EMC TEST REPORT for Intentional & Unintentional Radiator
No. SH12020037-002

Applicant	: Aruba Networks, Inc. 1322 Crossman Ave., Sunnyvale CA 94089 USA
Manufacturer	: Aruba Networks, Inc. 1322 Crossman Ave., Sunnyvale CA 94089 USA
Product Name	: Wireless Mesh Router
Type/Model	: MST2H23N0-XX(where – XX can be any alphanumeric or blank)

SUMMARY

The equipment complies with the requirements according to the following standard(s):

47CFR Part 15 (2010): Radio Frequency Devices

ANSI C63.4 (2003): 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

RSS-210 Issue 8 (December 2010): Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment

RSS-Gen Issue 3 (December 2010): General Requirements and Information for the Certification of Radiocommunication Equipment

ICES-003 Issue 4 (February 2004): Digital Apparatus

Date of issue: March 16, 2012

Prepared by:

Wakeyou Wang (*Project Engineer*)

Reviewed by:

Daniel Zhao (*Reviewer*)

Description of Test Facility

Name: Intertek Testing Services Limited Shanghai
Address: Building No.86, 1198 Qinzhou Road(North), Shanghai 200233, P.R. China

FCC Registration Number: 236597
IC Assigned Code: 2042B-1

Name of contact: Steve Li
Tel: +86 21 64956565 ext. 214
Fax: +86 21 54262335 ext. 214

Content

SUMMARY 1
1. GENERAL INFORMATION 5
1.1 Applicant Information 5
1.2 Identification of the EUT 5
1.3 Technical specification 6
1.4 Mode of operation during the test / Test peripherals used 7
2. TEST SPECIFICATION 8
2.1 Instrument list 8
2.2 Test Standard 8
2.3 Test Summary 9
2.4 Chain Power 10
2.5 Data rate VS power 11
3. MINIMUM 6DB BANDWIDTH 12
3.1 Limit 12
3.2 Test Configuration 12
3.3 Test Procedure and test setup 12
3.4 Test Protocol 13
4. MAXIMUM PEAK OUTPUT POWER 22
4.1 Test limit 22
4.2 Test Configuration 22
4.3 Test procedure and test setup 22
4.4 Test protocol 23
5. POWER SPECTRUM DENSITY 34
5.1 Test limit 34
5.2 Test Configuration 34
5.3 Test procedure and test setup 34
5.4 Test Protocol 35
6. RADIATED EMISSION 46
6.1 Test limit 46
6.2 Test Configuration 46
6.3 Test procedure and test setup 47
6.4 Test protocol 48
7. EMISSION OUTSIDE THE FREQUENCY BAND 50
7.1 Limit 50
7.2 Test Configuration 50
7.3 Test procedure and test setup 50
7.4 Test protocol 51
8. POWER LINE CONDUCTED EMISSION 53
8.1 Limit 53
8.2 Test configuration 53
8.3 Test procedure and test set up 54
8.4 Test protocol 55
9. CHANNEL NUMBER OF HOPPING SYSTEM 56
9.1 Limit 56
9.2 Test Configuration 56

9.3 Test procedure and test setup 56
9.4 Test protocol 56
10. AVERAGE TIME OF OCCUPANCY IN ANY CHANNEL 57
10.1 Limit 57
10.2 Test Configuration 57
10.3 Test procedure and test setup 57
10.4 Test protocol 58
11. OCCUPIED BANDWIDTH 59
11.1 Test limit 59
11.2 Test Configuration 59
11.3 Test procedure and test setup 59
11.4 Test protocol 60
12. POWER LINE CONDUCTED EMISSION FOR UNINTENTIONAL RADIATOR 69
12.1 Limits 69
12.1.1 Limits for conducted disturbance voltage at the mains ports of class A device 69
12.1.2 Limits for conducted disturbance voltage at the mains ports of class B device 69
12.2 Test setup 70
12.3 Test Setup and Test Procedure 71
12.4 Test Protocol 72
13. RADIATED EMISSION FOR UNINTENTIONAL RADIATOR 75
13.1 Radiated emission limits 75
13.2 Block diagram and test set up 76
13.3 Test Setup and Test Procedure 77
13.4 Test Protocol 78

1. General Information

1.1 Applicant Information

Applicant:		Aruba Networks, Inc. 1322 Crossman Ave., Sunnyvale CA 94089 USA
Name of contact:		Ivaylo Tankov
Tel:		408-754-3035
Fax:		408-227-4550
Manufacturer:		Aruba Networks, Inc. 1322 Crossman Ave., Sunnyvale CA 94089 USA
Sample received date	:	Feb 1, 2012
Sample Identification No	:	*0120201-18-001*
Date of test	:	Feb 1, 2012 ~ March 14, 2012

1.2 Identification of the EUT

Equipment:	Wireless Mesh Router
Type/model:	MST2H23N0-XX(where – XX can be any alphanumeric or blank)
FCC ID: IC:	Q9DMST200 4675A-MST200

1.3 Technical specification

Operation Frequency Band: 5745 – 5825 MHz, 5755 – 5795MHz

Modulation:
DBPSK @1Mbps
DQPSK@2Mbp
CCK@5.5/11Mbps
BPSK@6/9 Mbps
QPSK@12/18Mbps
16-QAM@24Mbps
64-QAM@48/54Mpb and above

Gain of Antenna: Internal, 13dBi

Rating: 48V d.c. powered by:
POE: input 100-240Va.c., 0.5A, 50/60Hz;
output 48V d.c., 0.35A

Description of EUT: Here are a series of models. They are electrically identical except for different model names.
The EUT supports wireless network of 802.11a/n.
The RF module used contains of two chains, namely chain 1 and chain 2.

Port identification:

Port	Description	Type	Number
1	Console	USB2.0	1
4	Ethernet	RJ45	1

Dimension: 26cm * 18cm *8cm
Declared Temperature range: -30°C ~ 55°C
Channel Description:

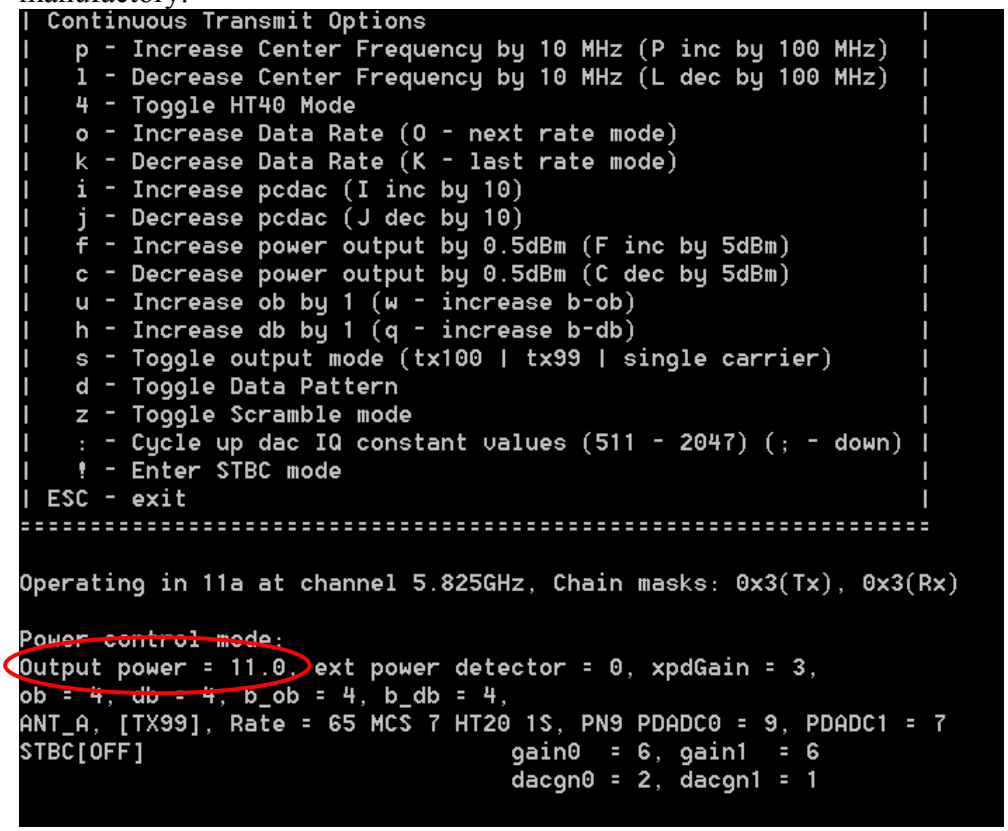
HT 20 Channel	Frequency (MHz)	HT 40 Channel	Frequency (MHz)
149	5745	151	5755
153	5765	159	5795
157	5785	/	
161	5805		
165	5825		

Category of EUT: Class B
Highest working frequency : >1GHz (for unintentional radiator)

EUT type:
☒ Table top
☐ Floor standing

1.4 Mode of operation during the test / Test peripherals used

While testing transmitting mode of EUT, the internal modulation and continuously transmission was applied.
The power level setting for 802.11a/b/g/n is “11.0” indicated in software offered by the manufactory.



Test peripherals used:

Item No	Description	Band and Model	S/No
1	Laptop computer	FUJITSU SIMENS, LIFEBOOK	NA

The lowest, middle and highest channel were tested as representatives.
For 802.11a----- lowest, 5745MHz; middle, 5785MHz; highest, 5825MHz.
For 802.11n HT20 ----- lowest, 5745MHz; middle, 5785MHz; highest, 5825MHz.
For 802.11n HT40 ----- lowest, 5755MHz; highest, 5795MHz.

.

2. Test Specification

2.1 Instrument list

Equipment	Type	Manu.	Internal no.	Cal. Date	Due date
Test Receiver	ESIB 26	R&S	EC 3045	2011-10-21	2012-10-20
Semi-anechoic chamber	-	Albatross project	EC 3048	2011-5-21	2012-5-20
Bilog Antenna	CBL 6112D	TESEQ	EC 4206	2011-5-16	2013-5-15
Horn antenna	HF 906	R&S	EC 3049	2011-5-13	2013-5-12
Pre-amplifier	Pre-amp 18	R&S	EC 3222	2011-4-12	2012-4-11
Test Receiver	ESCS 30	R&S	EC 2107	2011-10-21	2012-10-20
A.M.N.	ESH2-Z5	R&S	EC 3119	2012-1-9	2013-1-8
A.M.N.	ESH3-Z5	R&S	EC 2109	2012-1-10	2013-1-9
High Pass Filter	WHKX 1.0/15G-10SS	Wainwright	EC4297-1	2012-2-8	2013-2-7
High Pass Filter	WHKX 2.8/18G-12SS	Wainwright	EC4297-2	2012-2-8	2013-2-7
High Pass Filter	WHKX 7.0/1.8G-8SS	Wainwright	EC4297-3	2012-2-8	2013-2-7
Band Reject Filter	WRCGV 2400/2483-2390/2493-35/10SS	Wainwright	EC4297-4	2012-2-8	2013-2-7
Test Receiver	FSV40	R&S	/	2011-10-21	2012-10-20
Preamplifier	AP-025C	Quietek	QT-AP003	2011-11-25	2012-11-24
Preamplifier	AP-180C	Quietek	CHM-0602013	2011-11-25	2012-11-24
Broad-Band Horn Antenna	BBHA9120D	Schwarzbeck	496	2011-11-25	2012-11-24
Broad-Band Horn Antenna	BBHA9170	Schwarzbeck	294	2011-11-25	2012-11-24

2.2 Test Standard

47CFR Part 15 (2010)
ANSIC63.4 (2003)
RSS-210 Issue 8 (December 2010)
RSS-Gen Issue 3 (December 2010)
ICES-003 Issue 4 (February 2004)

2.3 Test Summary

This report applies to tested sample only. This report shall not be reproduced in part without written approval of Intertek Testing Service Shanghai Limited.

TEST ITEM	FCC REFERANCE	IC REFERANCE	RESULT
Minimum 6dB Bandwidth	15.247(a)(2)	RSS-210 Issue 8 Annex 8	Pass
Maximum peak output power	15.247(b)	RSS-210 Issue 8 Annex 8	Pass
Power spectrum density	15.247(e)	RSS-210 Issue 8 Annex 8	Pass
Radiated emission	15.205 & 15.209	RSS-210 Issue 8 Clause 2	Pass
Emission outside the frequency band	15.247(d)	RSS-210 Issue 8 Annex 8	Pass
Power line conducted emission	15.207	RSS-Gen Issue 3 Clause 7.2.4	Pass
Channel number of hopping system	15.247(a)(1)(iii)	RSS-210 Issue 8 Annex 8	NA
Average time of occupancy in any channel	15.247(a)(1)(iii)	RSS-210 Issue 8 Annex 8	NA
Occupied bandwidth	-	RSS-Gen Issue 3 Clause 4.6.1	Tested
Conducted emission	15B	ICES-003	Pass
Radiated emission	15B	ICES-003	Pass

2.4 Chain Power

Mode	Chain	CH	Output Power (dBm)
802.11a	1	M	16.56
	2	M	16.53
802.11na, HT20	1	M	16.72
	2	M	16.65
802.11na, HT40	1	L	15.80
	2	L	15.78

Based on the test data above, in this report, the chain 1 with higher output power is chosen to perform all tests for single chain mode.

2.5 Data rate VS power

Mode	Data Rate	CH	Level at Chain 1 (dBm)
802.11a	MCS0	M	16.17
	MCS1	M	16.06
	MCS2	M	16.10
	MCS3	M	15.99
	MCS4	M	16.42
	MCS5	M	16.42
	MCS6	M	16.44
	MCS7	M	16.56
802.11na, HT20	MCS0	L	16.36
	MCS1	L	16.20
	MCS2	L	16.25
	MCS3	L	16.63
	MCS4	L	16.58
	MCS5	L	16.66
	MCS6	L	16.66
	MCS7	L	16.72
802.11na, HT40	MCS0	L	15.42
	MCS1	L	15.32
	MCS2	L	15.39
	MCS3	L	15.70
	MCS4	L	15.68
	MCS5	L	15.75
	MCS6	L	15.76
	MCS7	L	15.80

Based on the test data above, in this report, the highest speed is applied for all tests in every mode.

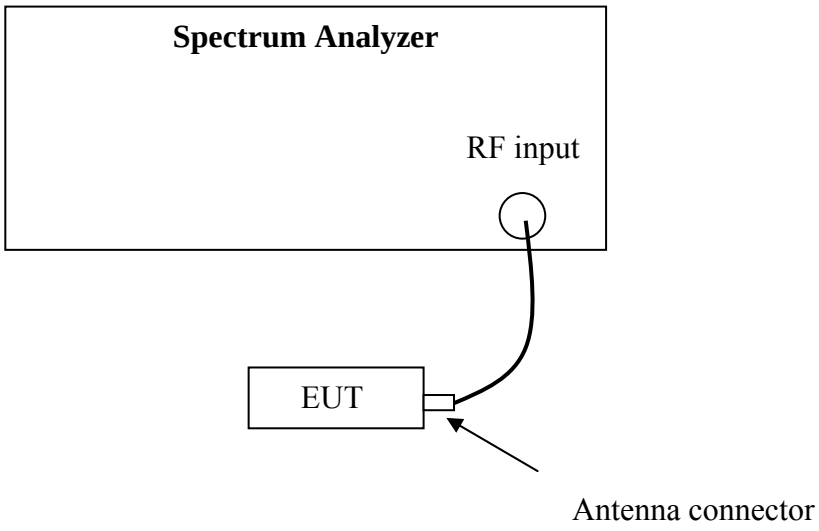
3. Minimum 6dB Bandwidth

Test result: PASS

3.1 Limit

For systems using digital modulation techniques that may operate in the 902 - 928 MHz, 2400 - 2483.5 MHz and 5725 - 5850 MHz bands, the minimum 6 dB bandwidth shall be at least 500 kHz.

3.2 Test Configuration



3.3 Test Procedure and test setup

The minimum 6dB bandwidth per FCC §15.247(a)(2) is measured using the Spectrum Analyzer according to DTS test procedure of "KDB558074 D01 DTS Meas Guidance v01" for compliance to FCC 47CFR 15.247 requirements.

