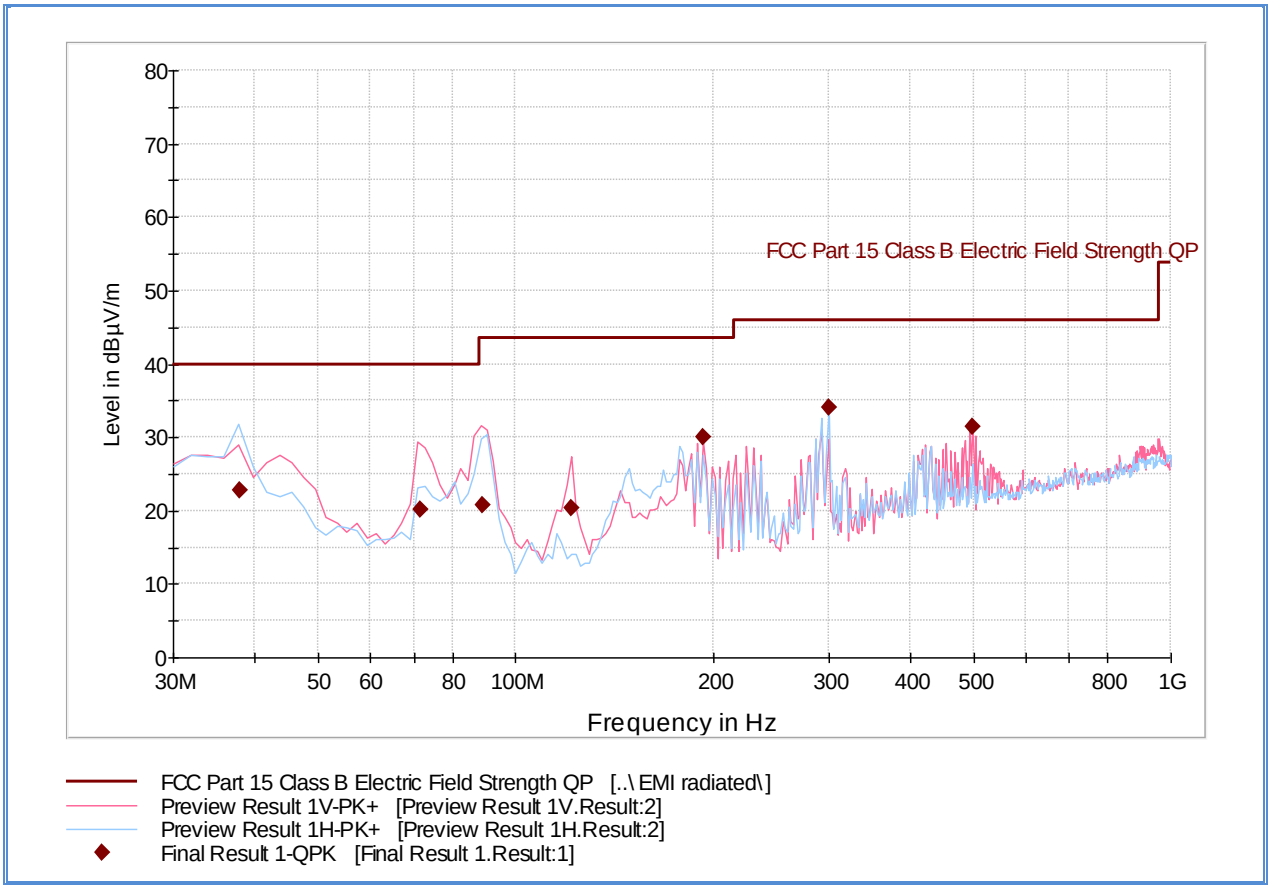
2.2.8 Sample Computation (Radiated Emission)

Measuring equipment raw measurement (dbµV) @ 30 MHz			24.4
Correction Factor (dB)	Asset# 1066 (cable)	0.3	-12.6
	Asset# 1172 (cable)	0.3	
	Asset# 1016 (preamplifier)	-30.7	
	Asset# 1175(cable)	0.3	
	Asset# 1002 (antenna)	17.2	
Reported QuasiPeak Final Measurement (dbµV/m) @ 30MHz			**11.8**

2.2.9 Test Results

See attached plots.

