FCC CFR47 PART 15 SUBPART C

ANT+
CERTIFICATION TEST REPORT

FOR

Phone with Bluetooth, DTS/UNII a/b/g/n, ANT+ & NFC

MODEL NUMBER: SM-A500FU

FCC ID: A3LSMA500FU

REPORT NUMBER: 14U19260-E5, REVISION A

ISSUE DATE: DECEMBER 8, 2014

Prepared for
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NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
--	11/7/14	Initial issue	D. Coronia
A	12/8/14	Updated company address	P. Zhang

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME:	**SAMSUNG ELECTRONICS CO., LTD.**
EUT DESCRIPTION:	**Phone with Bluetooth, DTS/UNII a/b/g/n, ANT+ & NFC**
MODEL:	**SM-A500FU**
SERIAL NUMBER:	**1989213 (CONDUCTED); 1989211 (RADIATED)**
DATE TESTED:	**NOVEMBER 3-7, 2014**

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 15 Subpart C	Pass

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL Verification Services Inc. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Approved & Released For

UL Verification Services Inc. By:

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Tested By:

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CONSUMER TECHNOLOGY DIVISION
LAB ENGINEER
UL Verification Services Inc.

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2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.4-2009, FCC CFR 47 Part 2, FCC CFR 47 Part 15.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 and 47266 Benicia Street, Fremont, California, USA. Line conducted emissions are measured only at the 47173 address. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

47173 Benicia Street	47266 Benicia Street
☐ Chamber A(IC: 2324B-1)	☐ Chamber D(IC: 2324B-4)
☒ Chamber B(IC: 2324B-2)	☐ Chamber E(IC: 2324B-5)
☒ Chamber C(IC: 2324B-3)	☐ Chamber F(IC: 2324B-6)
	☐ Chamber G(IC: 2324B-7)
	☐ Chamber H(IC: 2324B-8)

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at http://ts.nist.gov/standards/scopes/2000650.htm.

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)

36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

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4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Conducted Disturbance, 0.15 to 30 MHz	3.52 dB
Radiated Disturbance, 30 to 26000 MHz	4.94 dB

Uncertainty figures are valid to a confidence level of 95%.

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5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is a Phone with Bluetooth, DTS/UNII a/b/g/n, ANT+ & NFC

5.2. MAXIMUM OUTPUT FUNDAMENTAL FIELD STRENGTH

The ANT+ mode has maximum output fundamental field strength as follows:

Frequency Range (MHz)	Mode	Peak E-field Strength (dBuV/m)	Avg E-field Strength (dBuV/m)	Distance (m)
2402 - 2480	ANT +	73.73	73.06	3.00

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes an FPCB antenna, with a maximum gain of -4.08dBi.

5.4. WORST-CASE CONFIGURATION AND MODE

Radiated emission and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

The fundamental of the EUT was investigated in three orthogonal orientations X,Y,Z, it was determined that X orientation was worst-case orientation; therefore, all final radiated testing was performed with the EUT in X orientation.

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5.5. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
AC Adapter	SAMSUNG	EP-TA50EWE	N/A	N/A
Earphone	SAMSUNG	EHS64AVFWE	N/A	N/A

I/O CABLES

I/O Cable List						
Cable No	**Port**	**# of identical ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	DC Power	1	Mini-USB	Shielded	1.2m	N/A
2	Audio	1	Mini-Jack	Unshielded	1m	N/A

TEST SETUP

The EUT is set to continuously transmit in ANT + test mode

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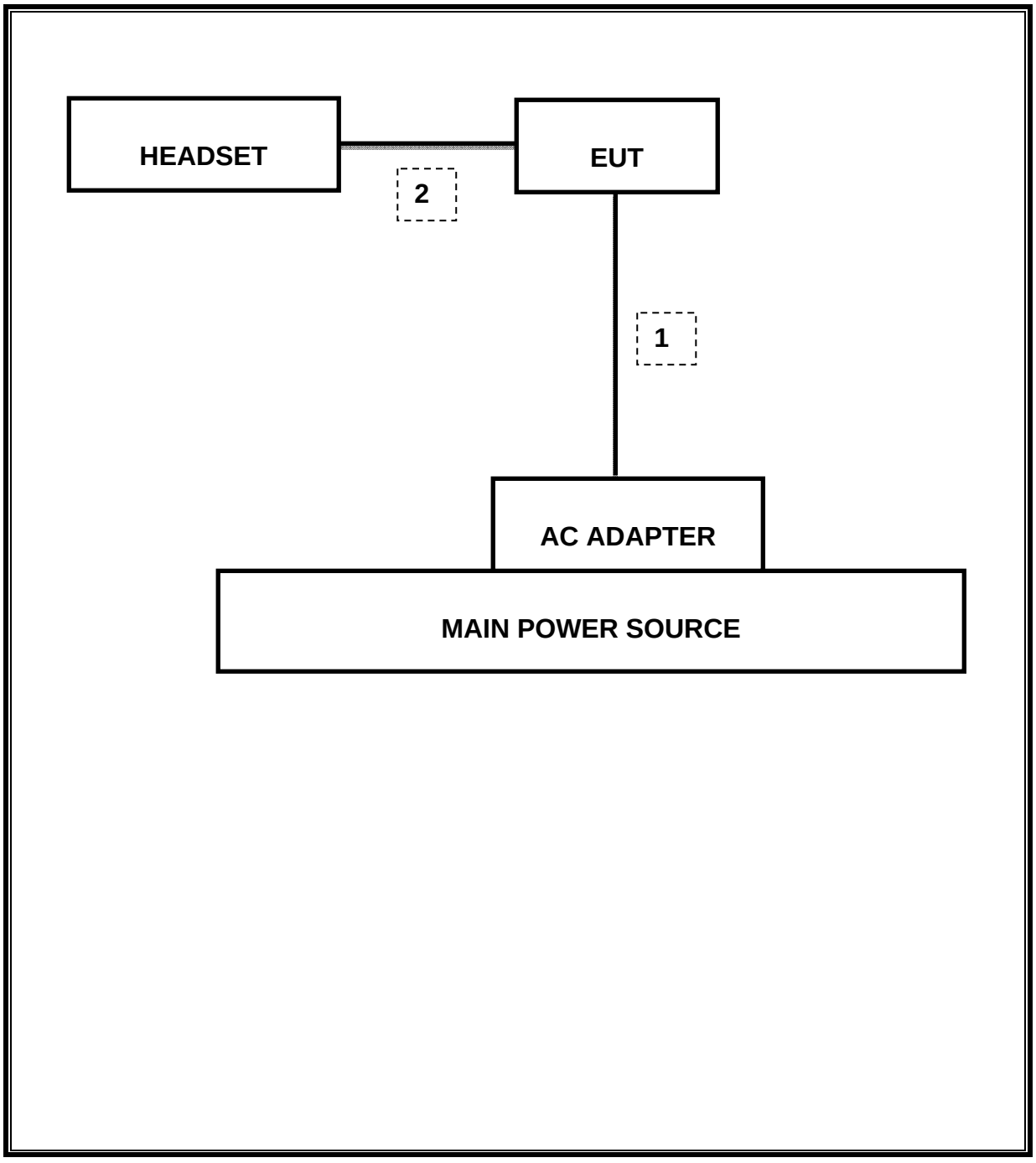
SETUP DIAGRAM FOR TESTS