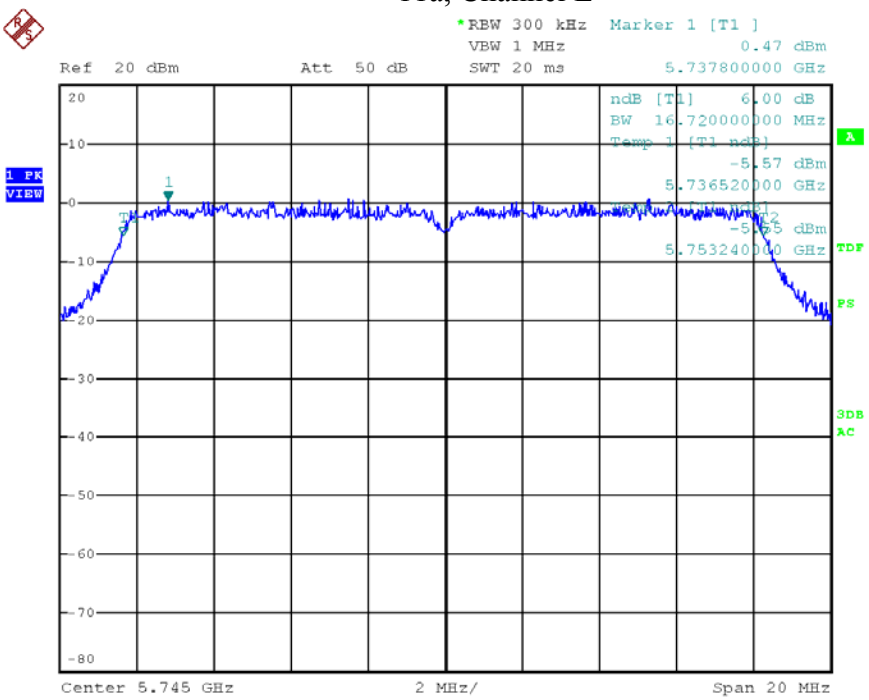
3.4 Test Protocol

Temperature : 22°C
Relative Humidity : 43%

Single Chain

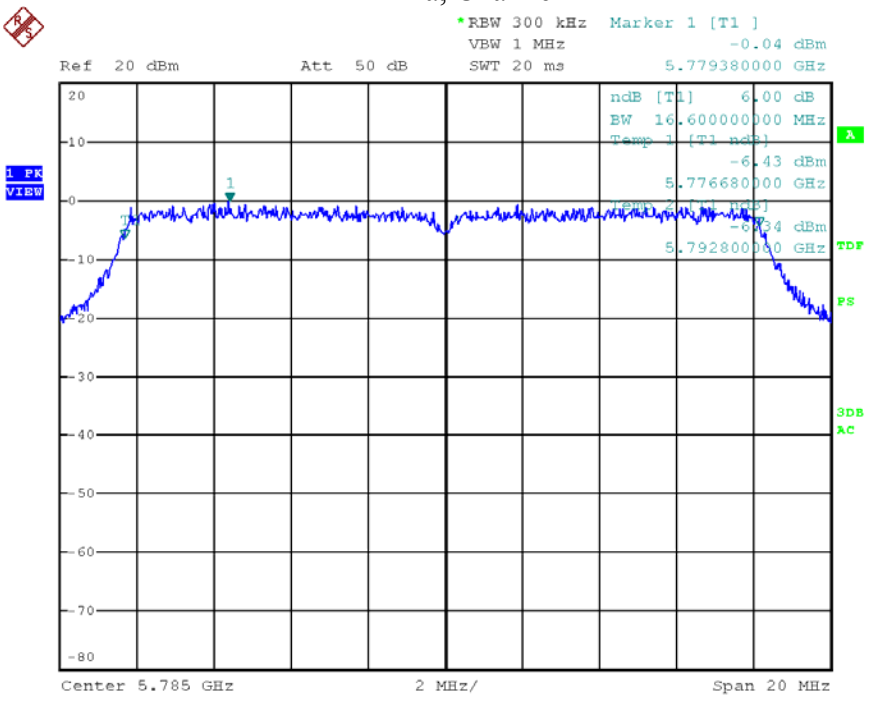
Mode	CH	Chain 1 (MHz)	Limit (MHz)
11a	L	16.72	⩾0.5
	M	16.60	
	H	16.56	
11na, HT20	L	17.96	
	M	17.82	
	H	17.84	
11na, HT40	L	36.40	
	H	36.88	

11a, Channel L



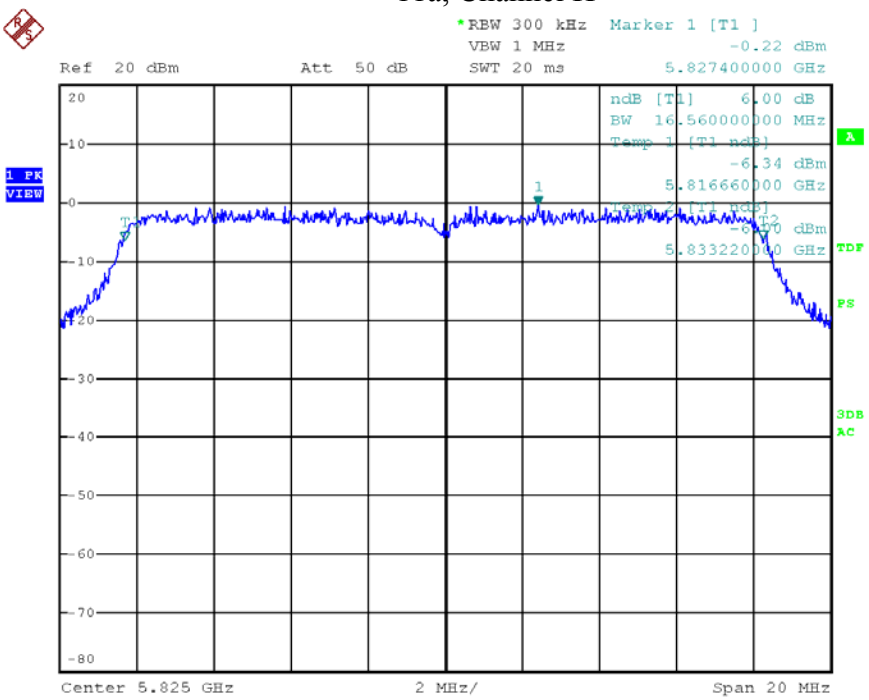
Date: 14.MAR.2012 20:25:10

11a, Channel M



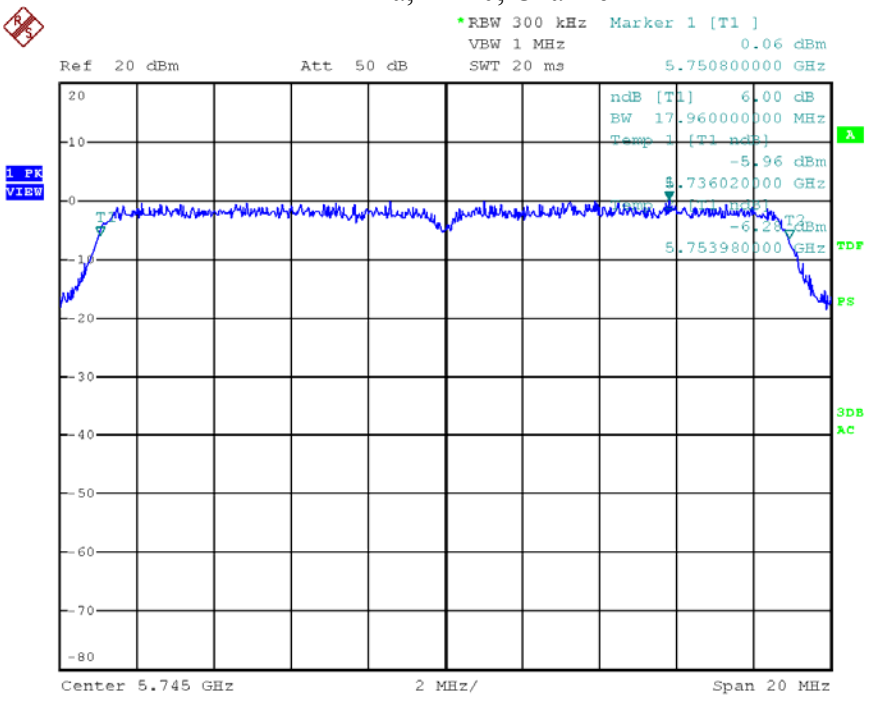
Date: 14.MAR.2012 20:25:59

11a, Channel H



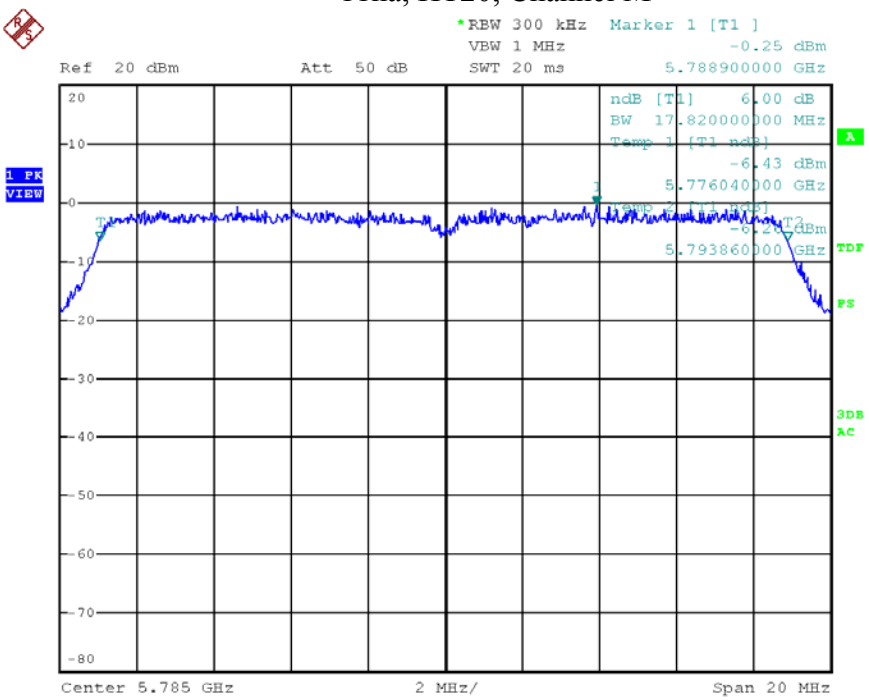
Date: 14.MAR.2012 20:26:46

11na, HT20, Channel L



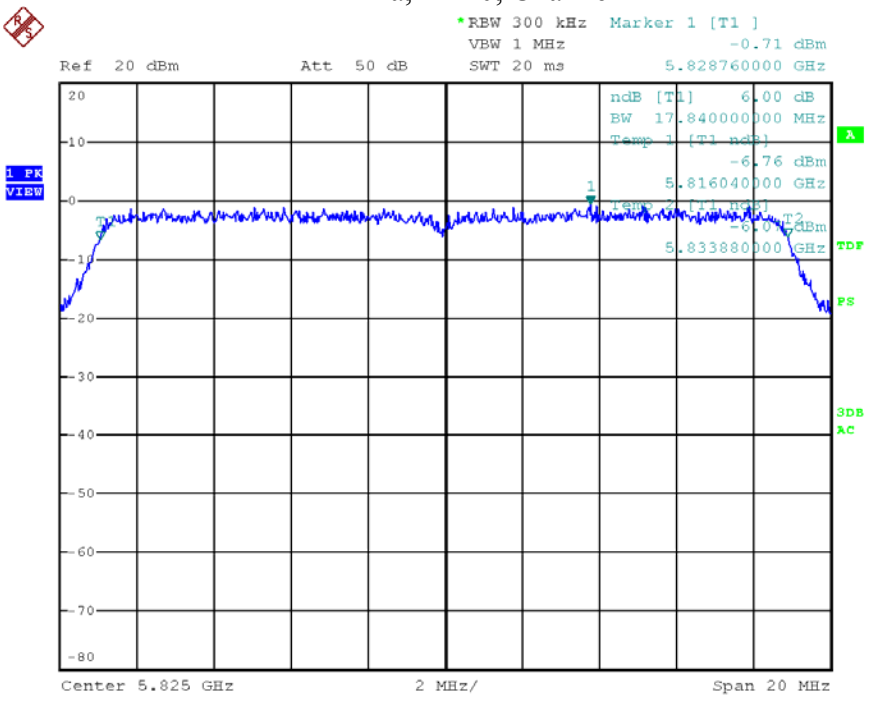
Date: 14.MAR.2012 20:30:25

11na, HT20, Channel M



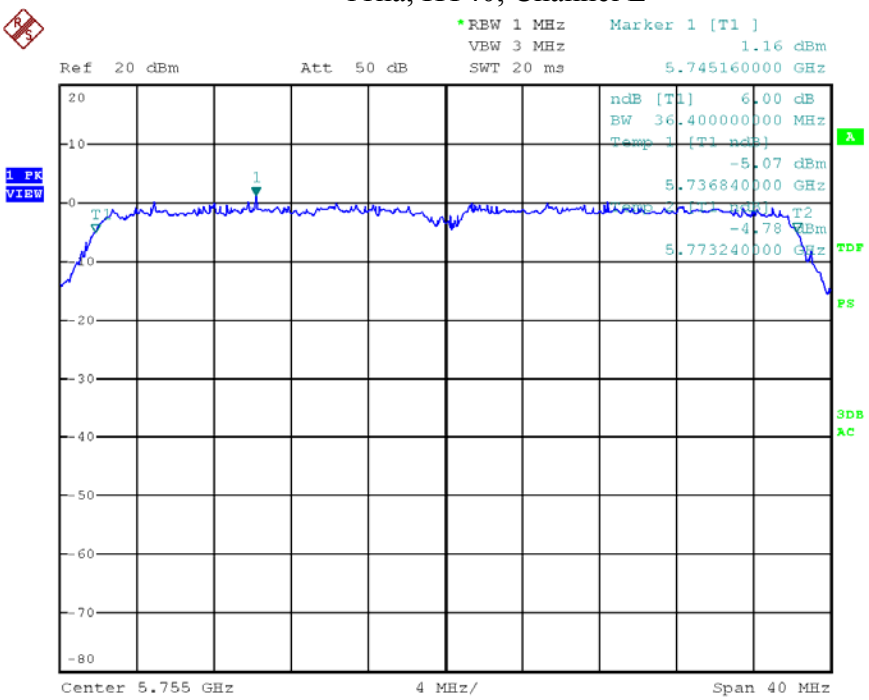
Date: 14.MAR.2012 20:29:56

11na, HT20, Channel H



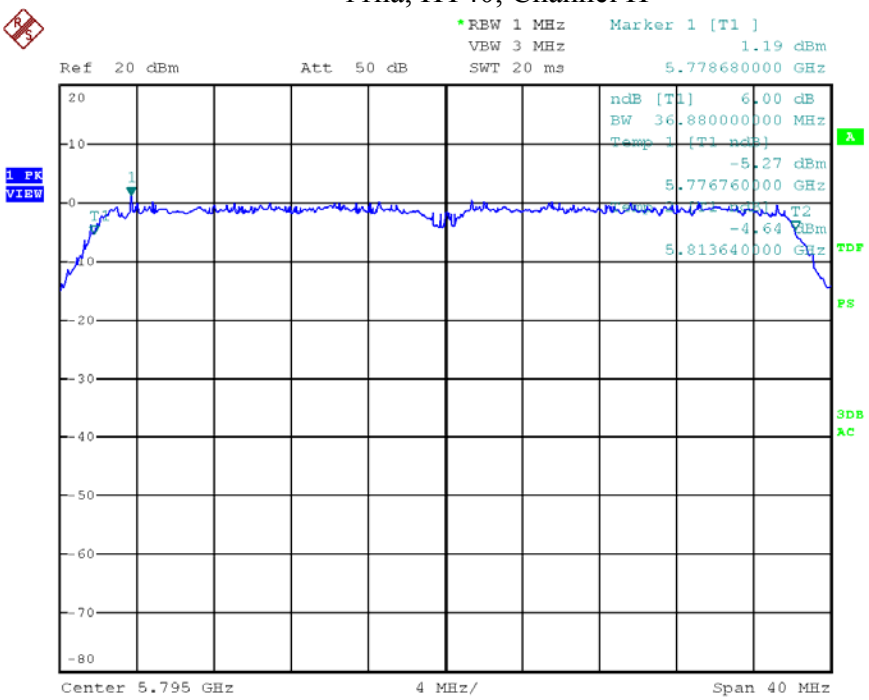
Date: 14.MAR.2012 20:29:08

11na, HT40, Channel L



Date: 14.MAR.2012 20:56:32

11na, HT40, Channel H

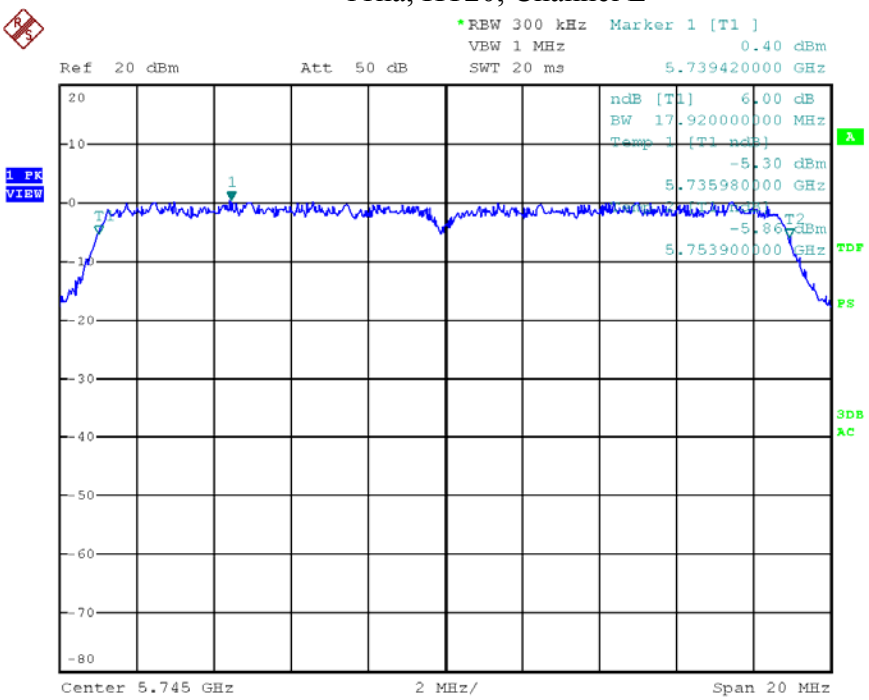


Date: 14.MAR.2012 20:56:01

Dual Chain

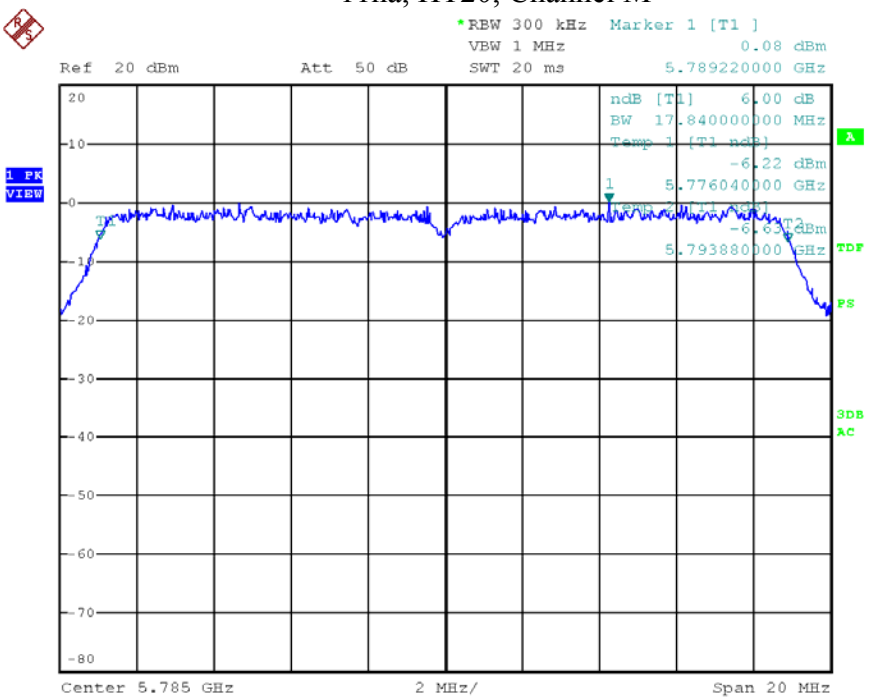
Mode	CH	Chain 1 (MHz)	Limit (MHz)
11na, HT20	L	17.92	⩾0.5
	M	17.84	
	H	17.90	
11na, HT40	L	37.12	
	H	36.72	