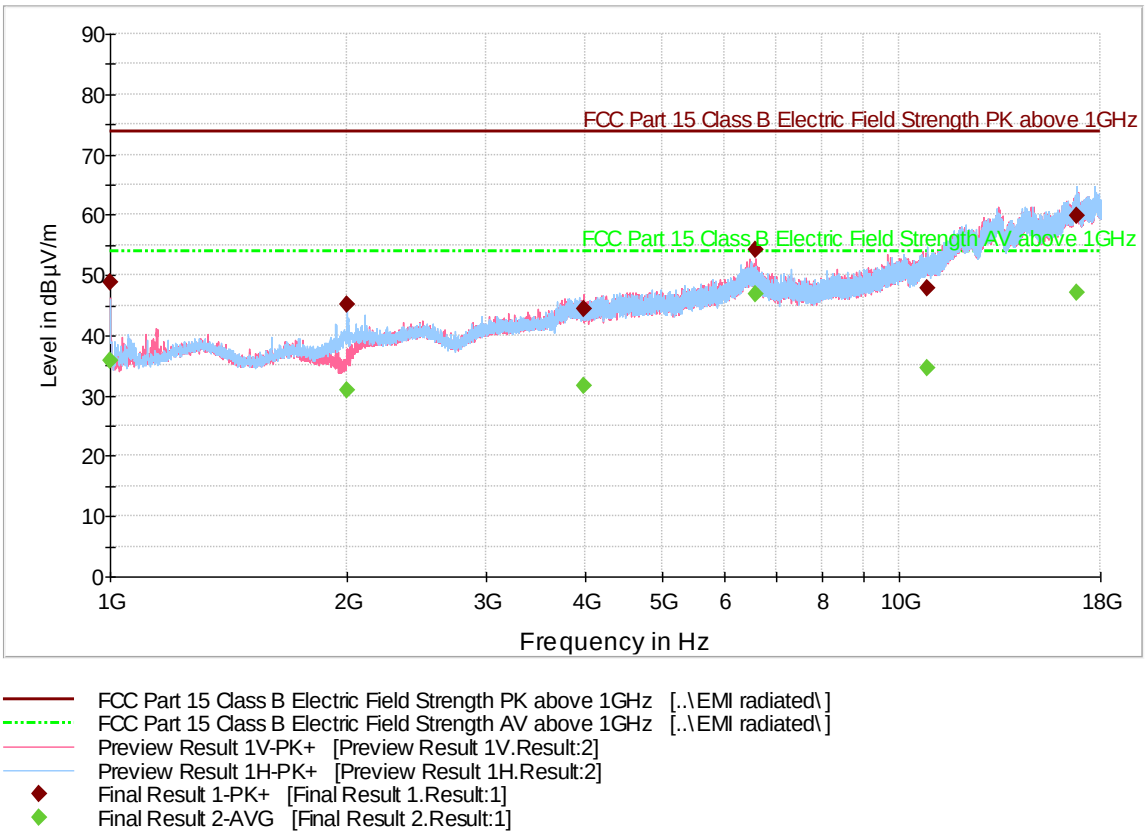
2.2.10 Below 1GHz Radiated Emission Test



Quasi-Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
37.815551	22.8	1000.0	120.000	400.0	H	0.0	-14.7	17.2	40.0
71.661643	20.2	1000.0	120.000	116.0	V	228.0	-21.4	19.8	40.0
88.820521	20.7	1000.0	120.000	100.0	V	-4.0	-20.1	22.8	43.5
121.282725	20.4	1000.0	120.000	100.0	V	-11.0	-19.5	23.1	43.5
192.846573	30.1	1000.0	120.000	100.0	V	134.0	-15.4	13.4	43.5
300.000401	34.0	1000.0	120.000	100.0	H	-7.0	-11.2	12.0	46.0
497.636954	31.5	1000.0	120.000	100.0	V	171.0	-6.0	14.5	46.0