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6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

Test Equipment List				
Description	**Manufacturer**	**Model**	**Asset**	**Cal Due**
Antenna, Biconolog, 30MHz-1 GHz	Sunol Sciences	JB1	C01171	02/13/15
Antenna, Horn, 18GHz	EMCO	3115	C00783	10/25/15
Antenna, Horn, 26.5 GHz	ARA	MWH-1826/B	C00980	11/14/14
Preamplifier, 1300 MHz	Agilent / HP	8447D	C00580	01/28/15
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C01052	10/22/15
Spectrum Analyzer, 44 GHz	Agilent / HP	E4446A	C01069	12/20/14
CBT Bluetooth Tester	R & S	CBT	None	07/12/15
Peak Power Meter	Agilent / HP	E4416A	C00963	12/13/14
Peak / Average Power Sensor	Agilent / HP	E9327A	C00964	12/13/14
LISN, 30 MHz	FCC	50/250-25-2	C00626	01/14/15
Reject Filter, 2.4GHz	Micro-Tronics	BRM50702	N02684	CNR

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7. LIMITS AND RESULTS

7.1. 99% BANDWIDTH

LIMIT

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 99 % bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

RESULTS

Frequency (MHz)	99% Bandwidth (MHz)
2402	0.930
2442	0.838
2480	0.890

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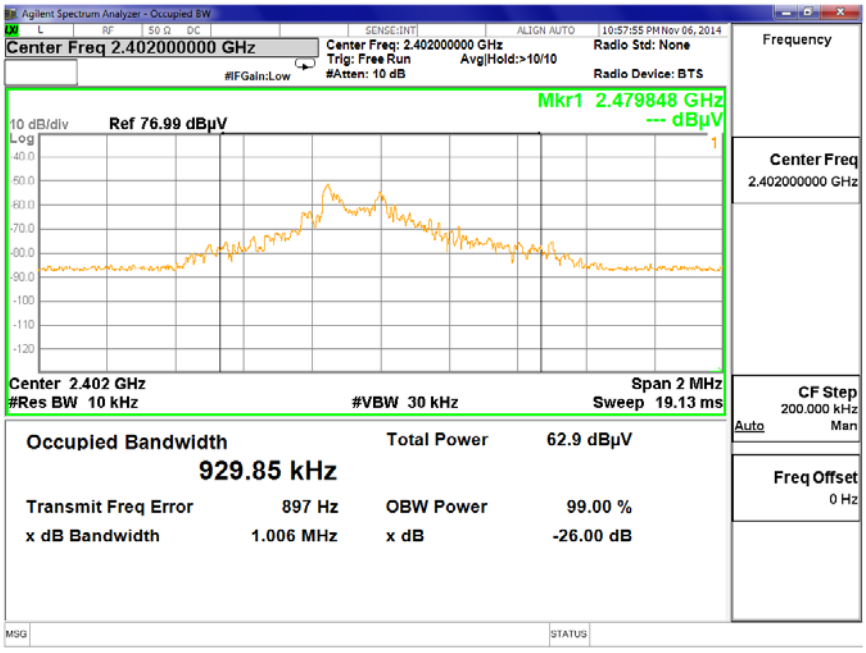
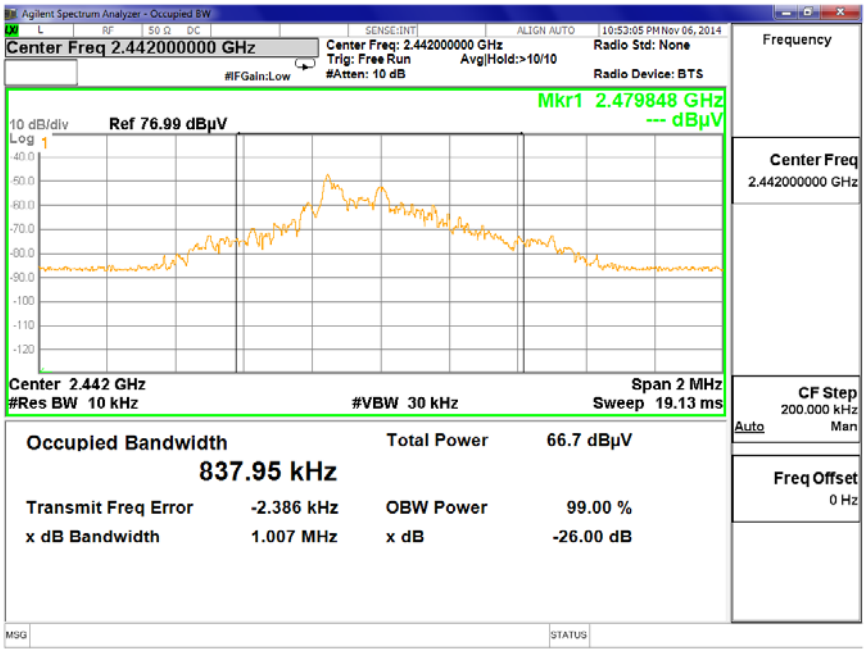
99% BANDWIDTH

99% BANDWIDTH LOW CH



99% BANDWIDTH MID CH



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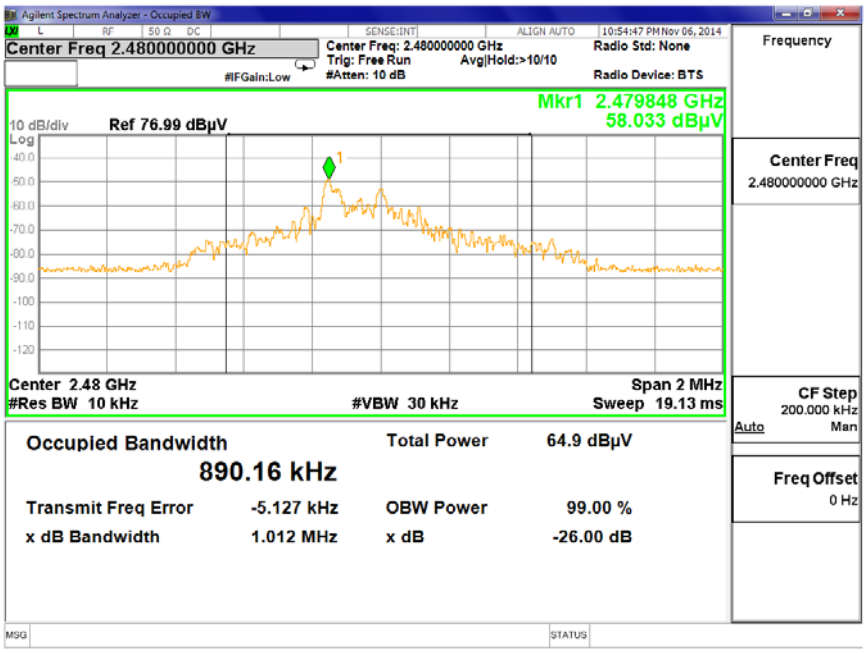
99% BANDWIDTH HIGH CH