11na, HT20, Channel L



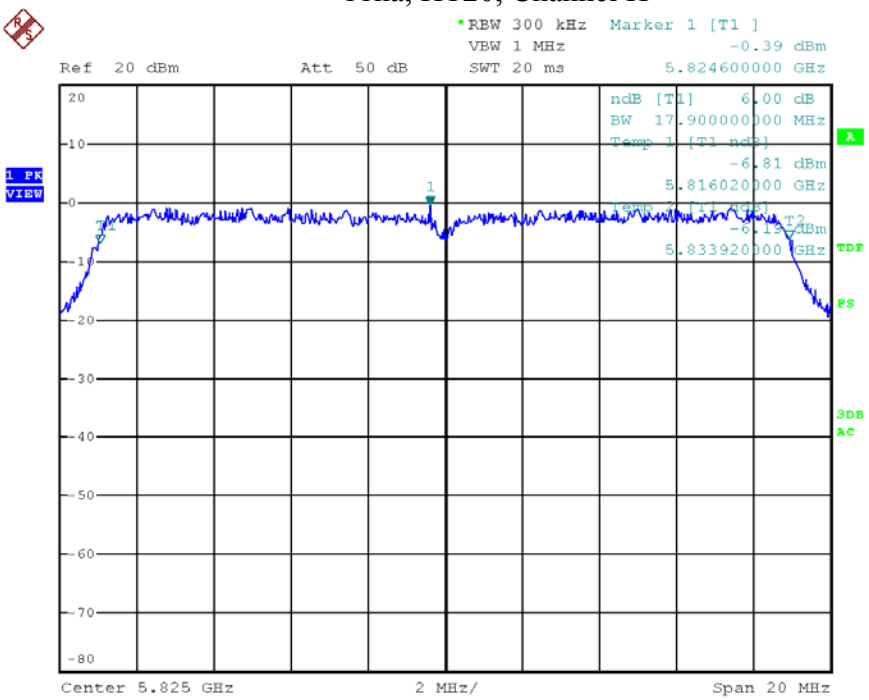
Date: 14.MAR.2012 20:31:34

11na, HT20, Channel M



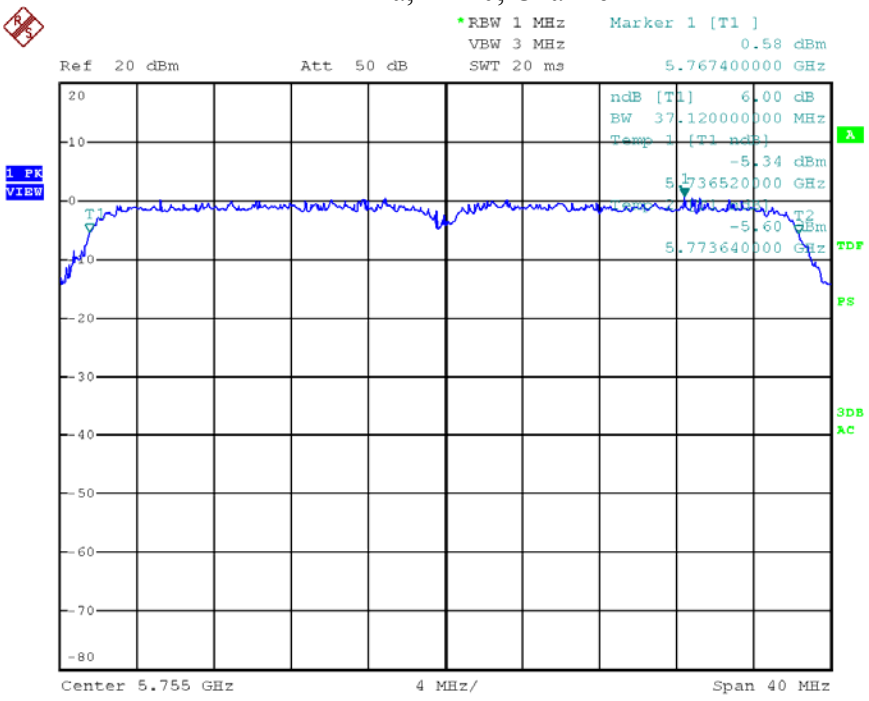
Date: 14.MAR.2012 20:33:05

11na, HT20, Channel H



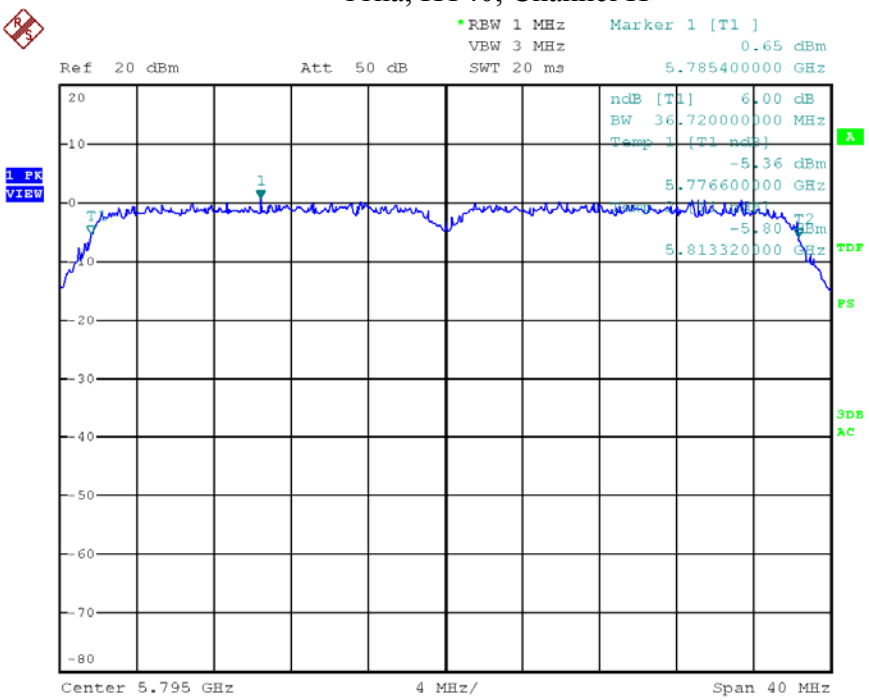
Date: 14.MAR.2012 20:34:15

11na, HT40, Channel L



Date: 14.MAR.2012 20:57:16

11na, HT40, Channel H



Date: 14.MAR.2012 20:57:47

4. Maximum peak output power

Test result: Pass

4.1 Test limit

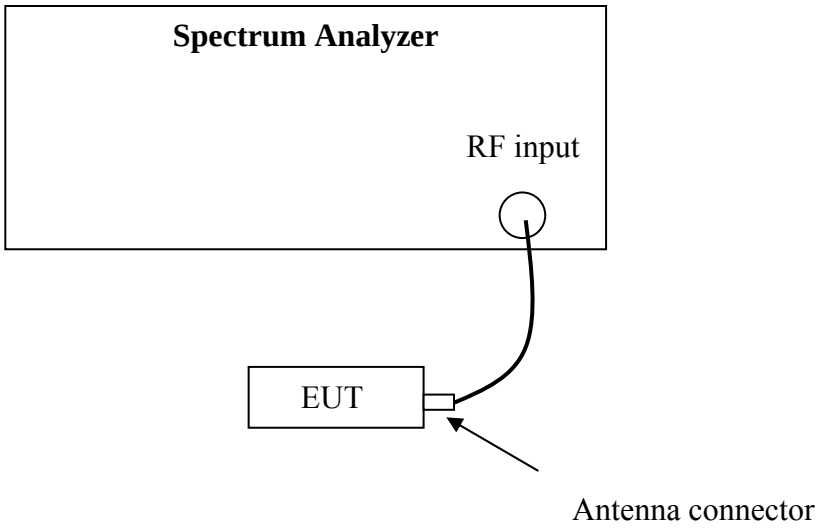
☐ For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt

☐ For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts

☒ For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.

If the transmitting antenna of directional gain greater than 6dBi is used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

4.2 Test Configuration



4.3 Test procedure and test setup

The EUT was tested according to DTS test procedure of "KDB558074 D01 DTS Meas Guidance v01" for compliance to FCC 47CFR 15.247 requirements (Measurement Procedure PK2).

4.4 Test protocol

Temperature: 22 °C

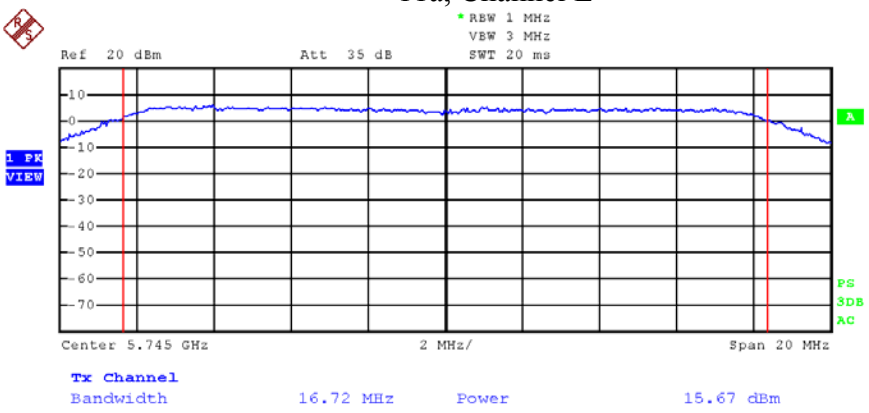
Relative Humidity: 43 %

For gain of antenna is 13dBi, the limit should be 30dBm – (13dBi – 6dBi) = 23dBm

Single Chain

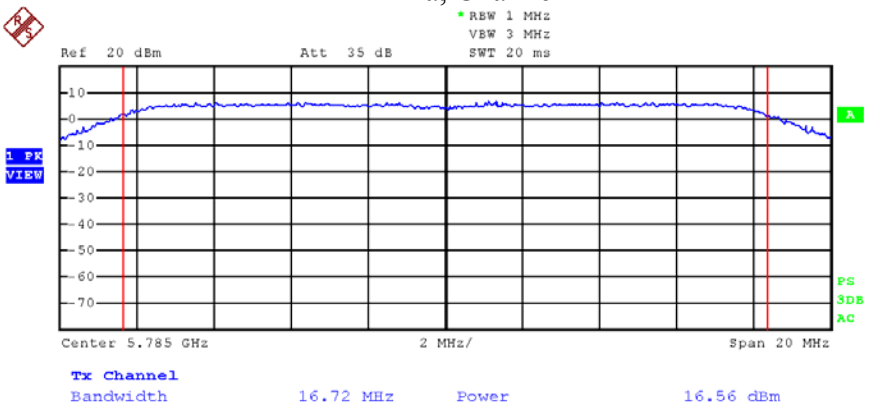
Mode	CH	Chain 1 (dBm)	Limit (dBm)
11a	L	15.67	≤23
	M	16.56	
	H	16.24	
11na, HT20	L	15.45	
	M	16.72	
	H	16.01	
11na, HT40	L	15.80	
	H	16.42	