2.2.11 Above 1GHz Radiated Emission Test



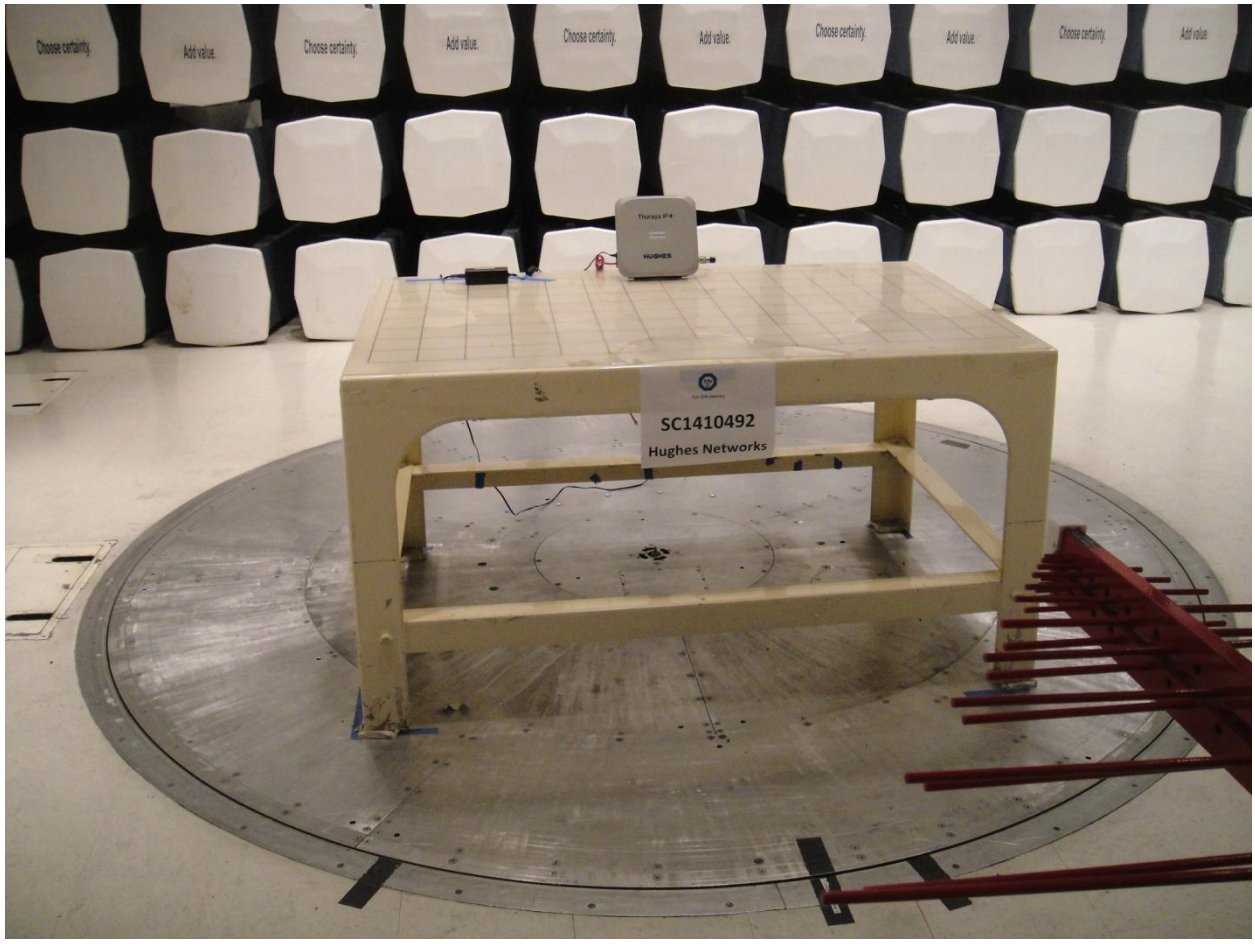
Peak Data

Frequency (MHz)	Max Peak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.000000	48.8	1000.0	1000.000	178.6	V	46.0	-7.0	25.1	73.9
1999.233333	45.2	1000.0	1000.000	301.2	H	50.0	-1.0	28.7	73.9
3977.266667	44.4	1000.0	1000.000	333.1	V	329.0	5.9	29.5	73.9
6565.433333	54.1	1000.0	1000.000	346.1	V	155.0	12.8	19.8	73.9
10876.23333	47.9	1000.0	1000.000	302.2	H	239.0	16.7	26.0	73.9
16777.66666	59.9	1000.0	1000.000	355.1	H	20.0	25.9	14.0	73.9

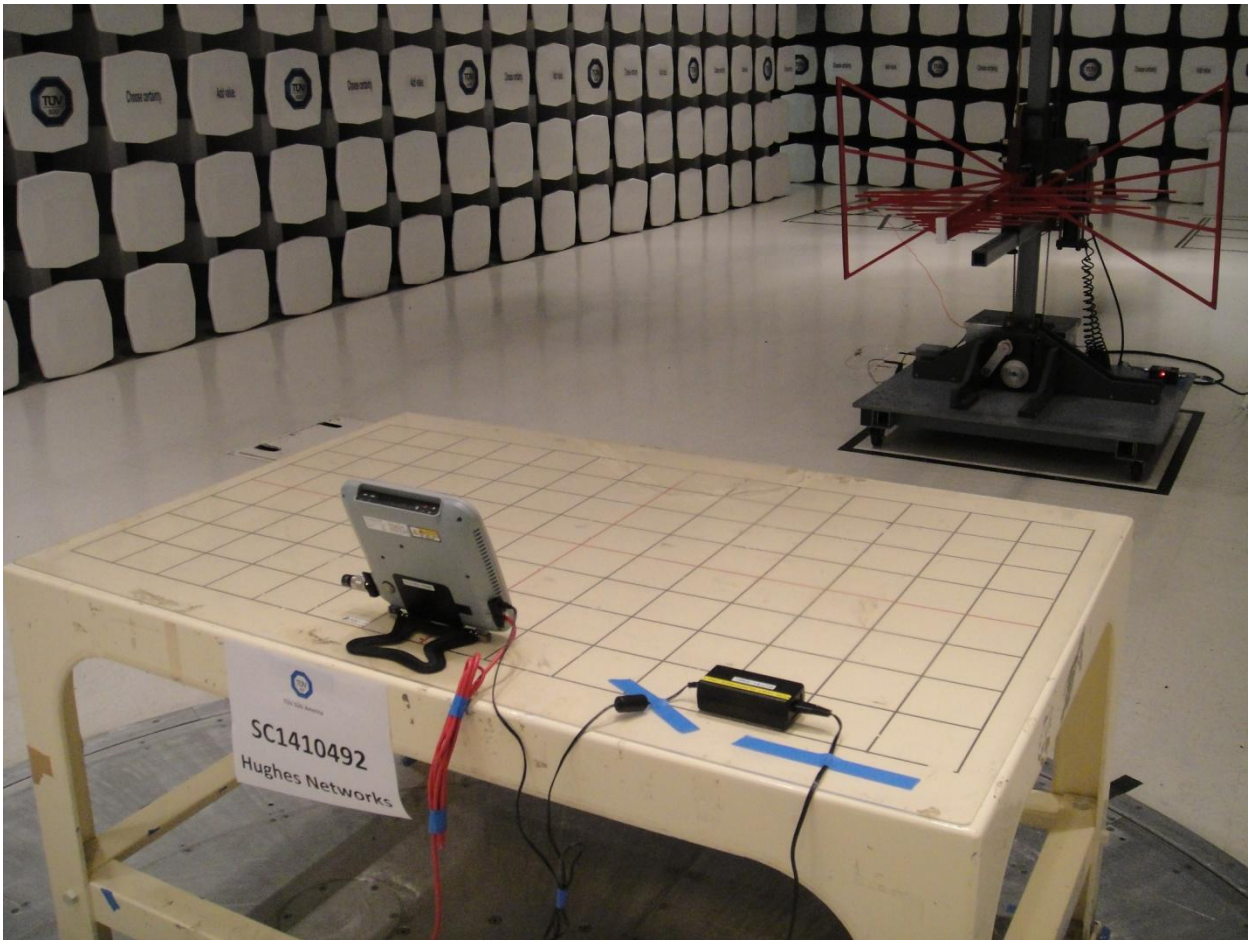
Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.000000	35.7	1000.0	1000.000	178.6	V	46.0	-7.0	18.2	53.9
1999.233333	30.8	1000.0	1000.000	301.2	H	50.0	-1.0	23.1	53.9
3977.266667	31.7	1000.0	1000.000	333.1	V	329.0	5.9	22.2	53.9
6565.433333	46.8	1000.0	1000.000	346.1	V	155.0	12.8	7.1	53.9
10876.23333	34.7	1000.0	1000.000	302.2	H	239.0	16.7	19.2	53.9
16777.66666	47.1	1000.0	1000.000	355.1	H	20.0	25.9	6.8	53.9