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7.2. TRANSMITTER RADIATED EMISSIONS

TEST PROCEDURE

ANSI C63.4-2009

LIMIT

FCC 15.249

Operation within the bands 902–928 MHz, 2400–2483.5 MHz, 5725–5875 MHZ, and 24.0–24.25 GHz.
(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (microvolts/meter)
902–928 MHz	50	500
2400–2483.5 MHz	50	500
5725–5875 MHz	50	500
24.0–24.25 GHz	250	2500

(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.

(e) As shown in Sec. 15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

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Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009–0.490	2400/F(kHz)	300
0.490–1.705	24000/F(kHz)	30
1.705–30.0	30	30
30–88	100 **	3
88–216	150 **	3
216–960	200 **	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54–72 MHz, 76–88 MHz, 174–216 MHz or 470–806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

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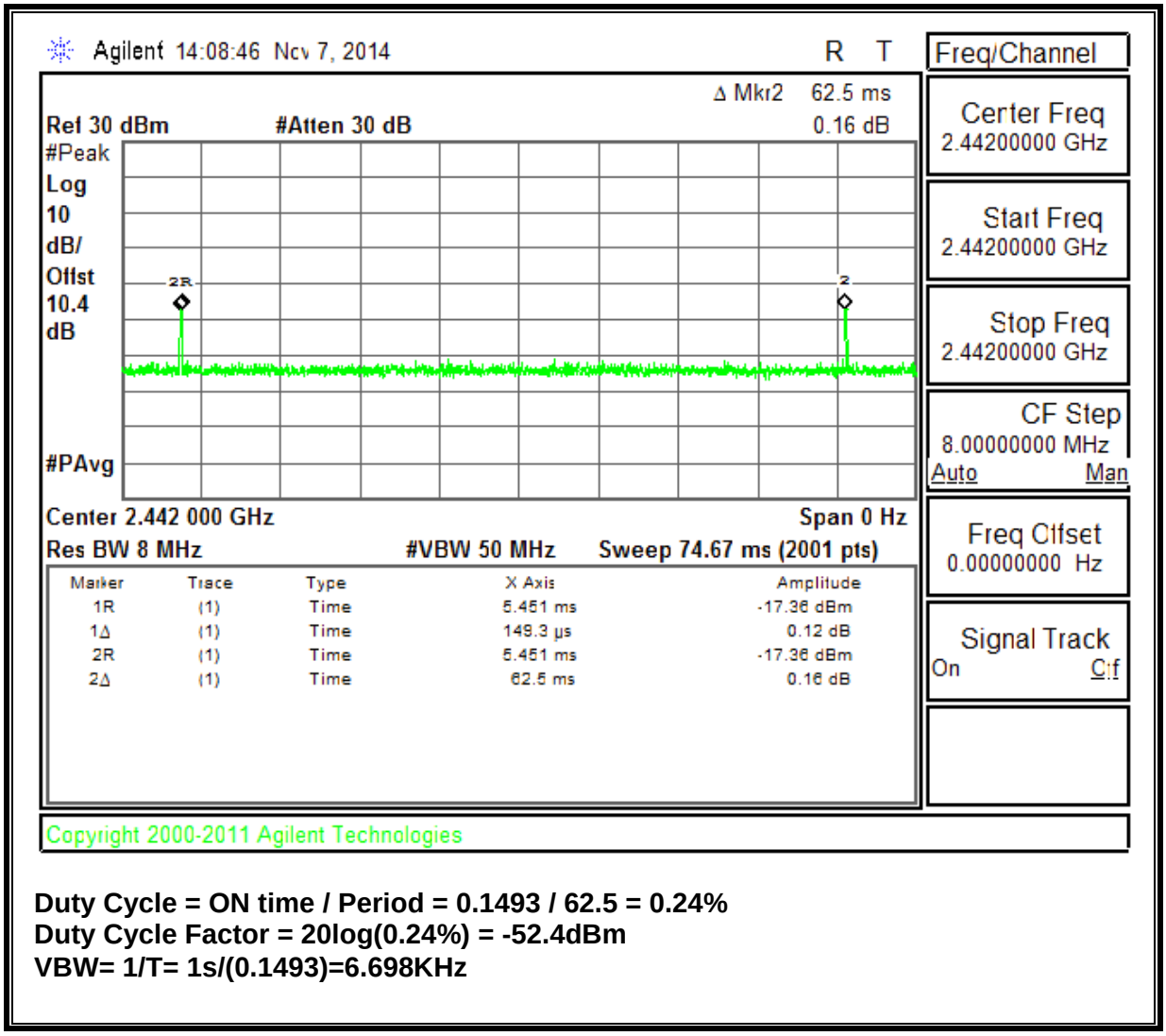
RESULTS

7.2.1. DUTY CYCLE



Duty Cycle = ON time / Period = 0.1493 / 62.5 = 0.24%
Duty Cycle Factor = 20log(0.24%) = -52.4dBm
VBW= 1/T= 1s/(0.1493)=6.698KHz

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7.2.2. FUNDAMENTAL FREQUENCY RADIATED EMISSION

FCC, VCCI, CISPR, CE, AUSTEL, NZ
UL, CSA, TUV, BSMI, DHHS, NVLAP

47173 BENICIA STREET, FREMONT, CA 94538, USA

Project #:	14U19260
Report #:	14U19260
Date& Time:	11/06/14
Test Engr:	D. Sblendorio
Company:	Samsung
EUT Description:	Phone + Bluetooth, DTS/UNII a/b/g/n ANT+ & NFC
Test Configuration :	X POSITION
Type of Test:	FCC
Mode of Operation:	Transmitting : ANT+ mode