11a, Channel L



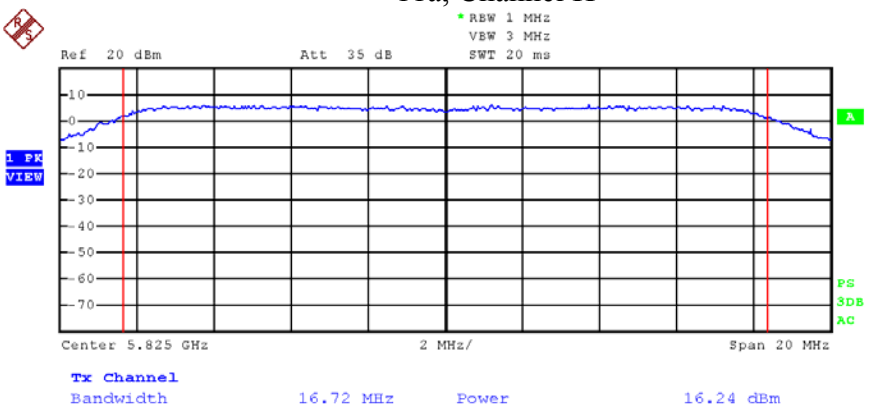
Date: 14.FEB.2012 14:27:09

11a, Channel M



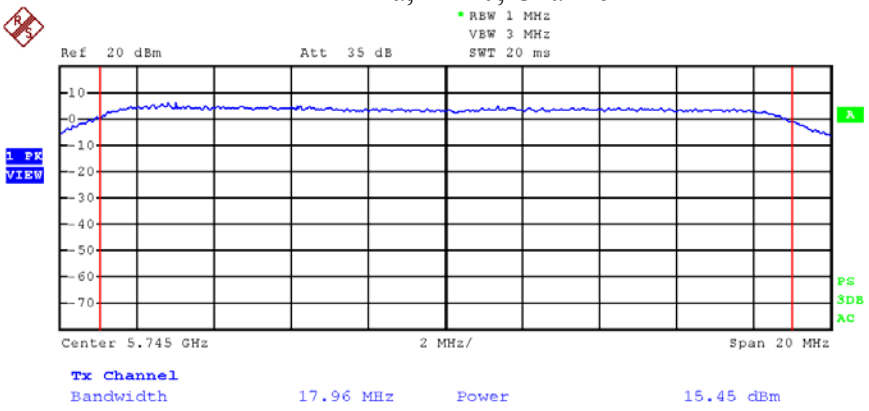
Date: 14.FEB.2012 14:27:46

11a, Channel H



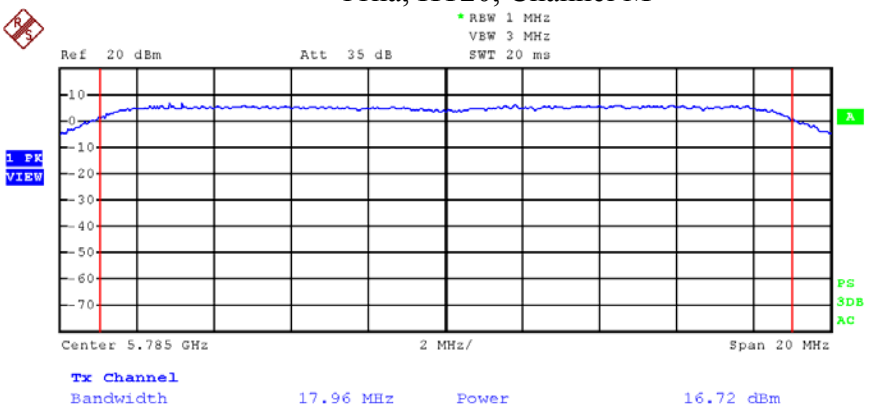
Date: 14.FEB.2012 14:28:16

11na, HT20, Channel L



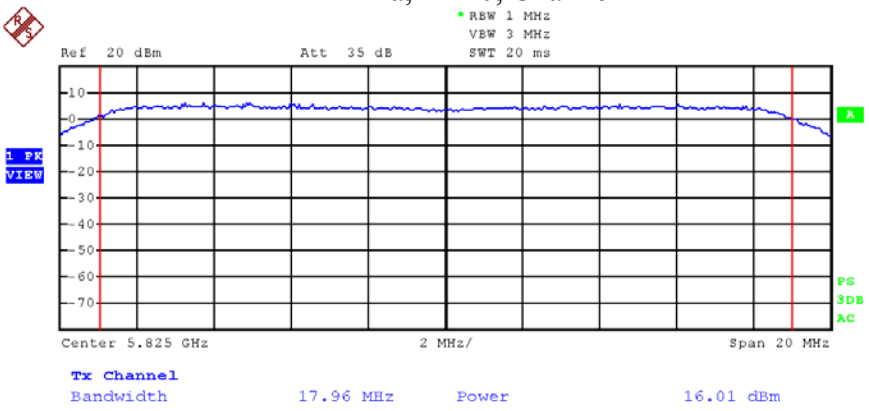
Date: 14.FEB.2012 14:32:04

11na, HT20, Channel M



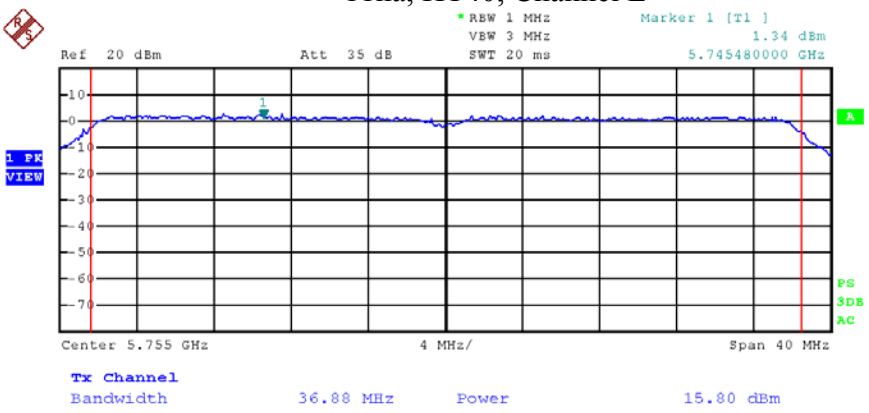
Date: 14.FEB.2012 14:31:35

11na, HT20, Channel H



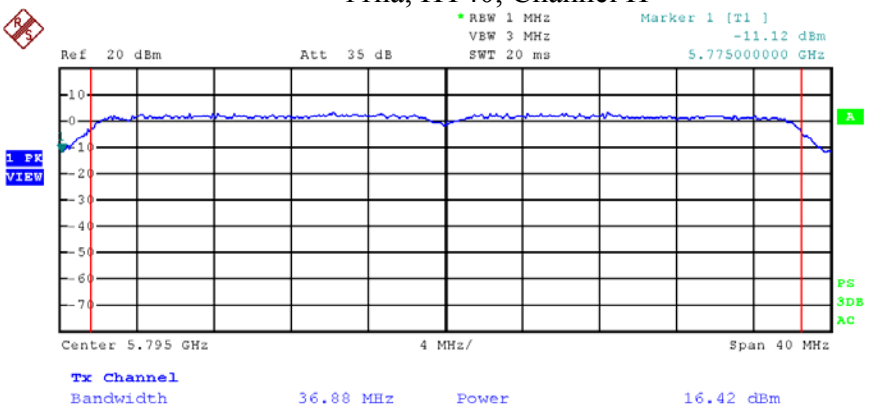
Date: 14.FEB.2012 14:31:04

11na, HT40, Channel L



Date: 14.FEB.2012 15:07:24

11na, HT40, Channel H



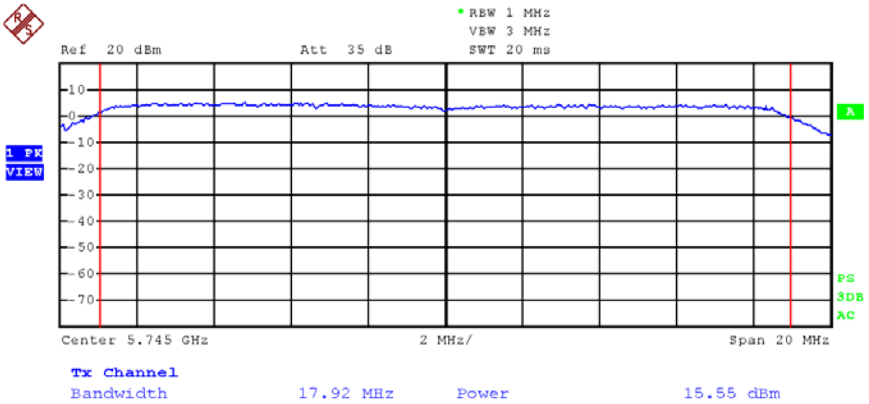
Date: 14.FEB.2012 15:07:57

Dual Chain

Mode	CH	Chain 1 (dBm)	Chain 2 (dBm)	Total Power (dBm)	Limit (dBm)
11na, HT20	L	15.55	19.02	20.63	≤23
	M	16.83	18.08	20.51	
	H	16.14	18.34	20.39	
11na, HT40	L	15.91	17.90	20.03	
	H	16.60	17.33	19.99	

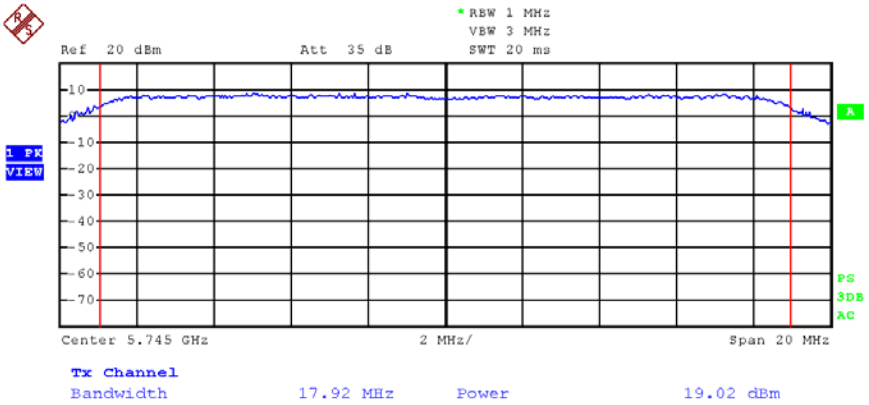
11na, HT20, Channel L

Chain 1



Date: 14.FEB.2012 14:33:10

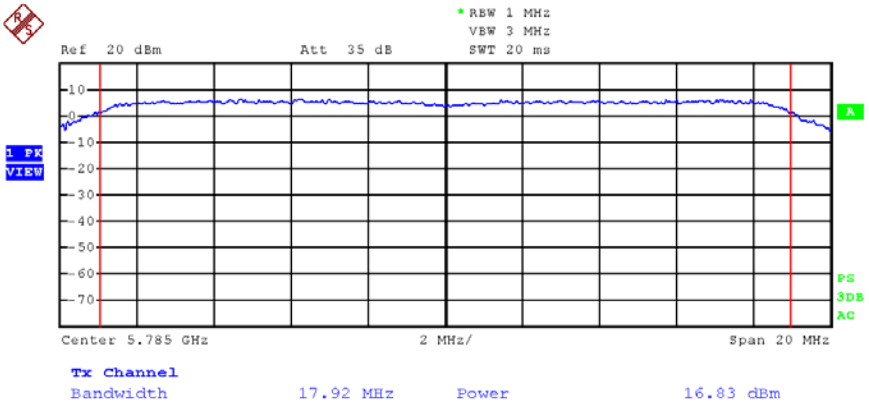
Chain 2



Date: 14.FEB.2012 14:37:19

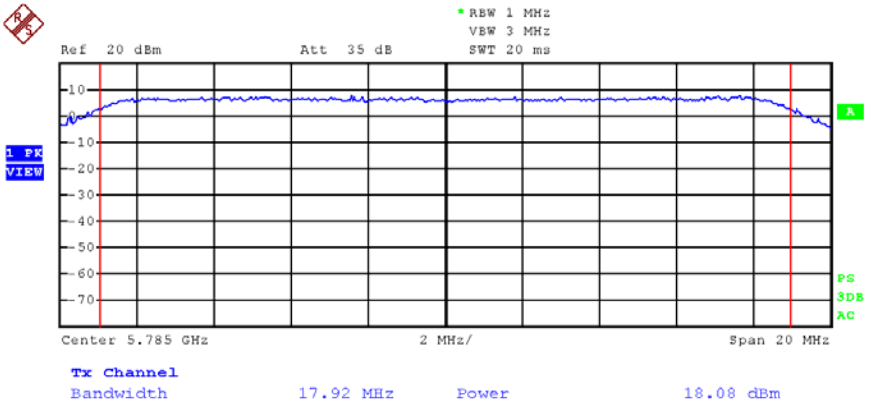
11na, HT20, Channel M

Chain 1



Date: 14.FEB.2012 14:33:45

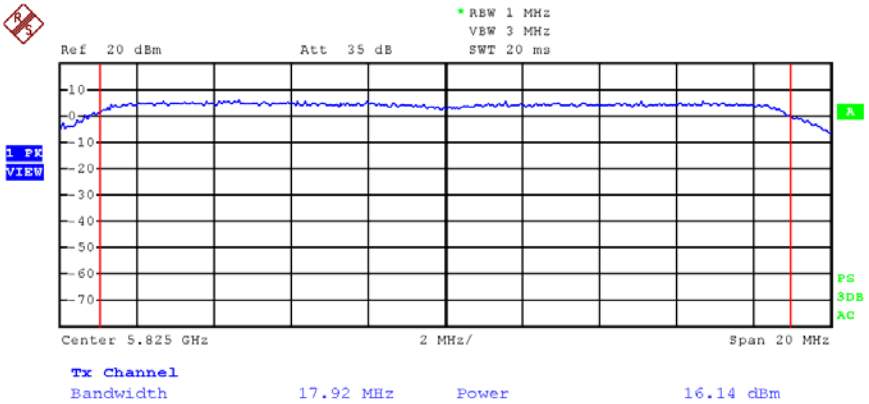
Chain 2



Date: 14.FEB.2012 14:36:29

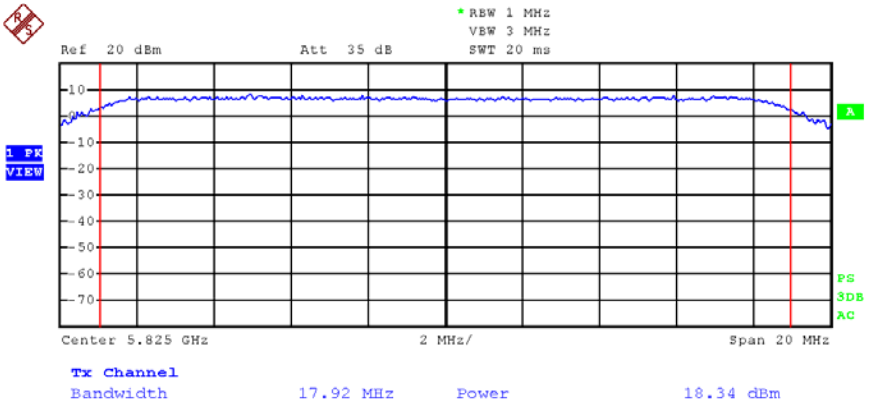
11na, HT20, Channel H

Chain 1



Date: 14.FEB.2012 14:34:13

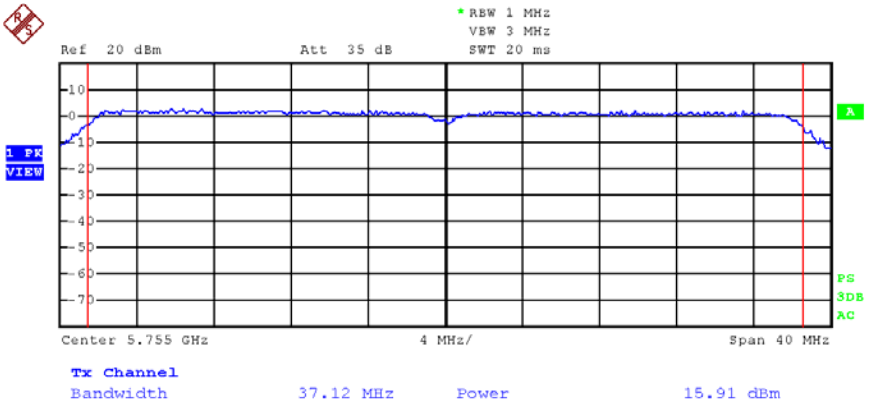
Chain 2



Date: 14.FEB.2012 14:35:35

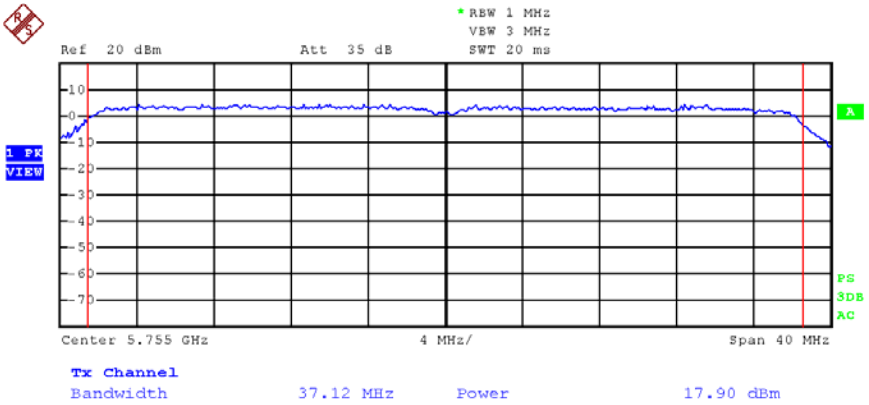
11na, HT40, Channel L

Chain 1



Date: 14.FEB.2012 15:09:39

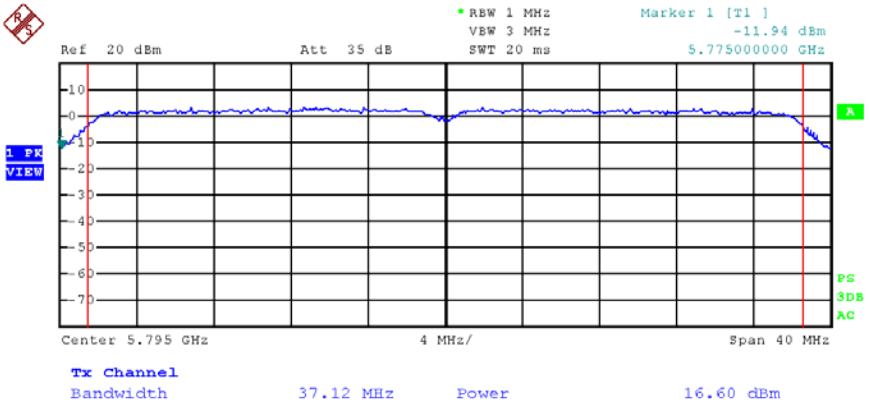
Chain 2



Date: 14.FEB.2012 15:10:36

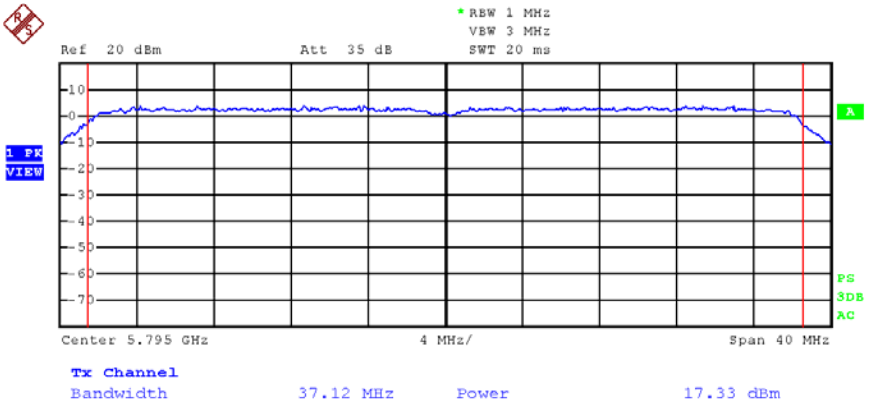
11na, HT40, Channel H

Chain 1



Date: 14.FEB.2012 15:09:09

Chain 2



Date: 14.FEB.2012 15:11:11

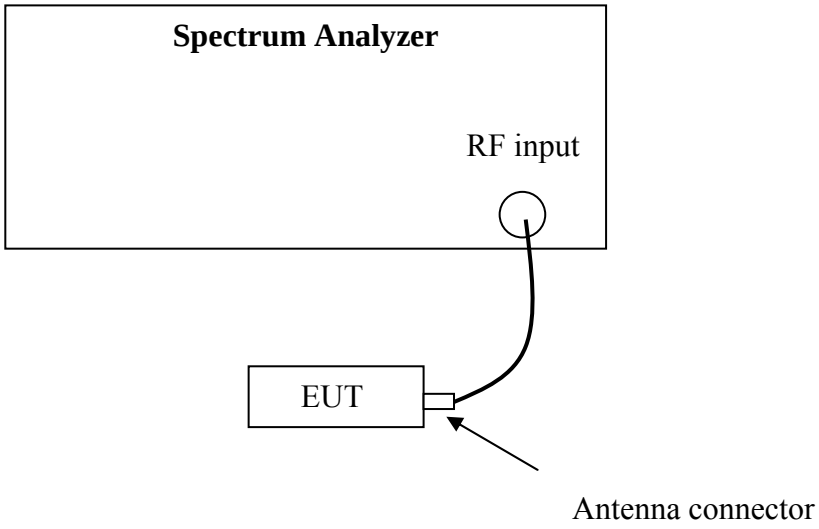
5. Power spectrum density

Test result: **Pass**

5.1 Test limit

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

5.2 Test Configuration



5.3 Test procedure and test setup

The power output per FCC §15.247(e) was tested according to DTS test procedure of "KDB558074 D01 DTS Meas Guidance v01" for compliance to FCC 47CFR 15.247 requirements.