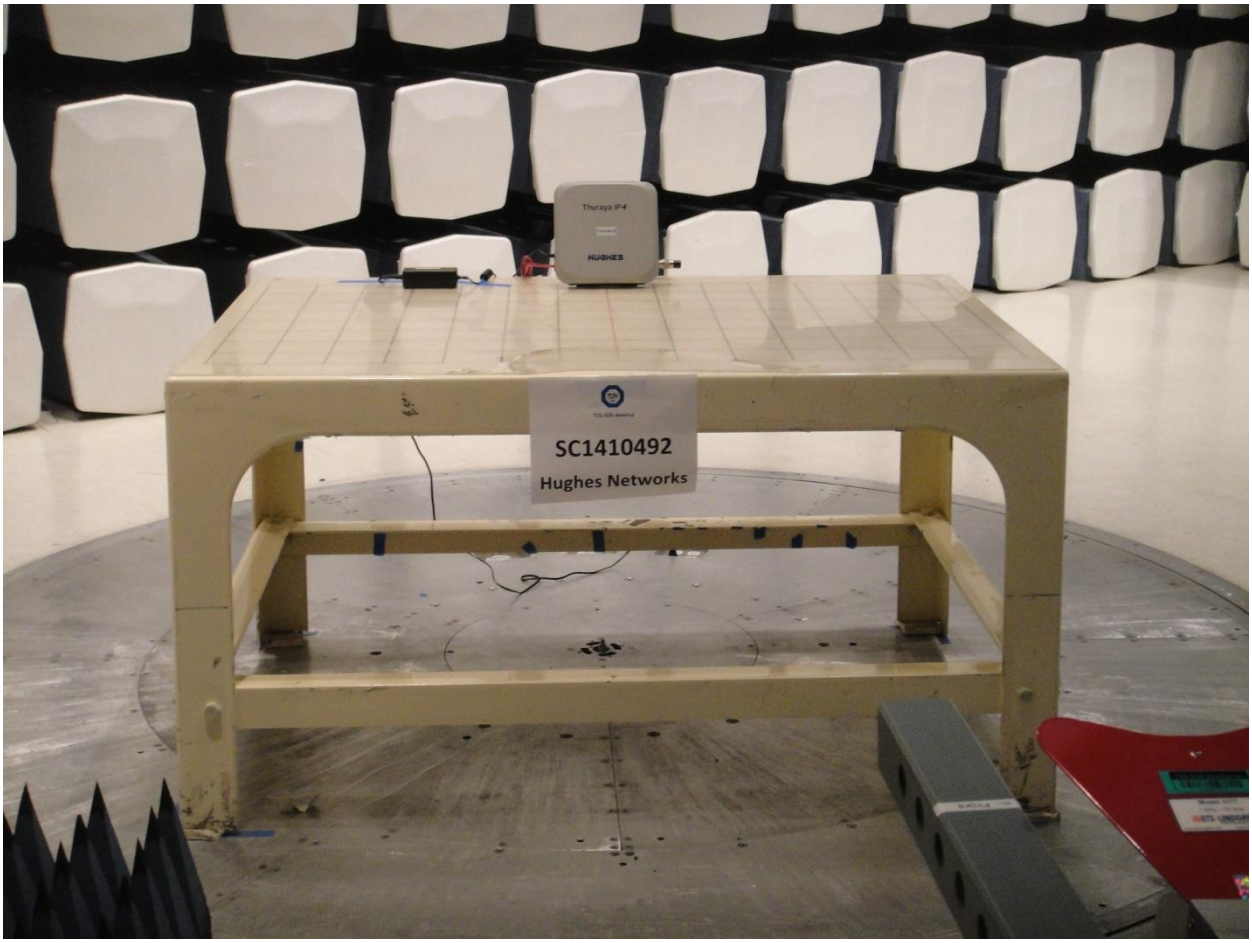
2.2.12 Test Setup Photo (Below 1GHz Front)