M% = ((t1+t2+t3+...)/T) * 66.83% = 0.24%

Av Reading = Pk Reading + 20*log(M%)
20 * log (M%) = -52.40

Freq.	Pk Rdg	Av Rdg	AF	Closs	Pre-amp	Pk Level	Av Level	Pk Limit	Av Limit	Pk Margin	Avg Margin	Pol	Az	Height
(MHz)	(dBuV)	(dBuV)	(dB)	(dB)	(dB)	(dBuV/m)	(dBuV/m)	FCC_B	FCC_B	(dB)	(dB)	(H/V)	(Deg)	(Meter)
Low channel														
2402.00	74.02	73.23	32.10	-34.00	0.00	72.12	71.33	114.00	94.00	-41.88	-22.67	3mV	0.00	1.00
2402.00	75.63	74.96	32.10	-34.00	0.00	73.73	73.06	114.00	94.00	-40.27	-20.95	3mH	0.00	2.00
Mid channel														
2442.00	74.96	73.58	32.10	-34.00	0.00	73.06	71.68	114.00	94.00	-40.94	-22.32	3mV	0.00	1.00
2442.00	73.45	72.79	32.10	-34.00	0.00	71.55	70.89	114.00	94.00	-42.45	-23.11	3mH	0.00	2.00
High channel														
2480.00	70.70	70.40	32.10	-34.00	0.00	68.80	68.50	114.00	94.00	-45.20	-25.50	3mV	0.00	1.00
2480.00	74.15	72.91	32.10	-34.00	0.00	72.25	71.01	114.00	94.00	-41.75	-23.00	3mH	0.00	2.00

AVG VB=1/Ton, Voltage Averaging Max Hold where: Ton is the duration of the packet

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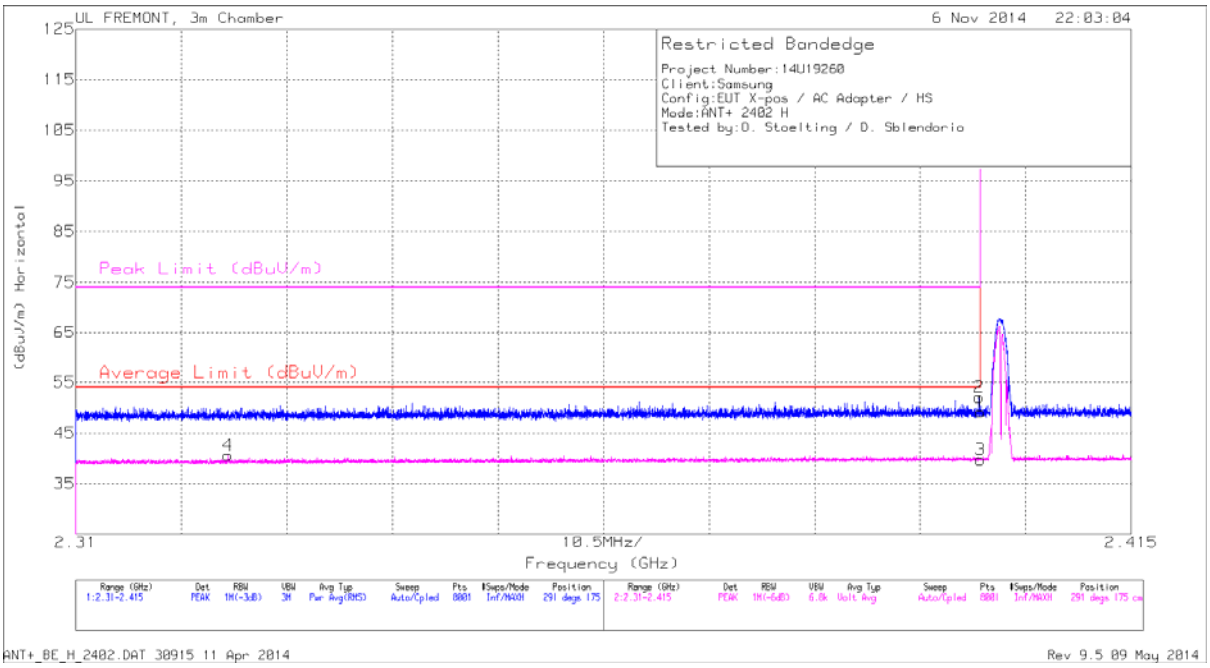
7.2.3. TRANSMITTER RESTRICTED BAND EDGES

BANDEDGE (LOW CHANNEL, HORIZONTAL)



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T345 (dB/m)	Amp/Cbl/ Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
4	2.325	31.58	VB1T	31.8	-22.8	40.58	54	-13.42	-	-	291	175	H
1	2.4	39.76	PK	32.1	-22.7	49.16	-	-	74	-24.84	291	175	H
2	2.4	42.7	PK	32.1	-22.7	52.1	-	-	74	-21.9	291	175	H
3	2.4	30.36	VB1T	32.1	-22.7	39.76	54	-14.24	-	-	291	175	H

PK - Peak detector

VB1T - FHSS Method: VB=1/Ton, Voltage Averaging Max Hold where: Ton is the duration of the packet

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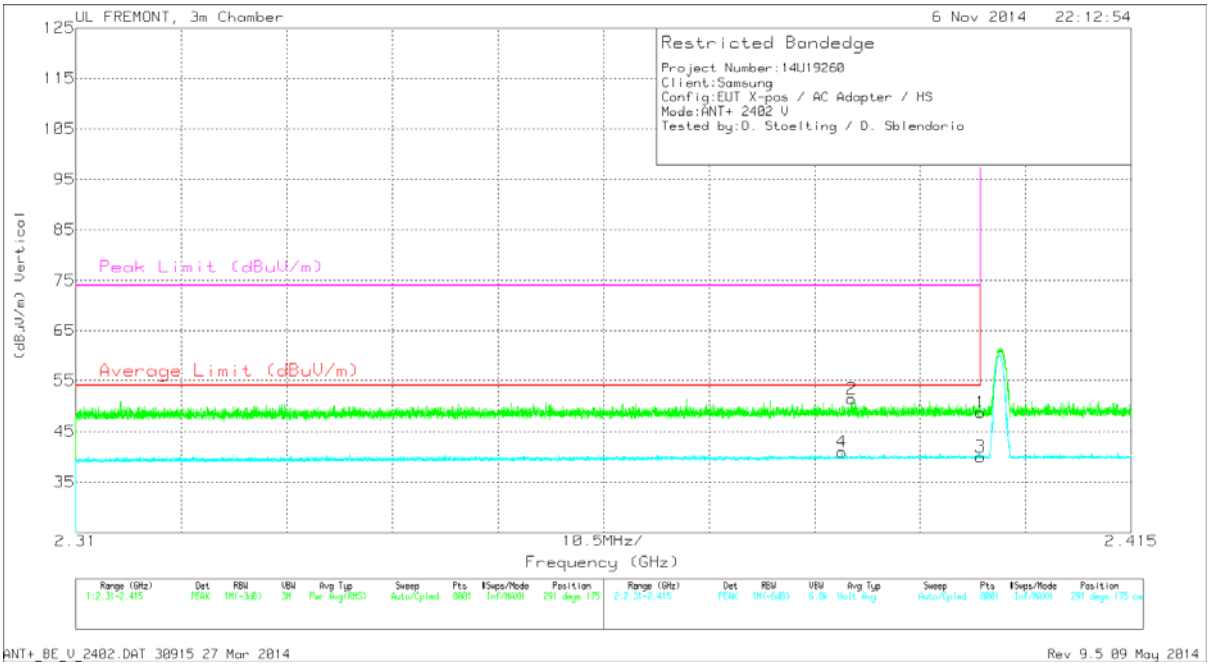
BANDEDGE (LOW CHANNEL, VERTICAL)