5.4 Test Protocol

Temperature: 22 °C

Relative Humidity: 43 %

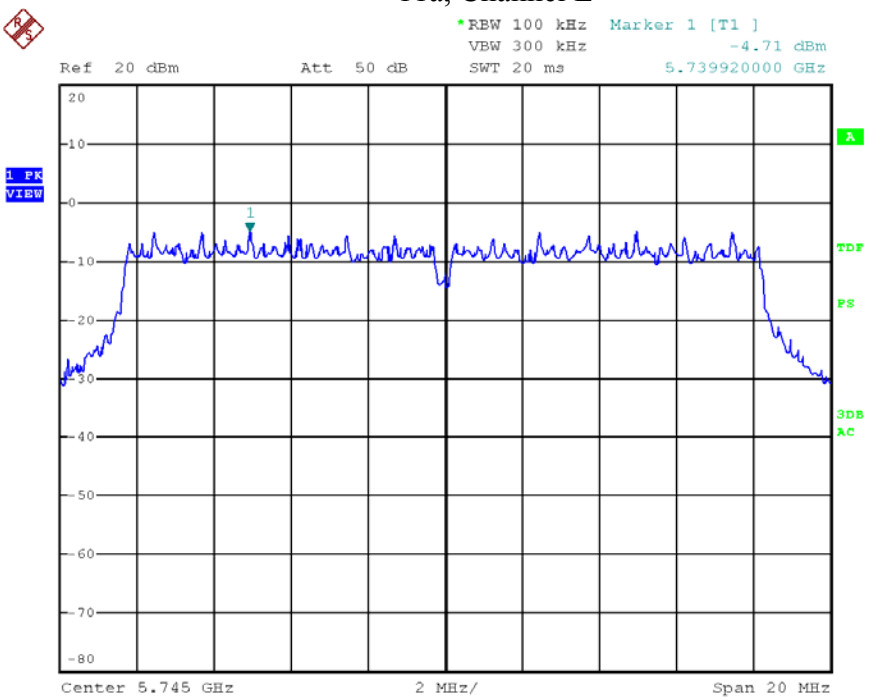
The maximum gain of all applied antennas is 13dBi, therefore, the strictest limit should be 8dBm/3kHz – (13dBi – 6dBi) = 1dBm/3kHz.

Single Chain

Mode	**CH**	**Chain 1** (dBm/100kHz)	**Chain 1** (dBm/3kHz)	**Limit** (dBm/3kHz)
11a	L	-4.71	-19.91	≤1
	M	-5.49	-20.69	
	H	-5.95	-21.15	
11na, HT20	L	-4.49	-19.69	
	M	-5.61	-20.81	
	H	-5.98	-21.18	
11na, HT40	L	-7.57	-22.77	
	H	-8.76	-23.96	

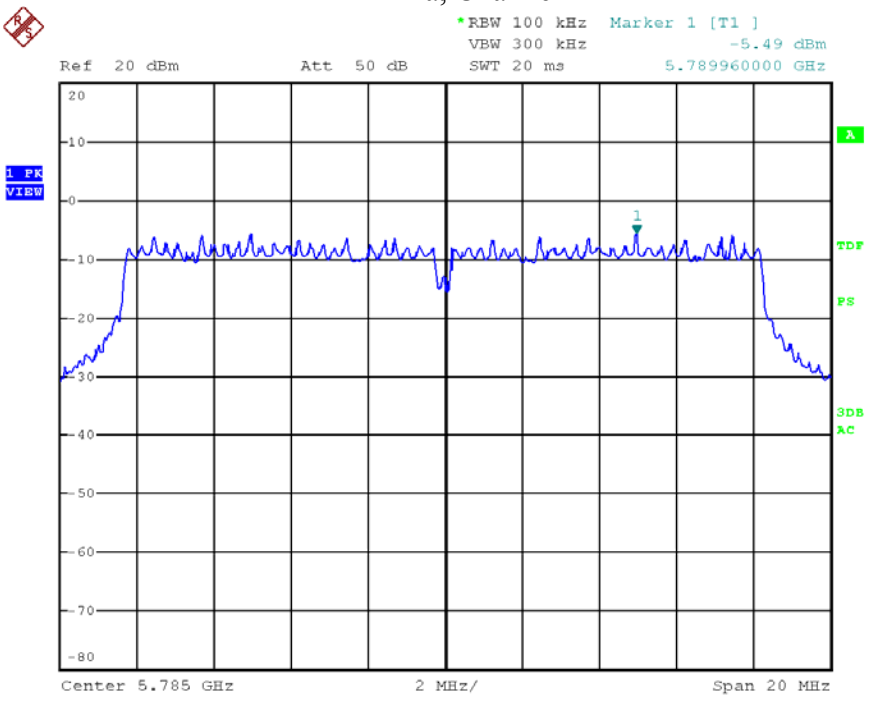
Note: power spectrum density of 3kHz is -15.20dB lower than that of 100kHz.