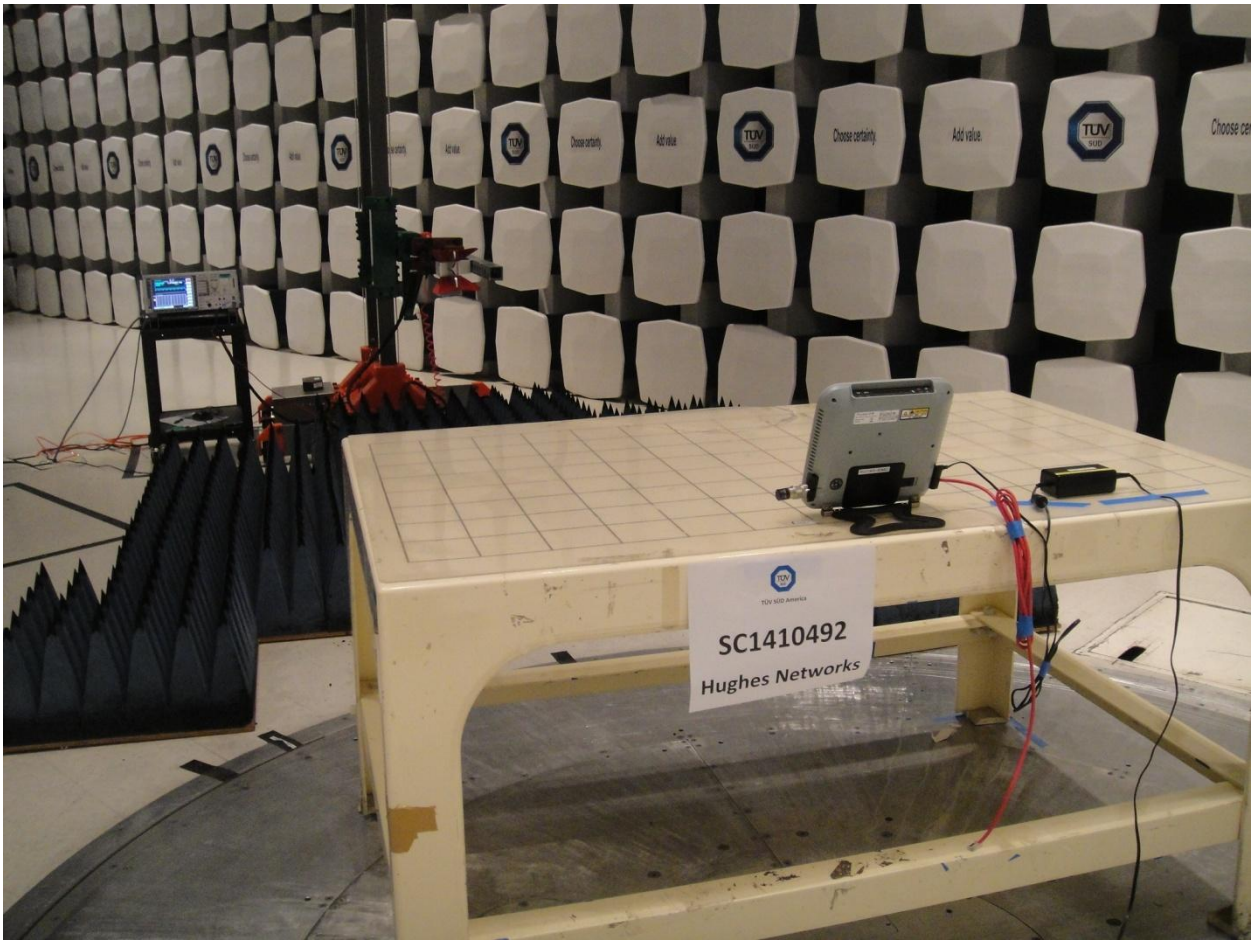
2.2.13 Test Setup Photo (Below 1GHz Back)



2.2.14 Test Setup Photo (Above 1GHz Front)



2.2.15 Test Setup Photo (Above 1GHz Back)



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SECTION 3

TEST EQUIPMENT USED

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3.1 TEST EQUIPMENT USED

List of absolute measuring and other principal items of test equipment.