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T345 (dB/m)	Amp/Cbl/ Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
4	2.386	31.54	VB1T	32.1	-22.7	40.94	54	-13.06	-	-	291	175	V
2	2.387	42.01	PK	32.1	-22.7	51.41	-	-	74	-22.59	291	175	V
1	2.4	39.33	PK	32.1	-22.7	48.73	-	-	74	-25.27	291	175	V
3	2.4	30.57	VB1T	32.1	-22.7	39.97	54	-14.03	-	-	291	175	V

PK - Peak detector

VB1T - FHSS Method: VB=1/Ton, Voltage Averaging Max Hold where: Ton is the duration of the packet

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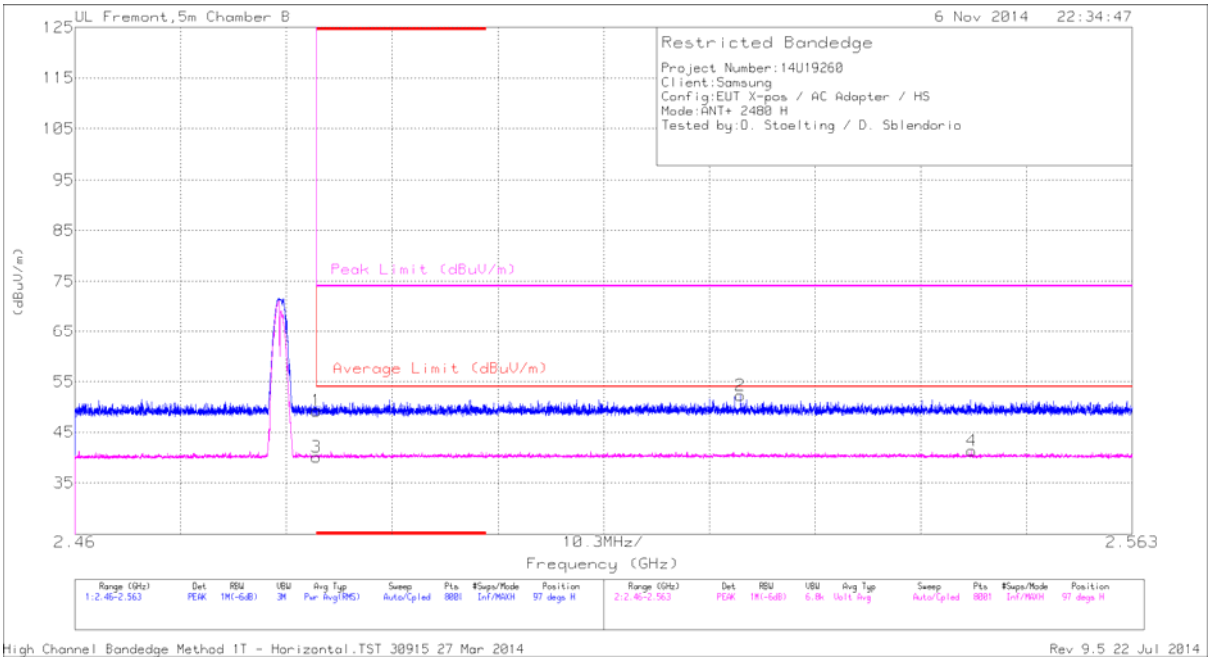
RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T345 (dB/m)	Amp/Cbl/ Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.484	39.44	PK	32.4	-22.6	49.24	-	-	74	-24.76	97	139	H
3	* 2.484	30.29	VB1T	32.4	-22.6	40.09	54	-13.91	-	-	97	139	H
2	2.525	42.29	PK	32.5	-22.5	52.29	-	-	74	-21.71	97	139	H
4	2.547	31.3	VB1T	32.5	-22.5	41.3	54	-12.7	-	-	97	139	H

PK - Peak detector

VB1T - FHSS Method: VB=1/Ton, Voltage Averaging Max Hold where: Ton is the duration of the packet

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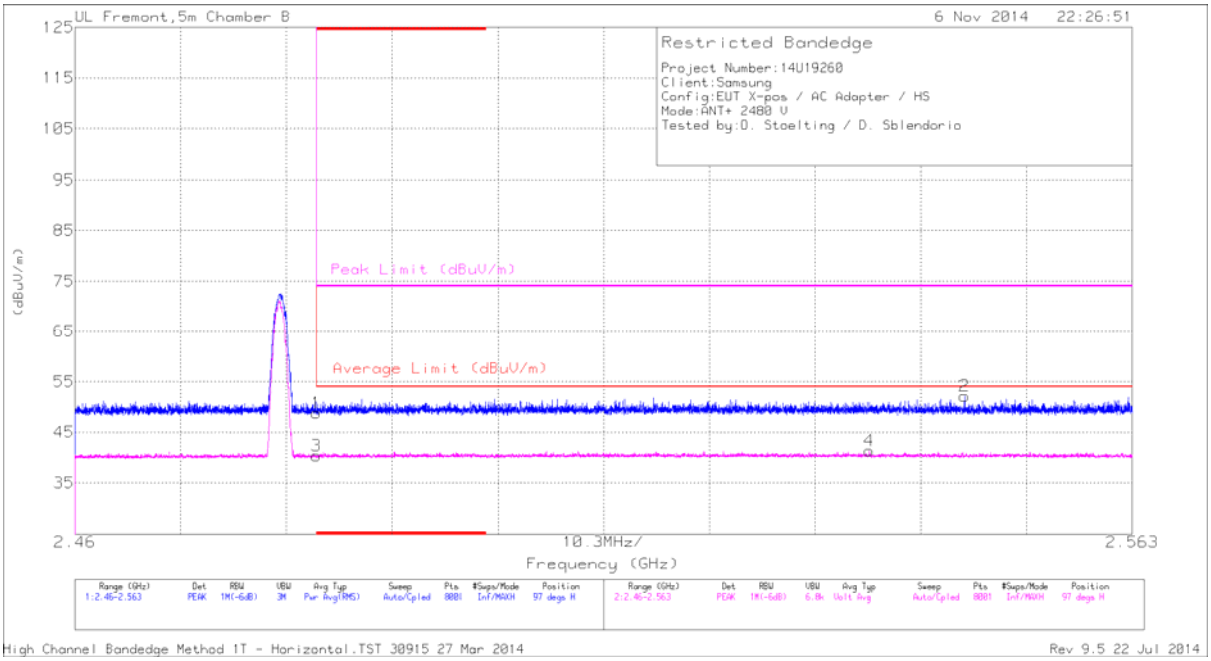
RESTRICTED BANDEDGE (HIGH CHANNEL, VERTICAL)