11a, Channel L



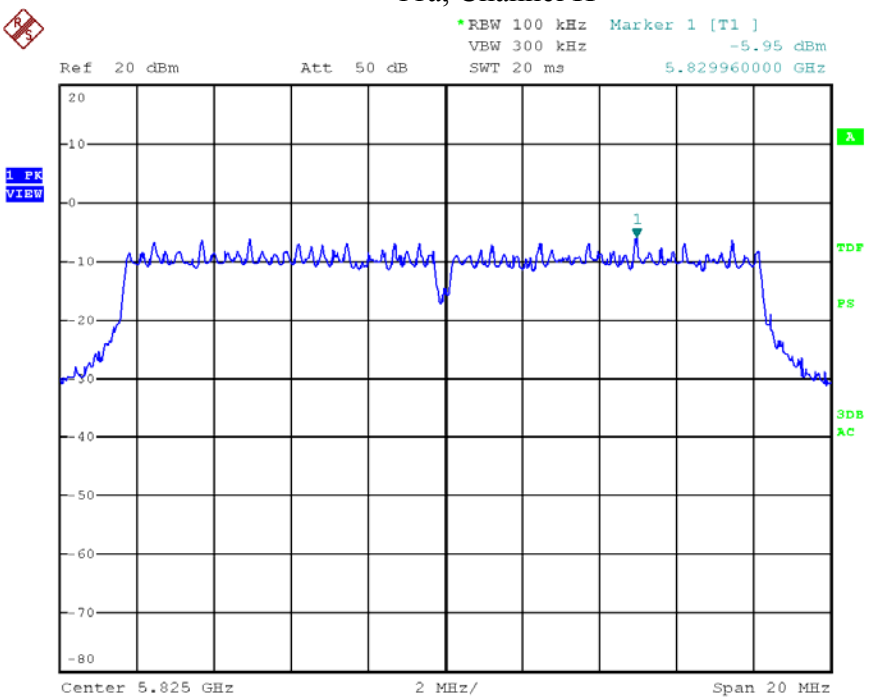
Date: 14.MAR.2012 21:09:00

11a, Channel M



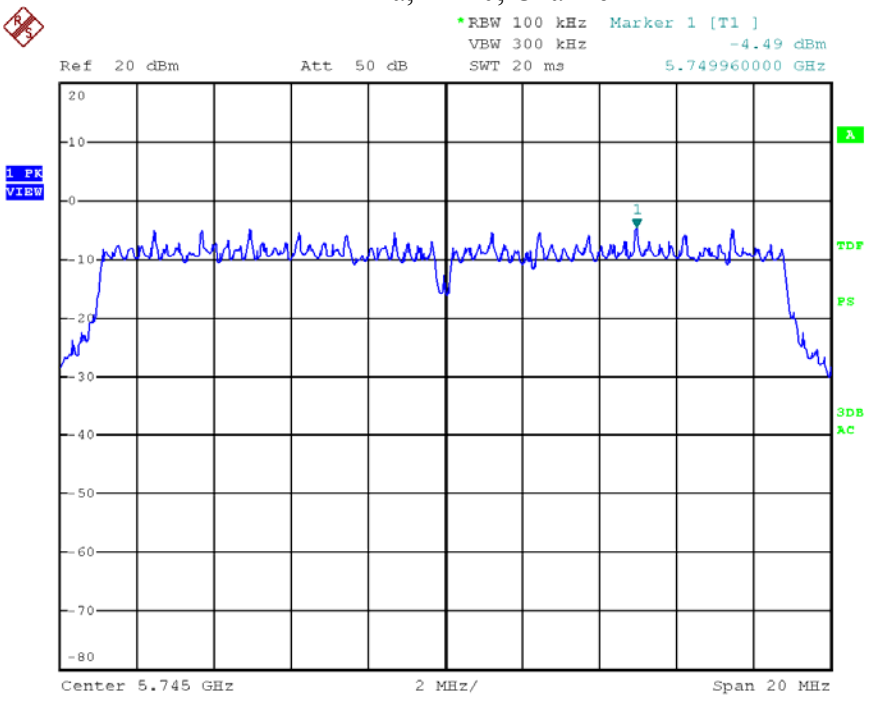
Date: 14.MAR.2012 21:09:37

11a, Channel H



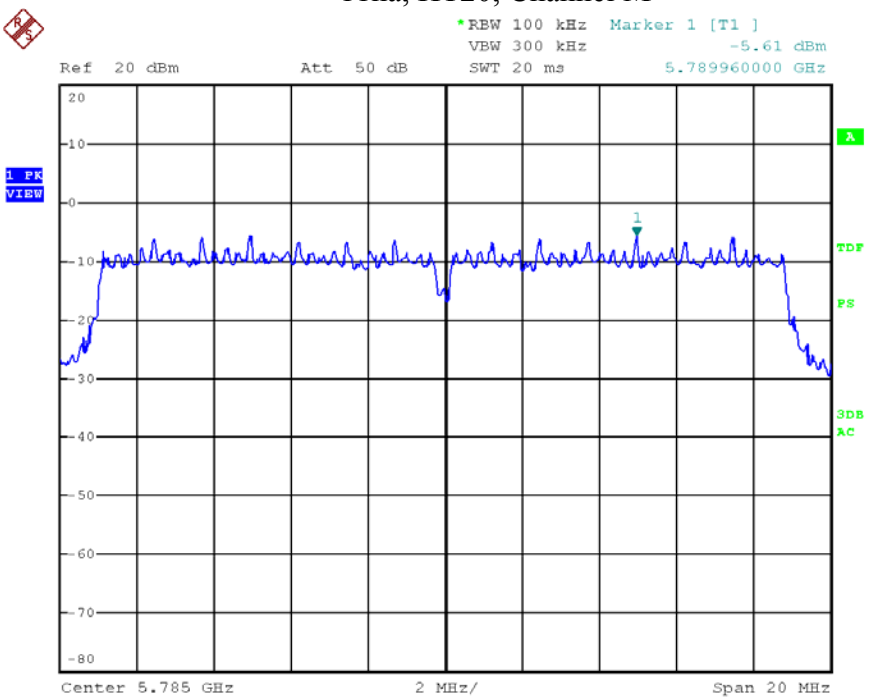
Date: 14.MAR.2012 21:10:04

11na, HT20, Channel L



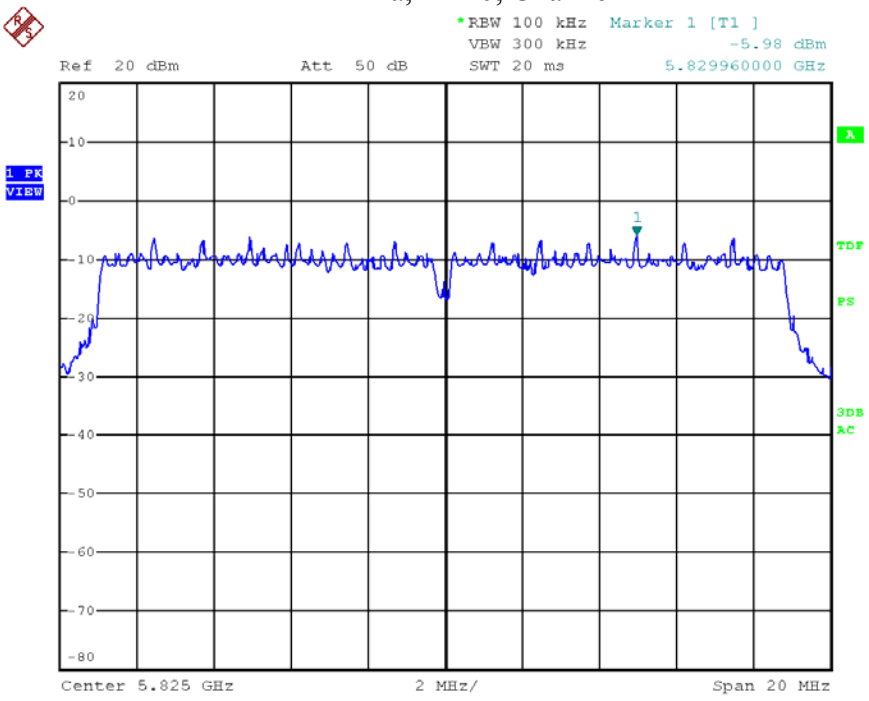
Date: 14.MAR.2012 21:11:44

11na, HT20, Channel M



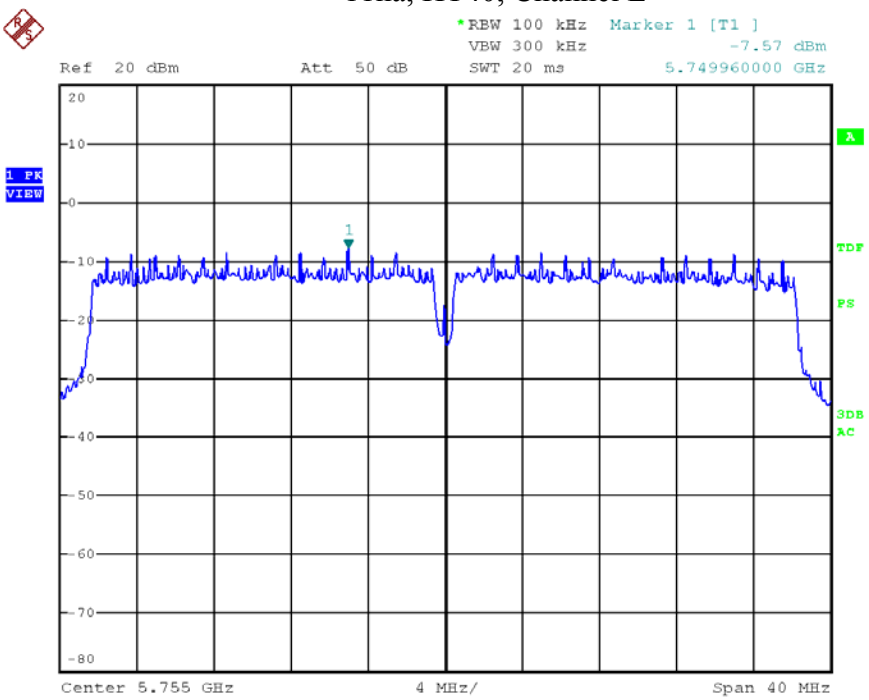
Date: 14.MAR.2012 21:11:27

11na, HT20, Channel H



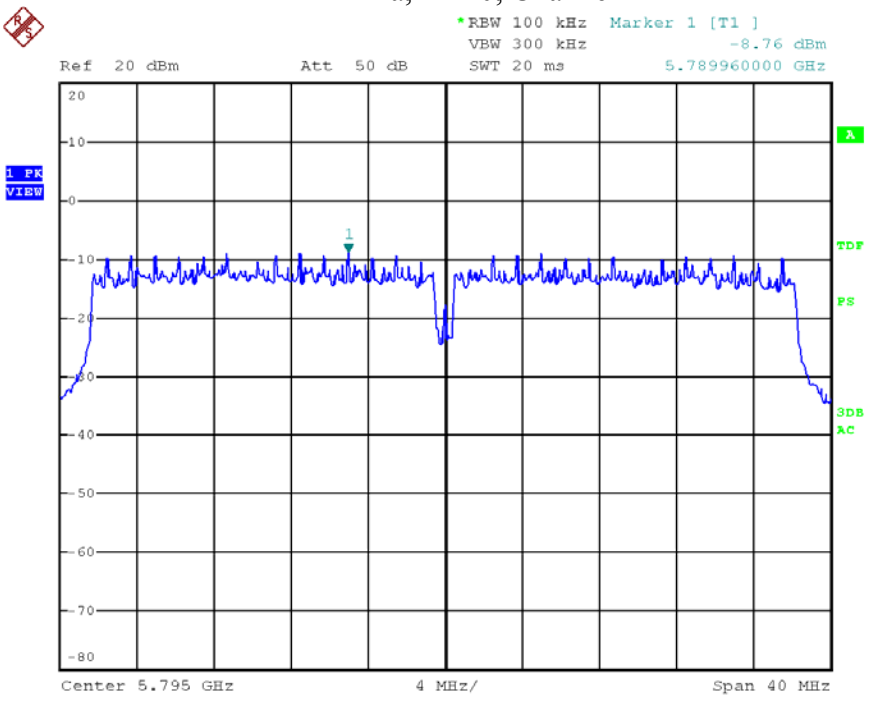
Date: 14.MAR.2012 21:10:45

11na, HT40, Channel L



Date: 14.MAR.2012 21:16:05

11na, HT40, Channel H



Date: 14.MAR.2012 21:15:36

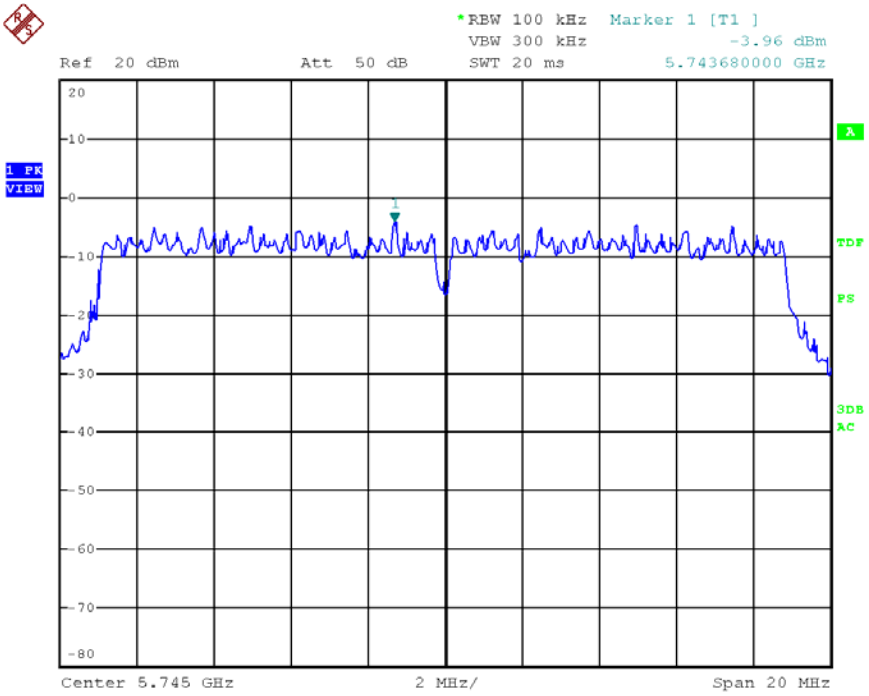
Dual Chain

Mode	**CH**	**Chain 1** (dBm/100kHz)	**Chain 2** (dBm/100kHz)	**Total power density** (dBm/3kHz)	**Limit** (dBm/3kHz)
11na, HT20	L	-3.96	-2.10	-15.12	≤1
	M	-4.84	-2.71	-15.84	
	H	-5.32	-3.01	-16.20	
11na, HT40	L	-7.31	-5.78	-18.67	
	H	-8.07	-5.77	-18.96	

Note: power spectrum density of 3kHz is -15.20dB lower than that of 100kHz.