ID Number (SDGE/SDRB)	Test Equipment	Type	Serial Number	Manufacturer	Cal Date	Cal Due Date
Conducted Emissions						
1024	EMI Test Receiver	ESCS 30	847793/001	Rhode & Schwarz	04/05/14	04/05/15
7568	LISN	FCC-LISN-50-25-2-10	120305	Fischer Custom Comm.	09/02/14	09/02/15
8822	20dB Attenuator	34-20-34	N/A	MCE / Weinschel	01/30/14	01/30/15
8824	20dB Attenuator	34-20-34	N/A	MCE / Weinschel	01/30/14	01/30/15
Radiated Emissions						
1040	EMI Test Receiver	ESIB40	100292	Rhode & Schwarz	08/29/14	08/29/15
1002	Bilog Antenna	3142C	00058717	ETS-Lindgren	01/30/14	01/30/16
1016	Pre-amplifier	PAM-0202	187	PAM	05/05/14	05/05/15
7575	Double-ridged waveguide horn antenna	3117	00155511	EMCO	04/08/14	04/08/15
8628	Pre-amplifier	QLJ 01182835-JO	8986002	QuinStar Technologies Inc.	04/03/14	04/03/15
1049	EMI Test Receiver	ESU	100133	Rhode & Schwarz	03/17/14	03/17/15
Miscellaneous						
7560	Barometer/Temperature /Humidity Transmitter	iBTHX-W	1240476	Omega	01/30/14	01/30/15
	Test Software	EMC32	V8.53	Rhode & Schwarz	N/A	

3.2 MEASUREMENT UNCERTAINTY

For a 95% confidence level, the measurement uncertainties for defined systems are:

3.2.1 Radiated Emission Measurements (Below 1GHz)

	Contribution	Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.45	0.26	0.07
2	Cables	Rectangular	0.50	0.29	0.08
3	Preamp	Rectangular	0.50	0.29	0.08
4	Antenna	Rectangular	0.75	0.43	0.19
5	Site	Rectangular	3.89	2.25	5.04
6	EUT Setup	Rectangular	1.00	0.58	0.33
				Combined Uncertainty (u_c):	2.41
				Coverage Factor (k):	2
				Expanded Uncertainty:	4.82

3.2.2 Radiated Emission Measurements (Above 1GHz)

	Contribution	Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.57	0.33	0.11
2	Cables	Rectangular	0.70	0.40	0.16
3	Preamp	Rectangular	0.50	0.29	0.08
4	Antenna	Rectangular	0.37	0.21	0.05
5	Site	Rectangular	3.89	2.25	5.04
6	EUT Setup	Rectangular	1.00	0.58	0.33
				Combined Uncertainty (u_c):	2.40
				Coverage Factor (k):	2
				Expanded Uncertainty:	4.81

3.2.3 Conducted Emissions Measurement

	Contribution	Probability Distribution Type	Probability Distribution x_i	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.36	0.21	0.04
2	Cables	Rectangular	0.50	0.29	0.08
3	LISN	Rectangular	0.66	0.38	0.15
	Attenuator	Rectangular	0.30	0.17	0.03
				Combined Uncertainty (u_c):	0.80
				Coverage Factor (k):	2
				Expanded Uncertainty:	1.59