Trace Markers

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T345 (dB/m)	Amp/Cbl/ Fltr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.484	38.95	PK	32.4	-22.6	48.75	-	-	74	-25.25	97	139	V
3	* 2.484	30.61	VB1T	32.4	-22.6	40.41	54	-13.59	-	-	97	139	V
4	2.537	31.36	VB1T	32.5	-22.5	41.36	54	-12.64	-	-	97	139	V
2	2.547	42.22	PK	32.5	-22.6	52.12	-	-	74	-21.88	97	139	V

PK - Peak detector

VB1T - FHSS Method: VB=1/Ton, Voltage Averaging Max Hold where: Ton is the duration of the packet

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HARMONICS AND SPURIOUS EMISSIONS ABOVE 1GHz

HARMONICS

FCC, VCCI, CISPR, CE, AUSTEL, NZ
UL, CSA, TUV, BSMI, DHHS, NVLAP

47173 BENICIA STREET, FREMONT, CA 94538, USA

Project #:	14U19260
Report #:	14U19260
Date& Time:	11/06/14
Test Engr:	D. Sblendorio
Company:	Samsung
EUT Description:	Phone + Bluetooth, DTS/UNII a/b/g/n, ANT+ & NFC
Test Configuration :	X POSITION
Type of Test:	FCC
Mode of Operation:	Transmitting : ANT+ mode

M% = ((t1+t2+t3+...)/T) * 66.83% = 0.24%

Av Reading = Pk Reading + 20*log(M%)
20 * log (M%) = -52.40

Freq. (MHz)	Pk Rdg (dBuV)	Av Rdg (dBuV)	AF (dB)	Closs (dB)	Pre-amp (dB)	Pk Level (dBuV/m)	Av Level (dBuV/m)	Pk Limit FCC_B	Av Limit FCC_B	Pk Margin (dB)	Avg Margin (dB)	Pol (H/V)	Az (Deg)	Height (Meter)
Low channel														
4804.00	44.29	33.46	32.10	-20.00	0.00	56.39	45.56	74.00	54.00	-17.61	-8.44	3mV	0.00	1.00
4804.00	43.23	33.20	32.10	-20.00	0.00	55.33	45.30	74.00	54.00	-18.67	-8.71	3mH	0.00	2.00
Mid channel														
4884.00	43.50	33.76	32.10	-20.00	0.00	55.60	45.86	74.00	54.00	-18.40	-8.14	3mV	0.00	1.00
4884.00	44.12	33.42	32.10	-20.00	0.00	56.22	45.52	74.00	54.00	-17.78	-8.48	3mH	0.00	2.00
High channel														
4960.00	43.95	33.53	32.10	-20.00	0.00	56.05	45.63	74.00	54.00	-17.95	-8.37	3mV	0.00	1.00
4960.00	44.08	33.62	32.10	-20.00	0.00	56.18	45.72	74.00	54.00	-17.82	-8.28	3mH	0.00	2.00

AVG VB=1/Ton, Voltage Averaging Max Hold where: Ton is the duration of the packet

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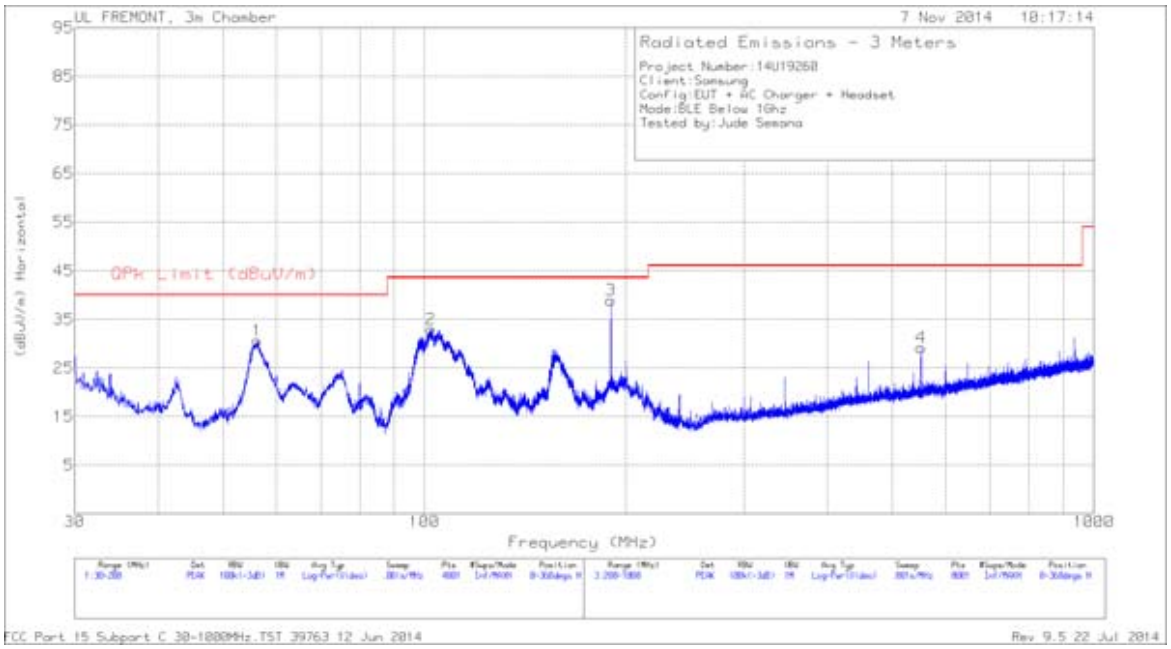
7.2.4. SPURIOUS BELOW 1 GHz

SPURIOUS EMISSIONS 30 TO 1000 MHz (HORIZONTAL)