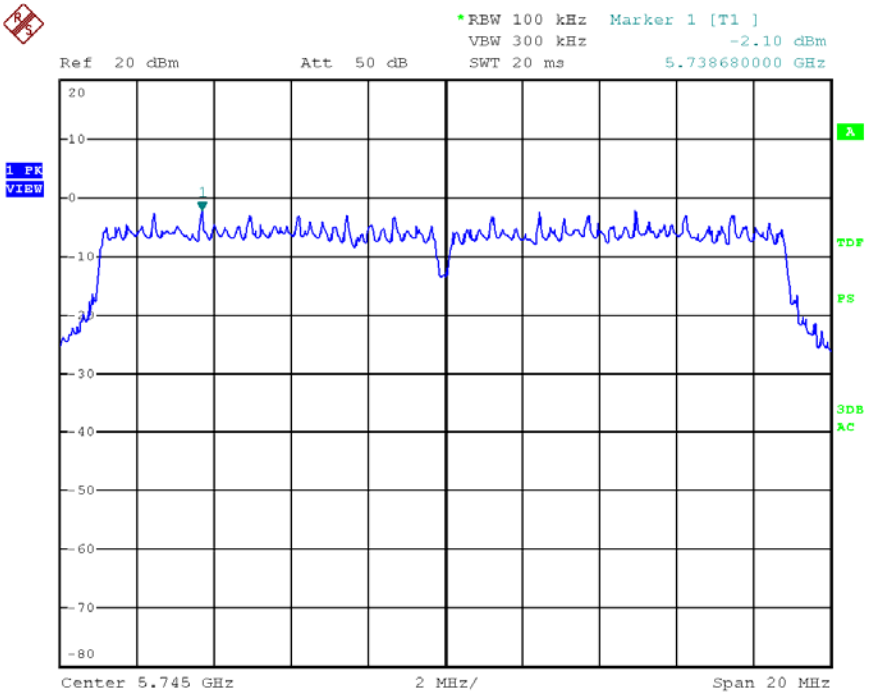
11na, HT20, Channel L

Chain 1



Date: 14.MAR.2012 21:13:22

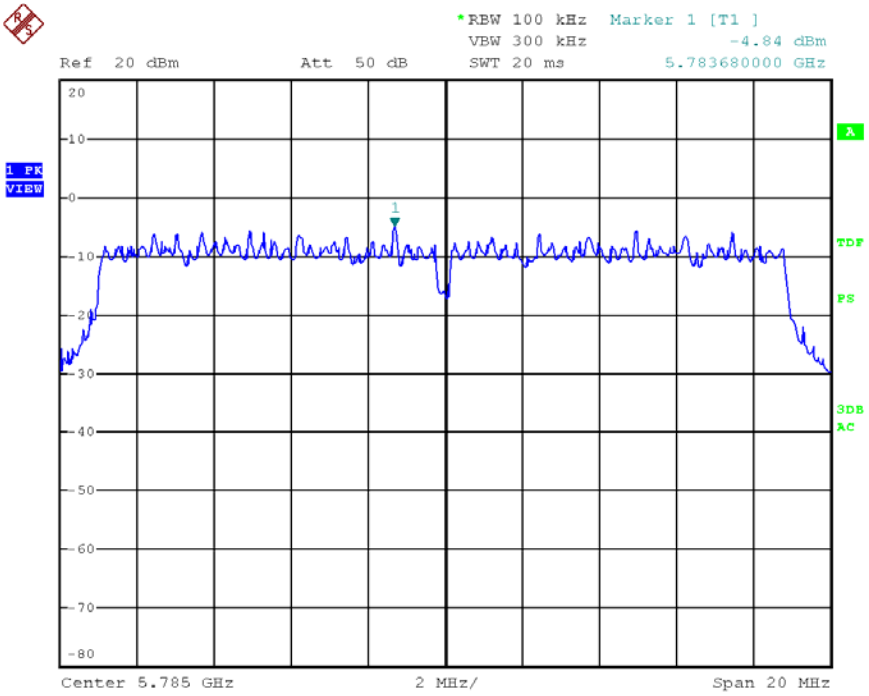
Chain 2



Date: 14.MAR.2012 21:28:52

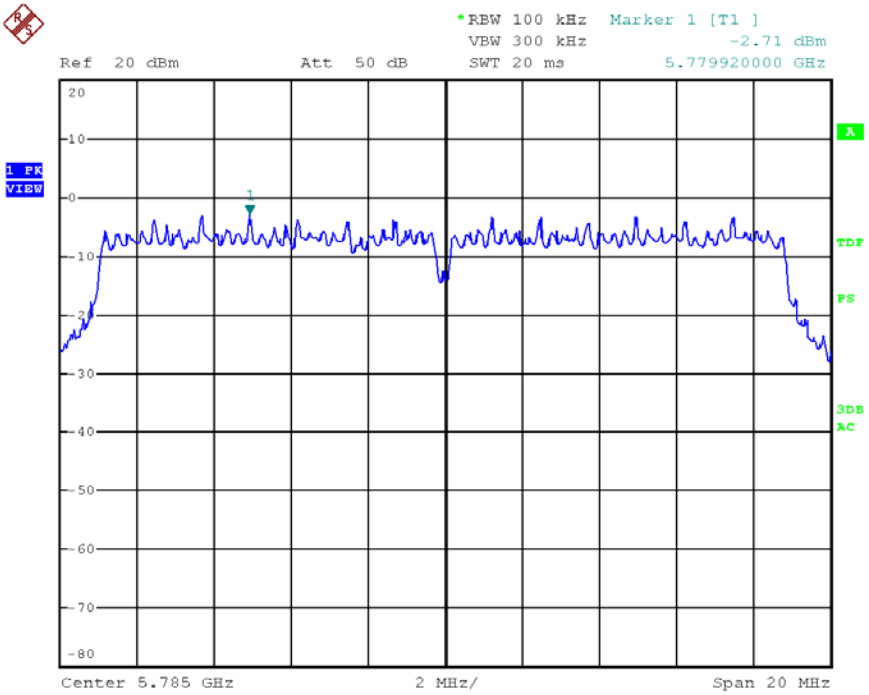
11na, HT20, Channel M

Chain 1



Date: 14.MAR.2012 21:13:56

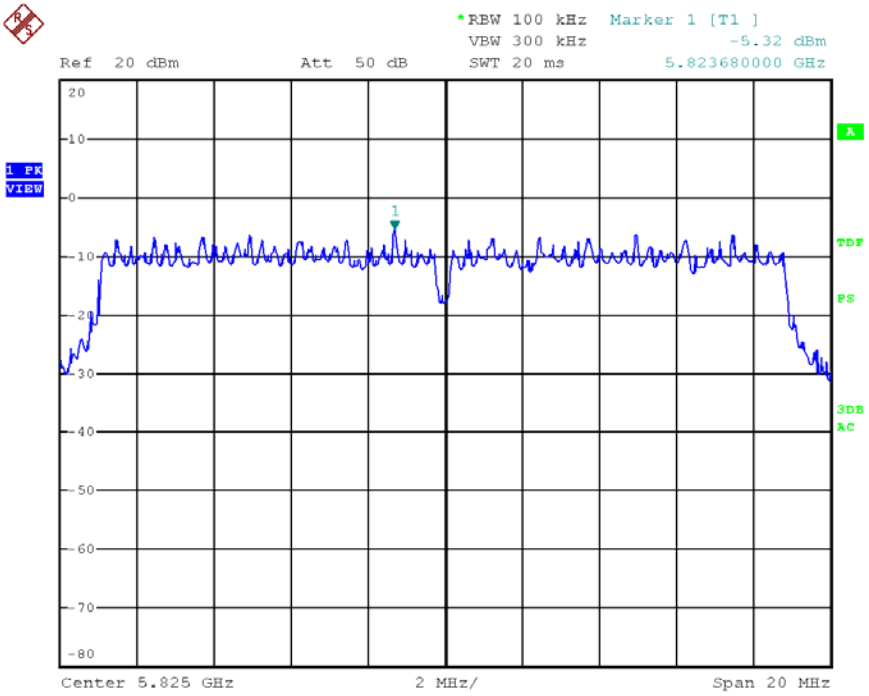
Chain 2



Date: 14.MAR.2012 21:29:18

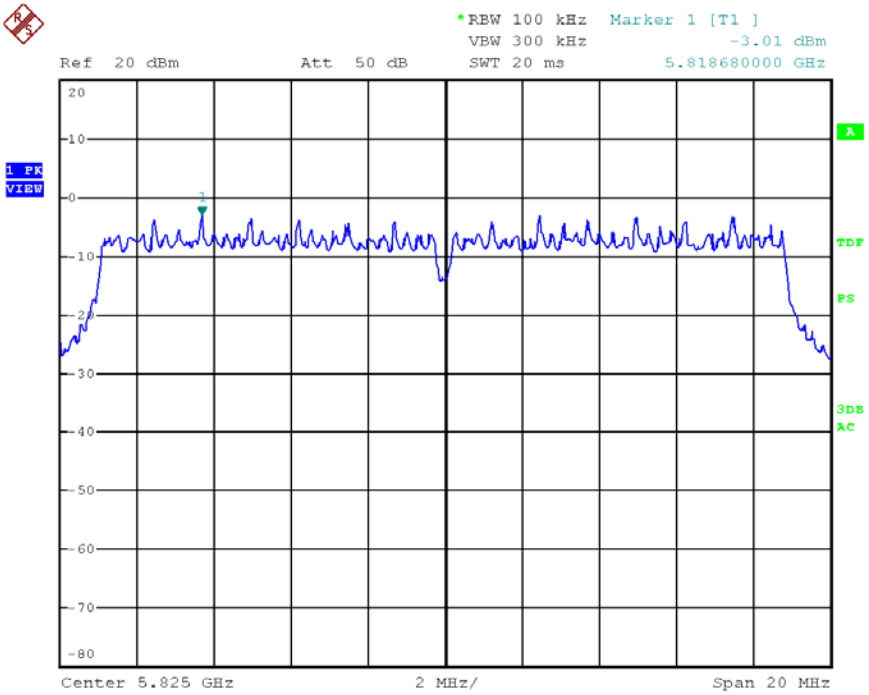
11na, HT20, Channel H

Chain 1



Date: 14.MAR.2012 21:14:22

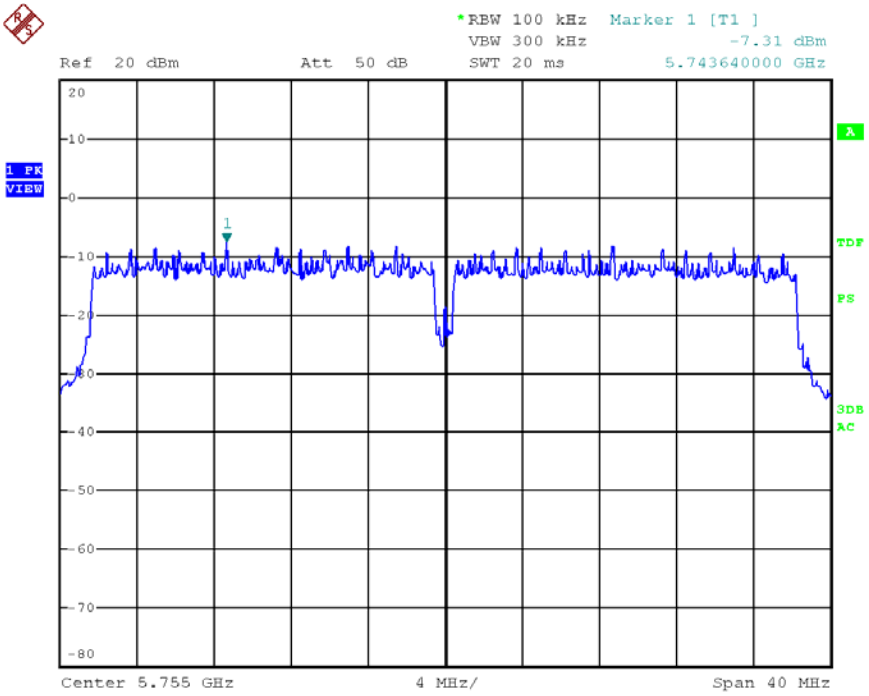
Chain 2



Date: 14.MAR.2012 21:29:38

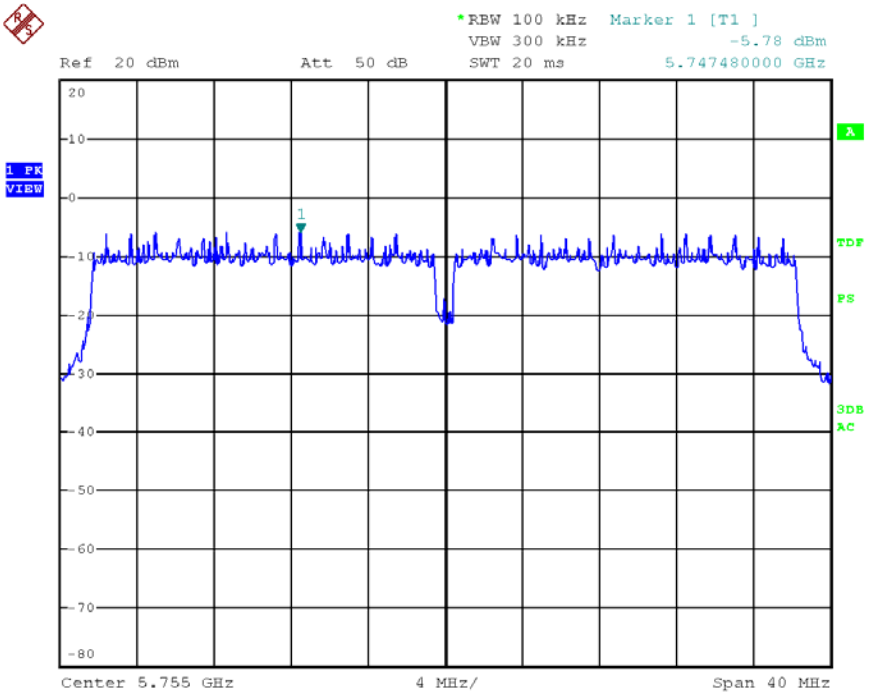
11na, HT40, Channel L

Chain 1



Date: 14.MAR.2012 21:16:37

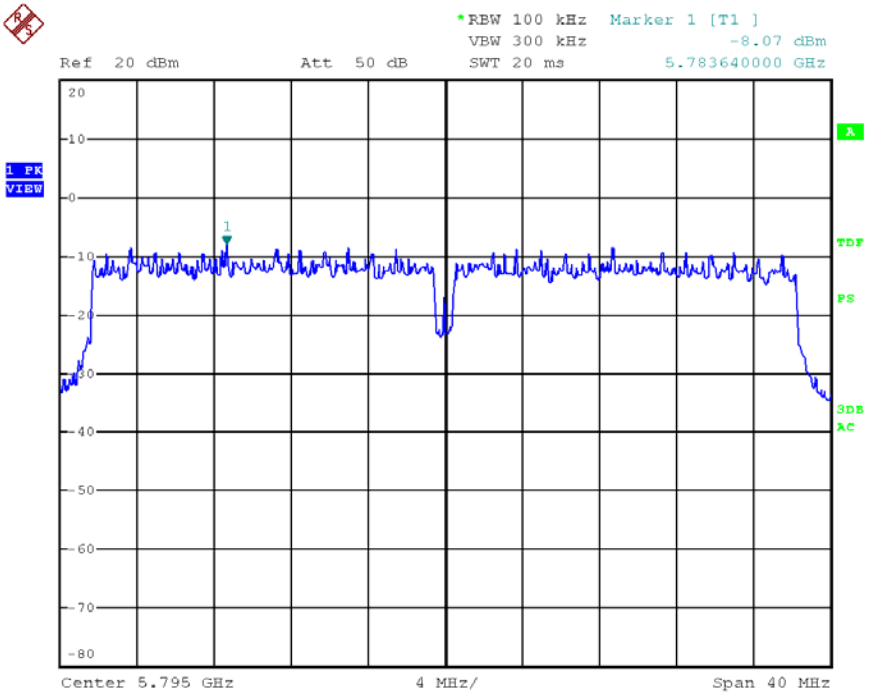
Chain 2



Date: 14.MAR.2012 21:25:45

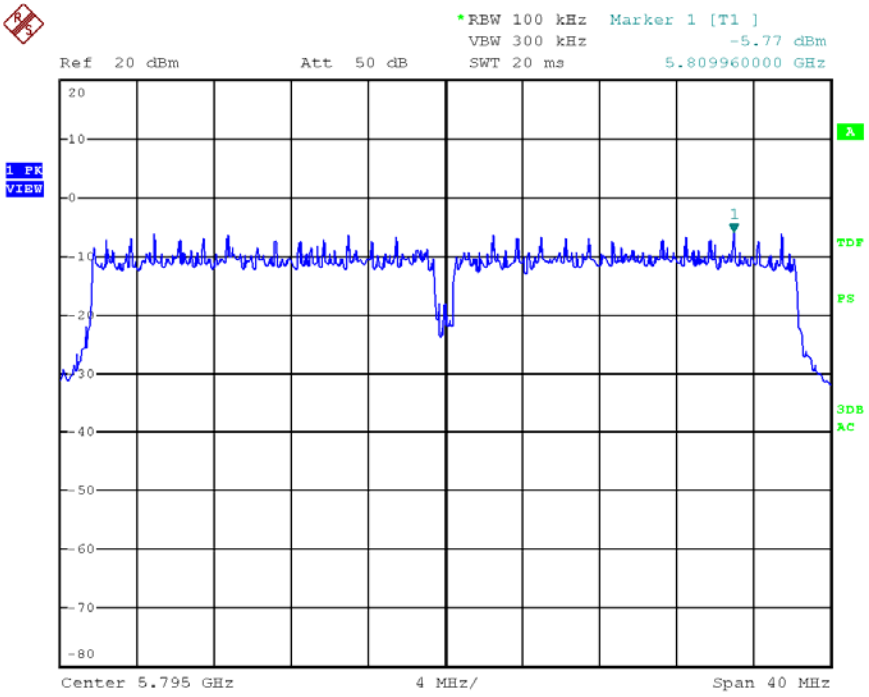
11na, HT40, Channel H

Chain 1



Date: 14.MAR.2012 21:17:17

Chain 2



Date: 14.MAR.2012 21:25:21

6. Radiated emission

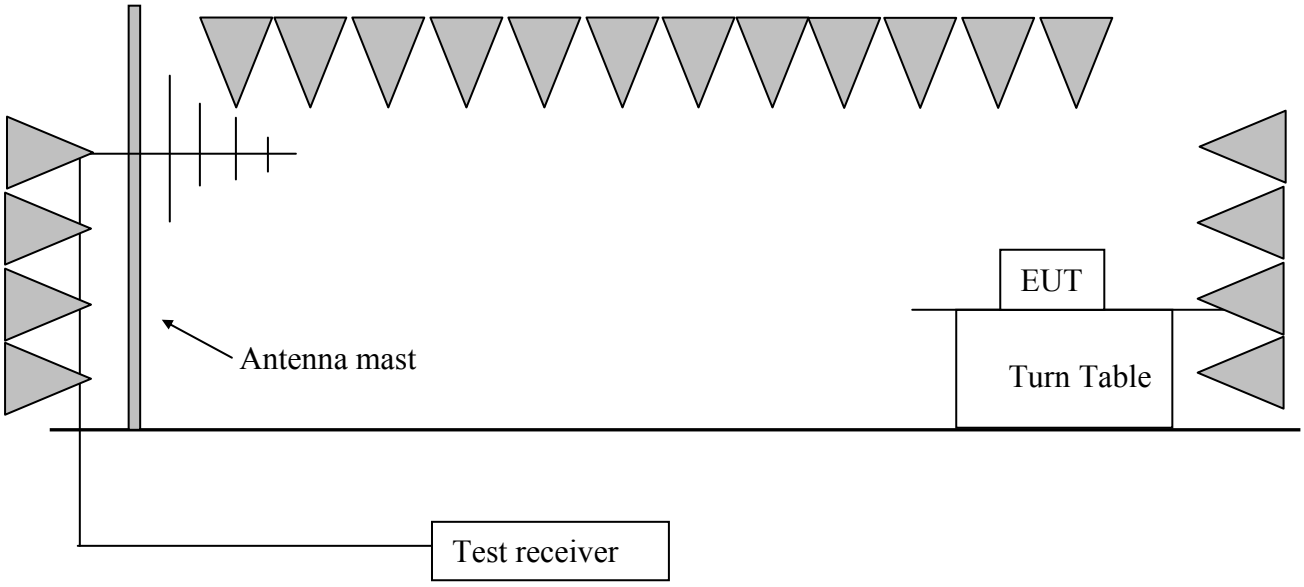
Test result: PASS

6.1 Test limit

The radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) showed as below:

Frequency (MHz)	Field Strength (dBuV/m)	Measurement Distance (m)
30 - 88	40.0	3
88 - 216	43.5	3
216 - 960	46.0	3
Above 960	54.0	3

6.2 Test Configuration



6.3 Test procedure and test setup

The measurement was applied in a semi-anechoic chamber. While testing for spurious emission higher than 1GHz, if applied, the pre-amplifier would be equipped just at the output terminal of the antenna.
The EUT and simulators were placed on a 0.8m high wooden turntable above the horizontal metal ground plane. The turn table rotated 360 degrees to determine the position of the maximum emission level. The EUT was set 3 meters away from the receiving antenna which was mounted on an antenna mast. The antenna moved up and down between from 1meter to 4 meters to find out the maximum emission level.
The EUT was tested according to DTS test procedure of KDB558074 D01 DTS "Meas Guidance v01" for compliance to FCC 47CFR 15.247 requirements.

The radiated emission was measured using the Spectrum Analyzer with the resolutions bandwidth set as:

RBW = 100kHz, VBW = 300kHz (30MHz-1GHz)
RBW = 1MHz, VBW = 3MHz (>1GHz for PK);
RBW = 1MHz, VBW = 10Hz (>1GHz for AV);

6.4 Test protocol

Dual chain, 11na, HT20 mode (which mode with max. output power):

CH	Polarization	Frequency (MHz)	Correct Factor (dB/m)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
L	V	5747.29	33.60	118.90	Fundamental	/	PK
	H	111.64	15.60	30.10	43.50	13.40	PK
	V	129.14	14.90	36.40	43.50	7.10	PK
	H	335.13	16.30	37.40	46.00	8.60	PK
	V	600.00	21.30	37.20	46.00	8.80	PK
	H	1000.02	24.60	41.50	54.00	12.50	PK
	V	5460.00	0.10	43.60	54.00	10.40	PK
	V	11466.03	12.90	60.30	74.00	13.70	PK
	V	11465.92	12.90	51.20	54.00	2.80	AV
M	V	5780.86	33.60	118.20	Fundamental	/	PK
	H	111.64	15.60	30.10	43.50	13.40	PK
	V	129.14	14.90	36.40	43.50	7.10	PK
	H	335.13	16.30	37.40	46.00	8.60	PK
	V	600.00	21.30	37.20	46.00	8.80	PK
	H	1000.02	24.60	41.50	54.00	12.50	PK
	V	5460.00	0.10	43.50	54.00	10.50	PK
	V	11565.67	13.30	59.20	74.00	14.80	PK
	V	11565.53	13.30	50.60	54.00	3.40	AV
H	V	5828.33	33.60	117.90	Fundamental	/	PK
	H	111.64	15.60	30.10	43.50	13.40	PK
	V	129.14	14.90	36.40	43.50	7.10	PK
	H	335.13	16.30	37.40	46.00	8.60	PK
	V	600.00	21.30	37.20	46.00	8.80	PK
	H	1000.02	24.60	41.50	54.00	12.50	PK
	V	5460.00	0.10	43.50	54.00	10.50	PK
	V	11648.71	13.70	58.50	74.00	15.50	PK

	V	11648.60	13.70	50.10	54.00	3.90	AV

Remark: 1. Correct Factor = Antenna Factor + Cable Loss (-Amplifier, is employed)
2. Corrected Reading = Original Receiver Reading + Correct Factor
3. Margin = limit – Corrected Reading
4. If the PK reading is lower than AV limit, the AV test can be elided.

Example: Assuming Antenna Factor = 30.20dB/m, Cable Loss = 2.00dB,
Gain of Preamplifier = 32.00dB, Original Receiver Reading = 10dBuV.
Then Correct Factor = 30.20 + 2.00 – 32.00 = 0.20dB/m; Corrected Reading = 10dBuV + 0.20dB/m = 10.20dBuV/m
Assuming limit = 54dBuV/m, Corrected Reading = 10.20dBuV/m, then Margin = 54 -10.20 = 43.80dBuV/m

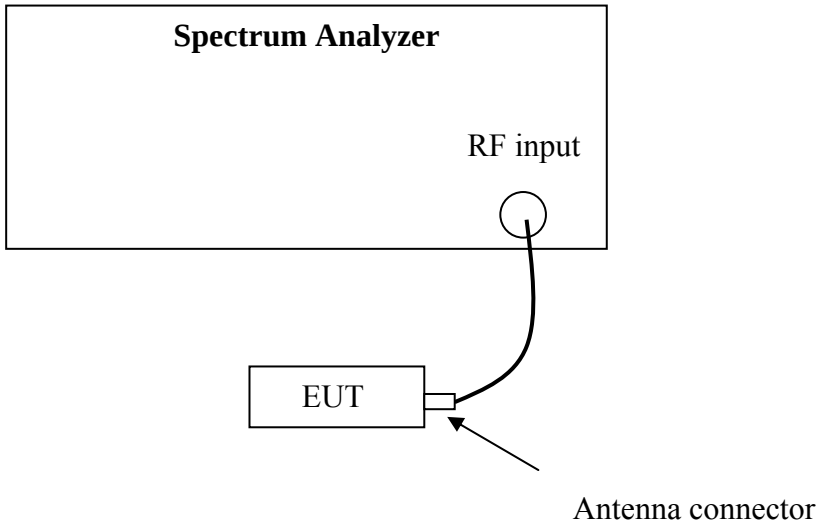
7. Emission outside the frequency Band

Test result: **PASS**

7.1 Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

7.2 Test Configuration



7.3 Test procedure and test setup

The Emission outside the frequency Band per FCC §15.247(d) is measured using the Spectrum Analyzer with the resolutions bandwidth set at 100kHz, the video bandwidth set at 300kHz, and the SPAN>>RBW.
The EUT was tested according to DTS test procedure of "KDB558074 D01 DTS Meas Guidance v01" for compliance to FCC 47CFR 15.247 requirements.

7.4 Test protocol

Single Chain

Mode	CH	Max reading among band (dBm)	The most restrict Attenuation outside band (dB)	Limit (dB)
11a	L	-4.71	42.92	≥20
	M	-5.49	43.26	
	H	-5.95	43.04	
11na, HT20	L	-4.49	40.81	
	M	-5.61	40.66	
	H	-5.98	40.66	
11na, HT40	L	-7.57	38.63	
	H	-8.76	39.34	

Dual Chain, Chain 1

Mode	CH	Max reading among band (dBm)	The most restrict Attenuation outside band (dB)	Limit (dB)
11na, HT20	L	-3.96	41.73	≥20
	M	-4.84	41.66	
	H	-5.32	42.04	
11na, HT40	L	-7.31	41.11	
	H	-8.07	40.25	

Dual Chain, Chain 2

Mode	CH	Max reading among band (dBm)	The most restrict Attenuation outside band (dB)	Limit (dB)
11na, HT20	L	-2.10	42.24	≥20
	M	-2.71	42.58	
	H	-3.01	41.71	
11na, HT40	L	-5.78	40.98	
	H	-5.77	40.26	

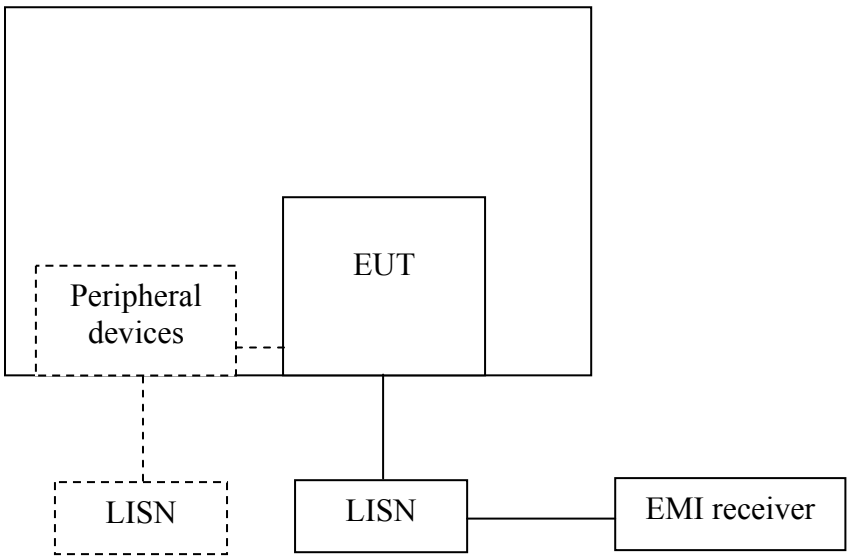
8. Power line conducted emission

Test result: **Pass**

8.1 Limit

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

8.2 Test configuration



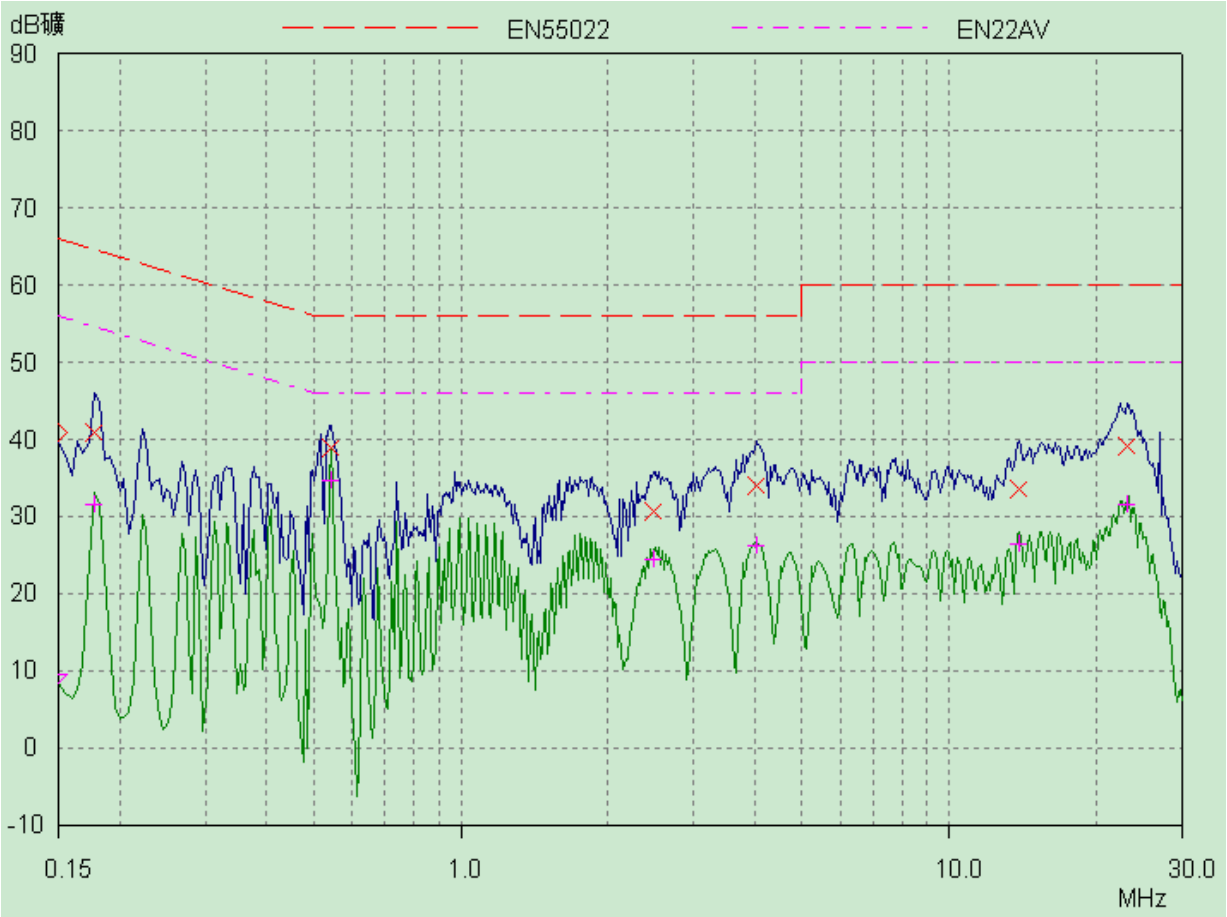
☒ For table top equipment, wooden support is 0.8m height table

☐ For floor standing equipment, wooden support is 0.1m height rack.