SECTION 4

DIAGRAM OF TEST SETUP

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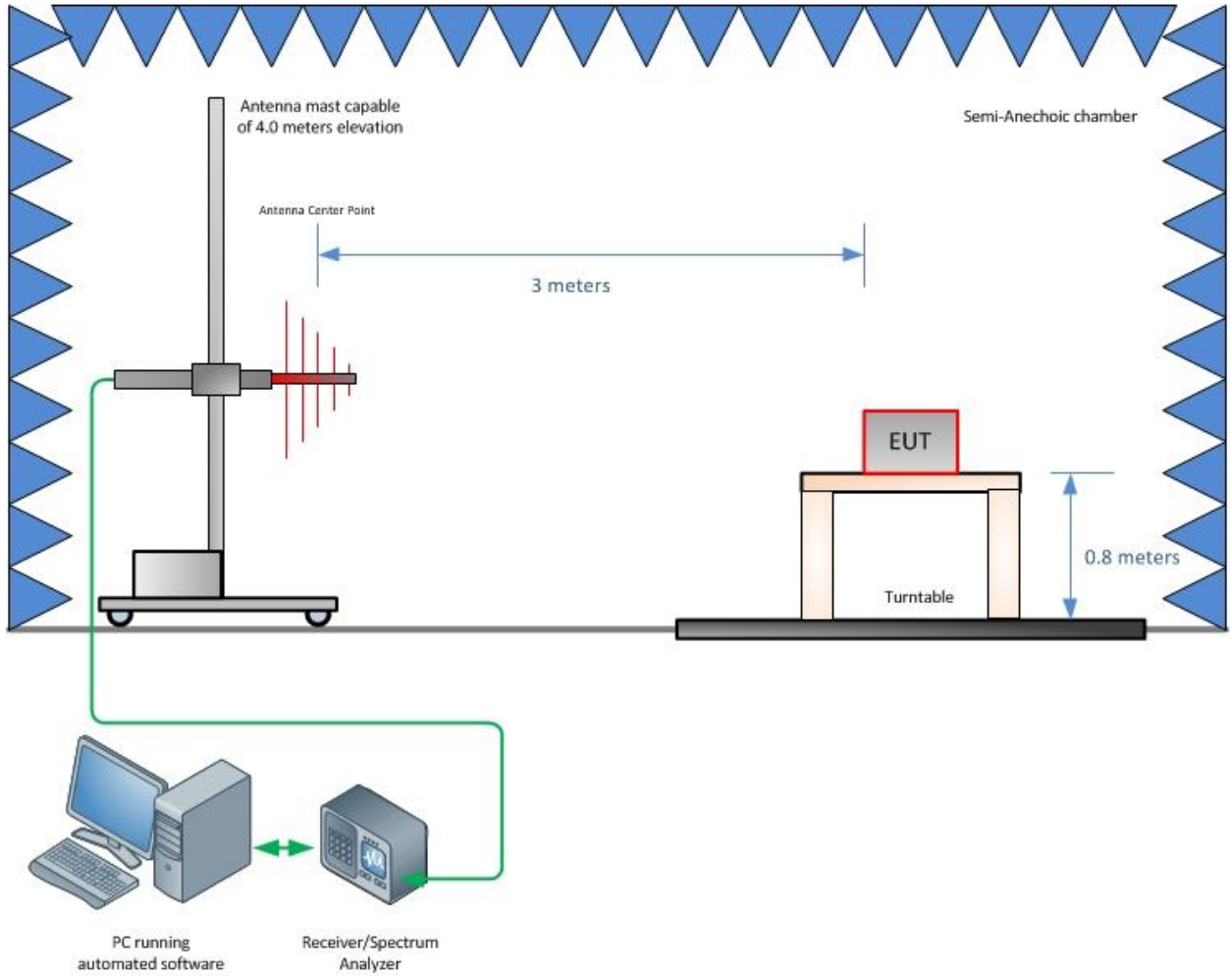
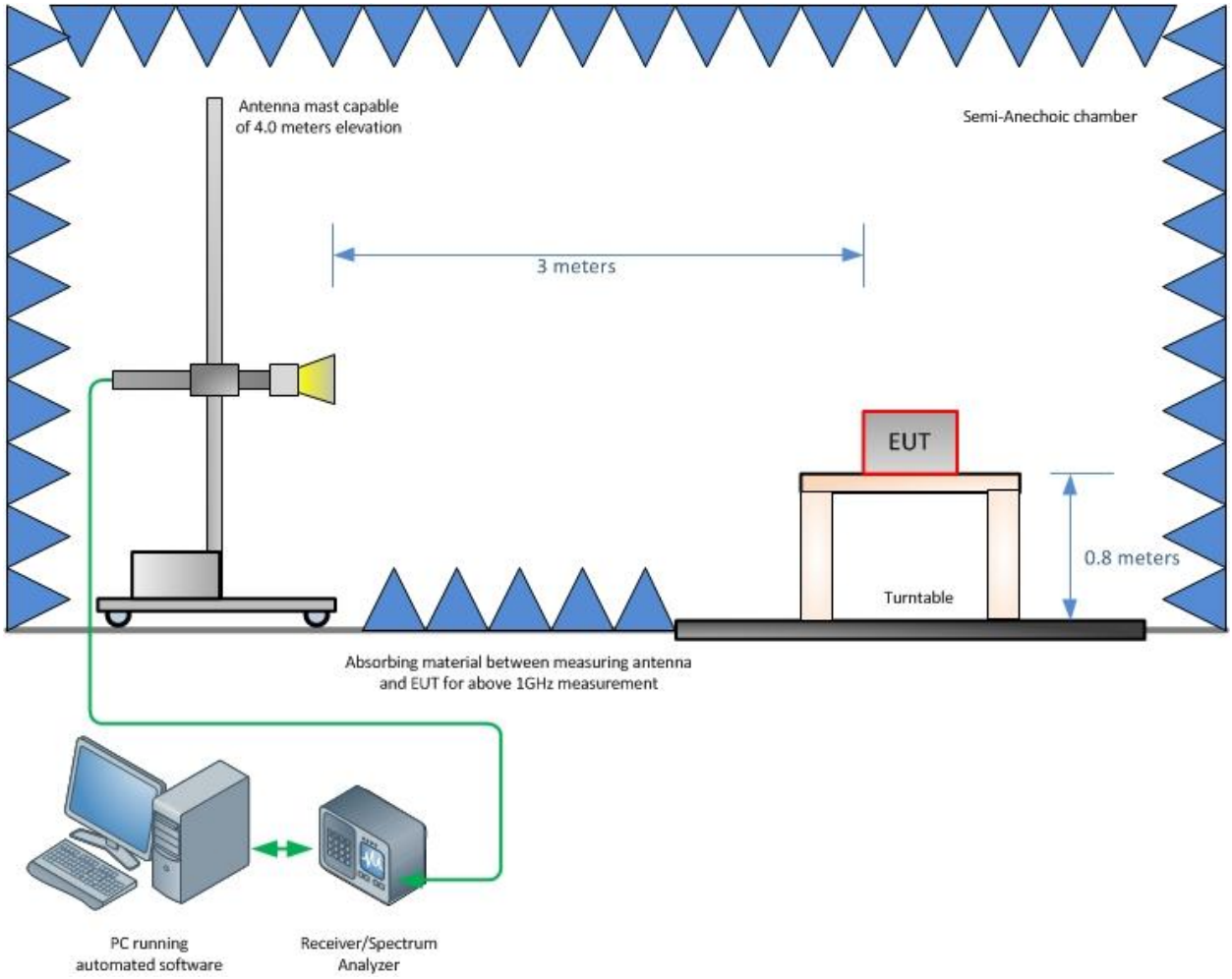
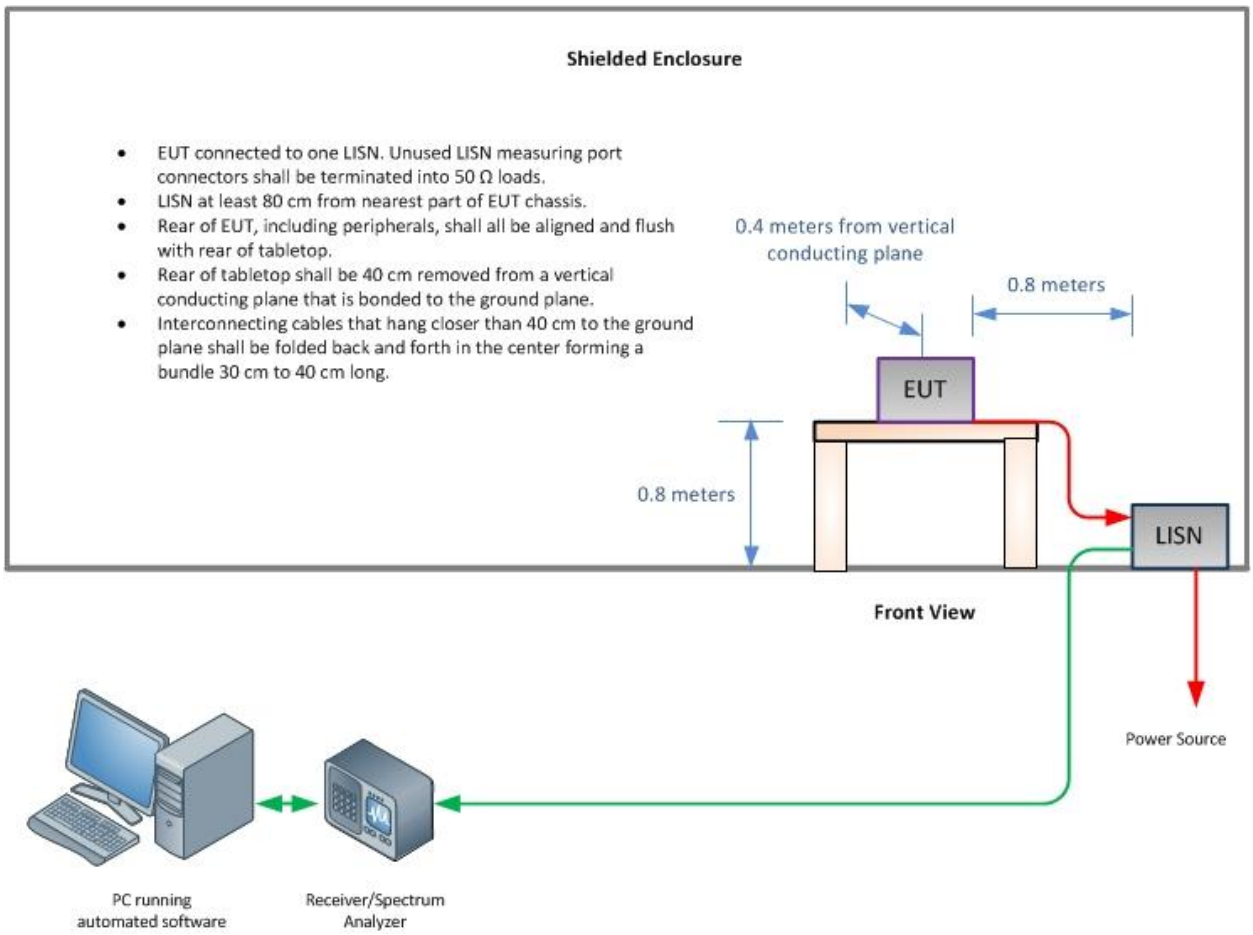
4.1 TEST SETUP DIAGRAM



Radiated Emission Test Setup (Below 1GHz)



Radiated Emission Test Setup (Above 1GHz)



Conducted Emission Test Setup

SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

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