HORIZONTAL PLOT



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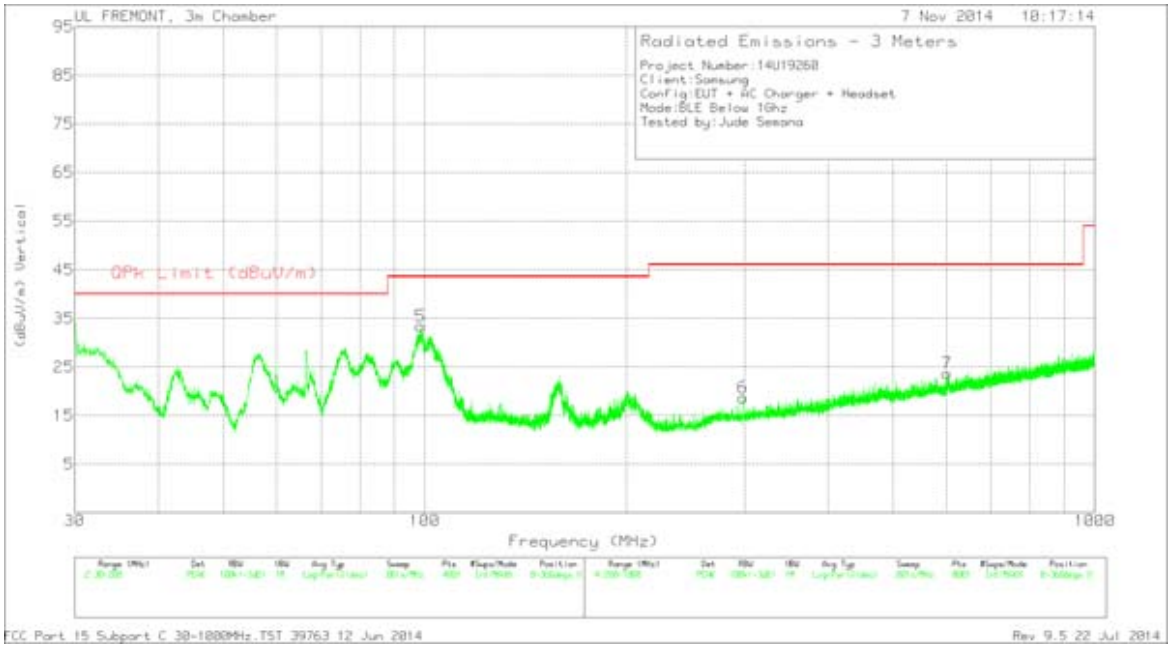
SPURIOUS EMISSIONS 30 TO 1000 MHz (VERTICAL)

VERTICAL PLOT



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Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AF T185 (dB/m)	Amp/Cbl (dB/m)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	56.3075	51.04	PK	6.8	-27.2	30.64	40	-9.36	0-360	400	H
5	98.5525	50.72	PK	9.5	-26.8	33.42	43.52	-10.1	0-360	100	V
2	102.2075	49.33	PK	10.5	-26.8	33.03	43.52	-10.49	0-360	200	H
3	189.885	53.85	PK	11	-25.9	38.95	43.52	-4.57	0-360	200	H
6	298.3	30.61	PK	13.3	-25.2	18.71	46.02	-27.31	0-360	200	V
4	552	36.9	PK	18.1	-25.8	29.2	46.02	-16.82	0-360	200	H
7	602.3	30.92	PK	18.4	-25.6	23.72	46.02	-22.3	0-360	100	V

PK - Peak detector

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8. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

RSS-Gen 7.2.2

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	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.

TEST PROCEDURE

ANSI C63.4 - 2009

RESULTS

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6 WORST EMISSIONS

Line-L1 .15 - 30MHz

Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	T24 IL L1 (dB)	LC Cables 1&3 (dB)	Corrected Reading dBuV	CISPR 22 Class B QP	Margin to Limit (dB)	CISPR 22 Class B Avg	Margin to Limit (dB)
1	.1545	44.43	PK	1.3	0	45.73	65.8	-20.07	-	-
2	.1545	29.62	Av	1.3	0	30.92	-	-	55.8	-24.88
3	.5595	44.01	PK	.3	0	44.31	56	-11.69	-	-
4	.5595	31.04	Av	.3	0	31.34	-	-	46	-14.66
5	1.0635	39.23	PK	.2	0	39.43	56	-16.57	-	-
6	1.0635	24.37	Av	.2	0	24.57	-	-	46	-21.43
7	9.4695	44.46	PK	.2	.1	44.76	60	-15.24	-	-
8	9.4695	28.35	Av	.2	.1	28.65	-	-	50	-21.35
9	19.527	36.91	PK	.3	.2	37.41	60	-22.59	-	-
10	19.527	21.37	Av	.3	.2	21.87	-	-	50	-28.13

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Line-L2 .15 - 30MHz

Trace Markers

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	T24 IL L2 (dB)	LC Cables 2&3 (dB)	Corrected Reading dBuV	CISPR 22 Class B QP	Margin to Limit (dB)	CISPR 22 Class B Avg	Margin to Limit (dB)
11	.258	41.51	PK	.7	0	42.21	61.5	-19.29	-	-
12	.258	25.25	Av	.7	0	25.95	-	-	51.5	-25.55
13	.537	42.89	PK	.3	0	43.19	56	-12.81	-	-
14	.537	30.87	Av	.3	0	31.17	-	-	46	-14.83
15	1.1625	40.83	PK	.3	0	41.13	56	-14.87	-	-
16	1.1625	23.55	Av	.3	0	23.85	-	-	46	-22.15
17	9.528	42.14	PK	.2	.2	42.54	60	-17.46	-	-
18	9.528	25.19	Av	.2	.2	25.59	-	-	50	-24.41
19	19.851	33.41	PK	.3	.2	33.91	60	-26.09	-	-
20	19.851	14.43	Av	.3	.2	14.93	-	-	50	-35.07

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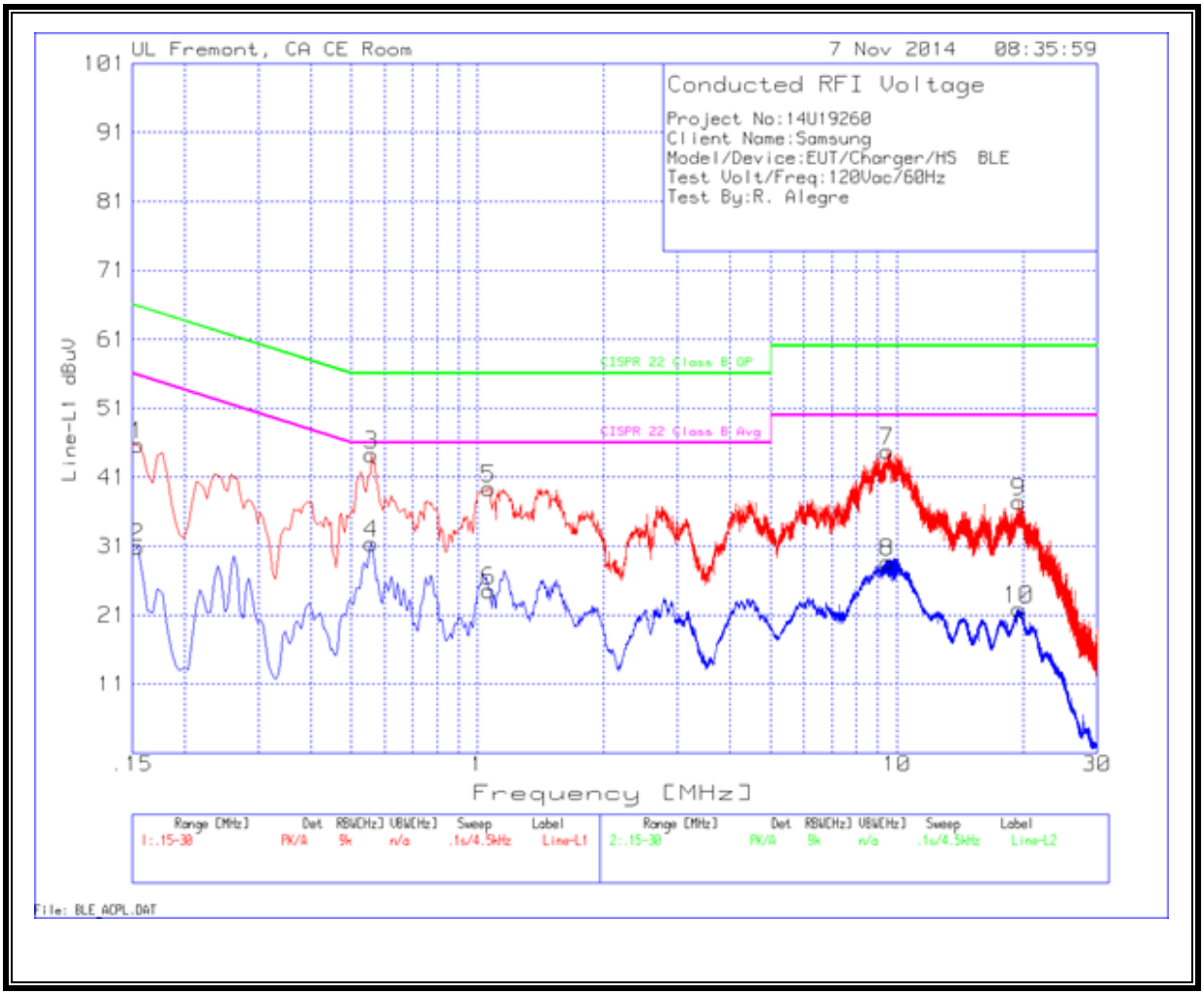
LINE 1 RESULTS



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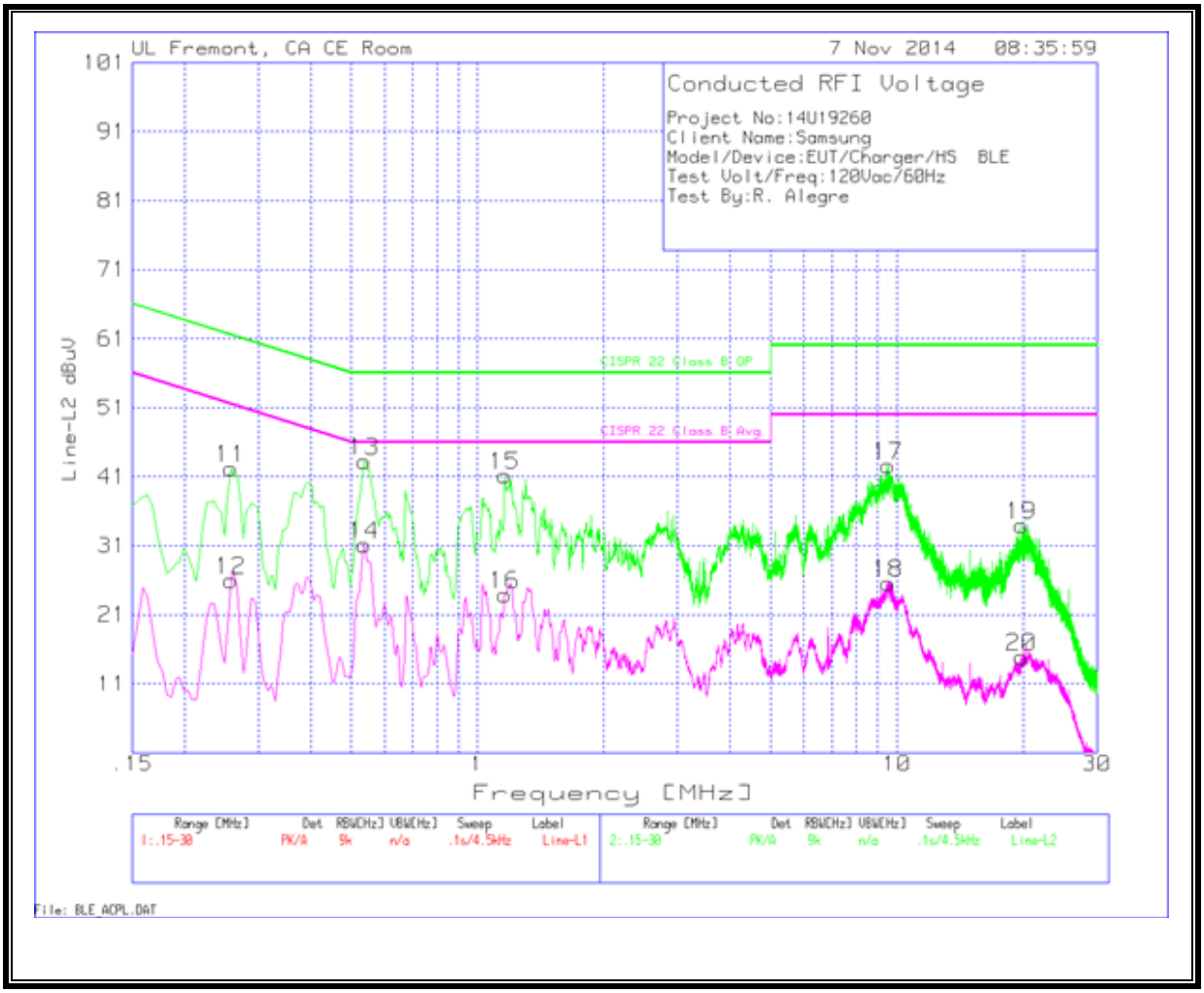
LINE 2 RESULTS



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