8.3 Test procedure and test set up

The EUT are connected to the main power through a line impedance stabilization network (LISN). This provides a 50Ω/50uH coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN that provides a 50Ω/50uH coupling impedance with 50Ω termination.
Both sides (Line and Neutral) of AC line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.4 on conducted measurement.
The bandwidth of the test receiver is set at 9 kHz.

8.4 Test protocol



Frequency	Correct Factor (dB)	Corrected Reading (dBuV)		Limit (dBuV)		Margin (dB)	
		QP	AV	QP	AV	QP	AV
0.18 (L)	3.00	40.95	31.44	64.63	54.63	23.68	23.19
0.54 (L)	3.00	38.88	34.71	56.00	46.00	17.12	11.29
2.47 (N)	3.00	30.74	24.42	56.00	46.00	25.26	21.58
4.00 (N)	3.00	33.96	26.30	56.00	46.00	22.04	19.70
13.80 (L)	3.00	33.50	26.33	60.00	50.00	26.50	23.67
23.06 (N)	3.00	39.08	31.56	60.00	50.00	20.92	18.44
Remark: 1. Correction Factor (dB) = LISN Factor (dB) + Cable Loss (dB). 2. Margin (dB) = Limit - Corrected Reading.							

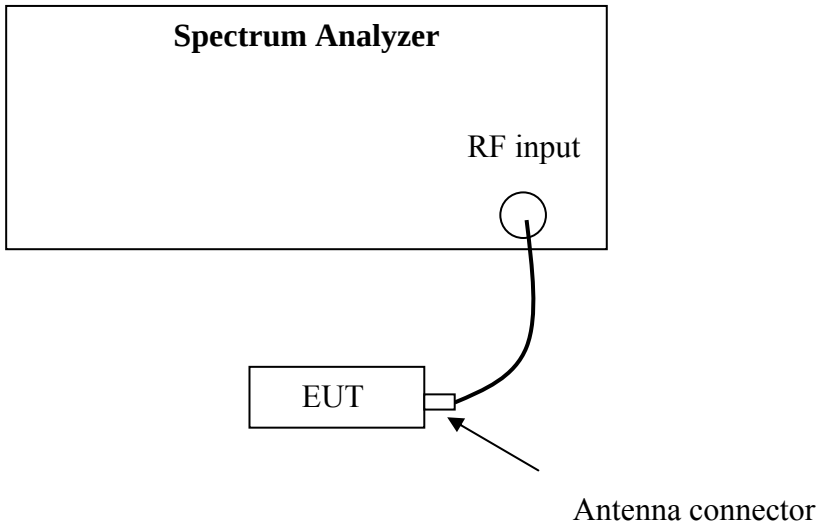
9. Channel Number of hopping system

Test result: **NA**

9.1 Limit

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

9.2 Test Configuration



9.3 Test procedure and test setup

The channel number per FCC §15.247(a)(1)(iii) is measured using the Spectrum Analyzer with the resolutions bandwidth set at 100kHz, the video bandwidth set at 300kHz, and the SPAN>>RBW.
The RF passband of the EUT was divided into 3 appropriate bands to test.

9.4 Test protocol

Channel Number	Limit
-	≥15

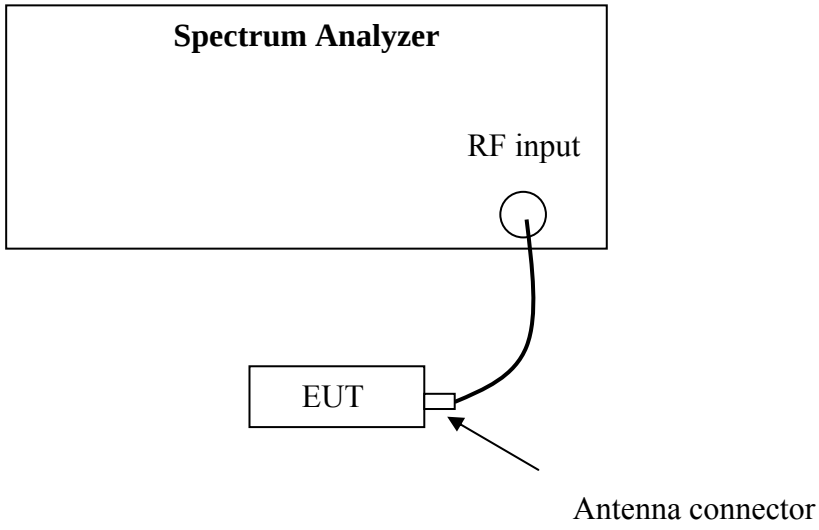
10. Average time of occupancy in any channel

Test result: **NA**

10.1 Limit

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

10.2 Test Configuration



10.3 Test procedure and test setup

Average time of occupancy in any channel per FCC § 15.247(a)(1)(iii)
is measured using the Spectrum Analyzer with the resolutions bandwidth set at 100kHz, the video bandwidth set at 300kHz, and the SPAN set to be 0Hz to test in time domain. The test is performed at the middle channel.

10.4 Test protocol

Packet	Observed period (s) **P**	Time of occupancy for single hopping (ms) **O**	Hops among the interval of 3.6 s **I**	Average time of occupancy (s) **T**	Limit (s)
Packet Type 4	-	-	-	-	≤0.4
Packet Type 11	-	-	-	-	≤0.4
Packet Type 15	-	-	-	-	≤0.4

Remark: 1. There are 79 channels in all. So the observed period P = 0.4 * 79 = 31.6 s.
2. Average time of occupancy **T = O *I * P / 3.6**

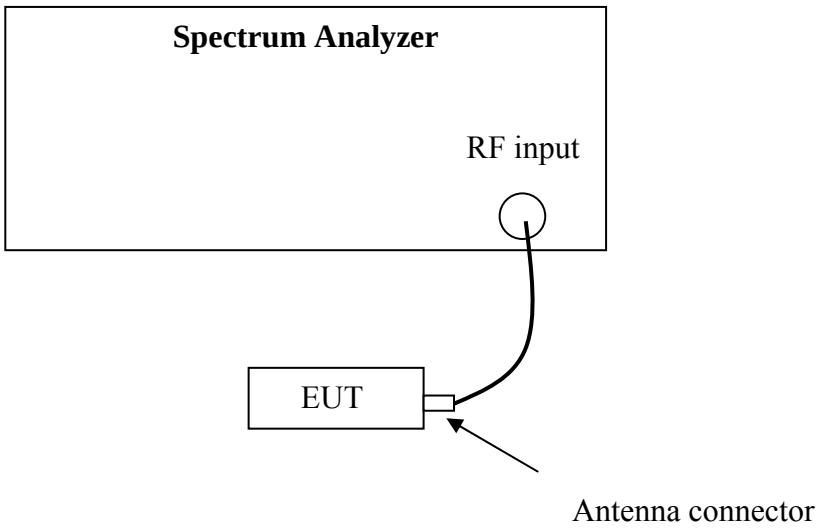
11. Occupied Bandwidth

Test Status: Tested

11.1 Test limit

None

11.2 Test Configuration



11.3 Test procedure and test setup

The occupied bandwidth per RSS-Gen Issue 3 Clause 4.6.1 was measured using the Spectrum Analyzer with the resolutions bandwidth set at 1MHz, the video bandwidth set at 3MHz.

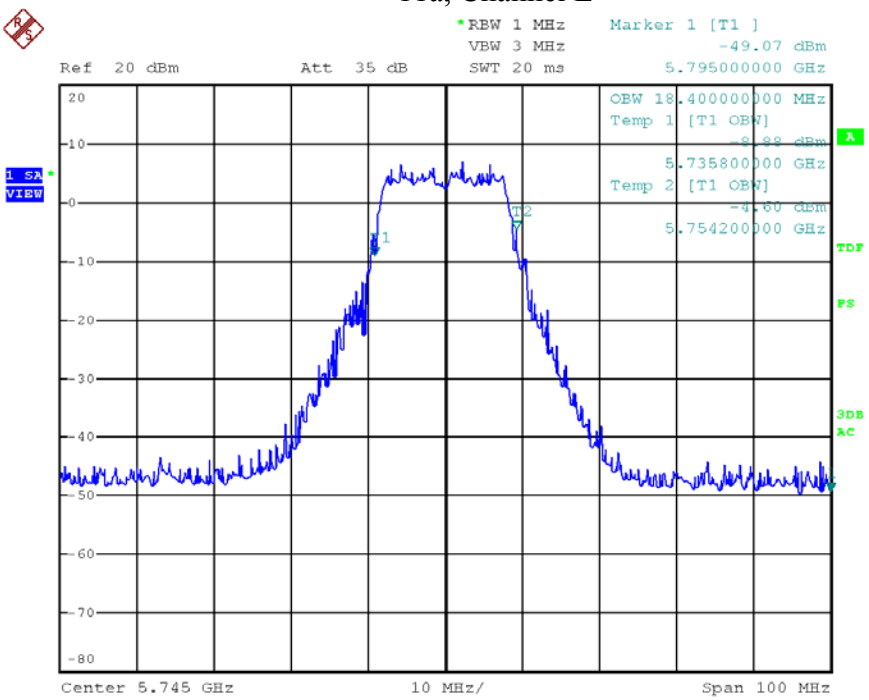
11.4 Test protocol

Temperature : 22 °C
Relative Humidity : 43 %

Single Chain

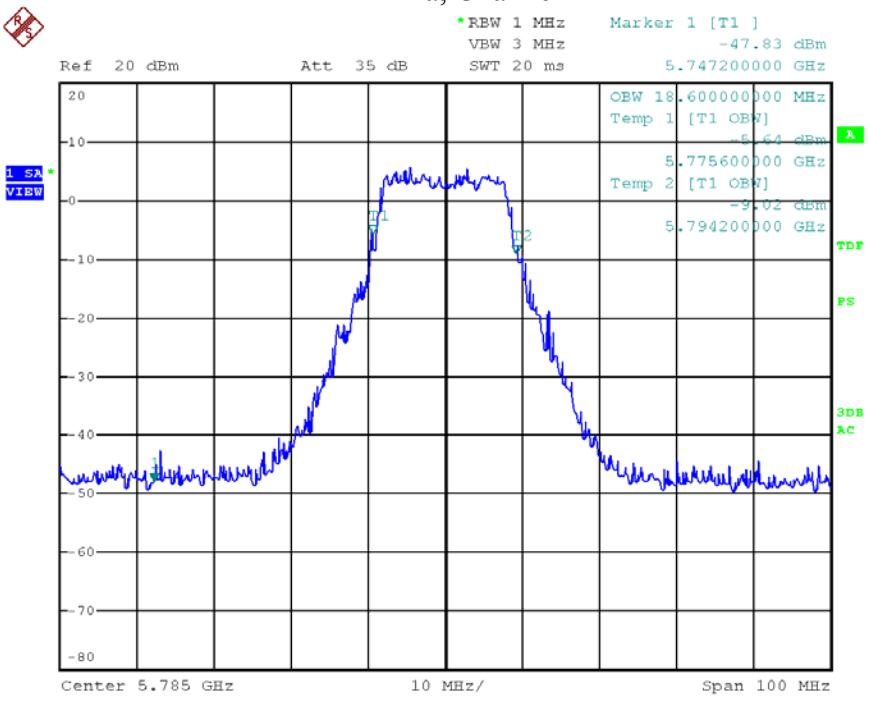
Mode	CH	99% Bandwidth (MHz)
11a	L	18.40
	M	18.60
	H	18.60
11na, HT20	L	19.00
	M	19.00
	H	19.40
11na, HT40	L	37.20
	H	37.20

11a, Channel L



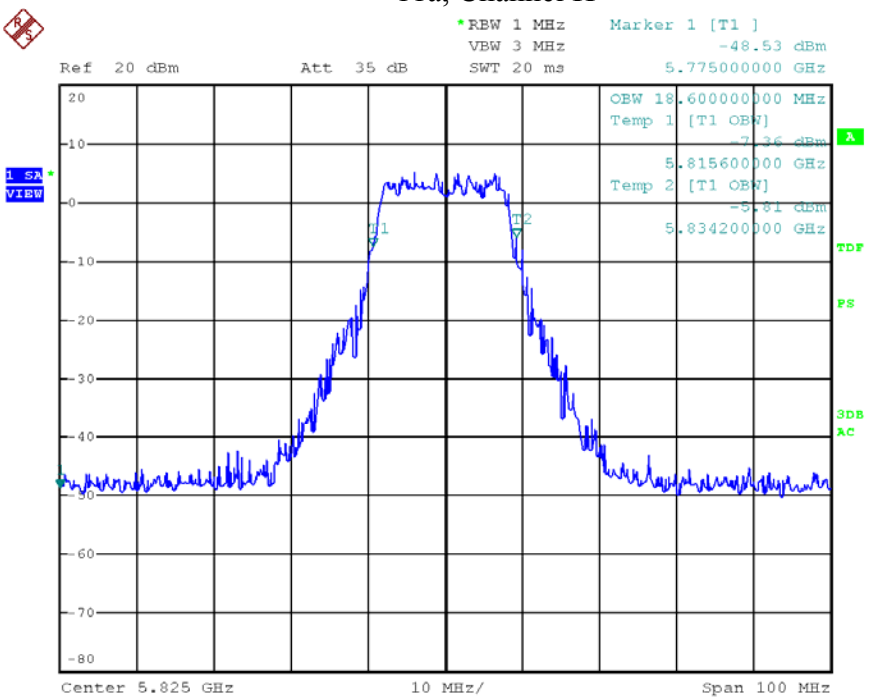
Date: 14.MAR.2012 21:36:22

11a, Channel M



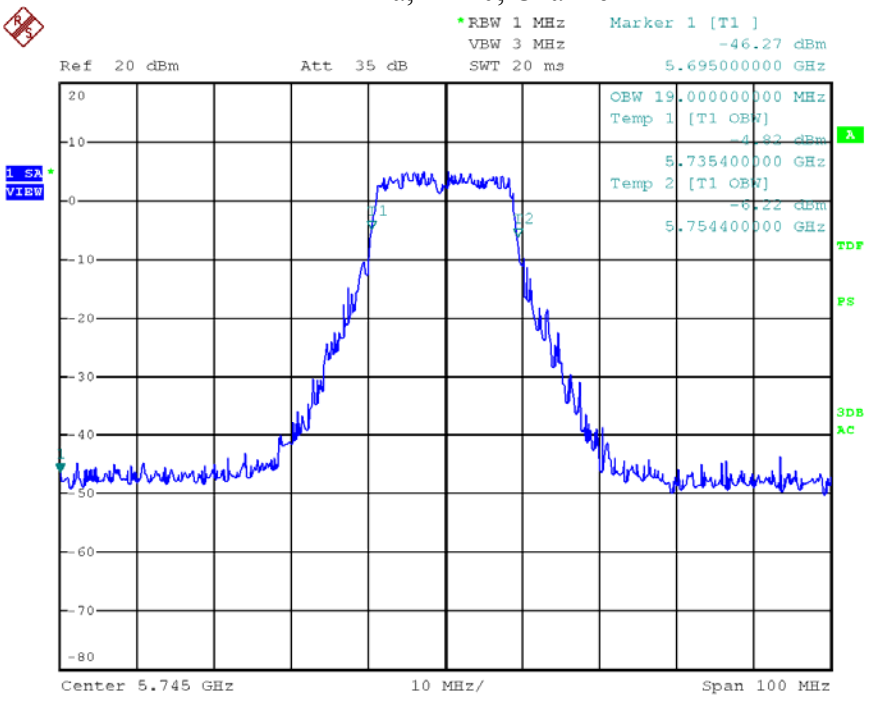
Date: 14.MAR.2012 21:37:38

11a, Channel H



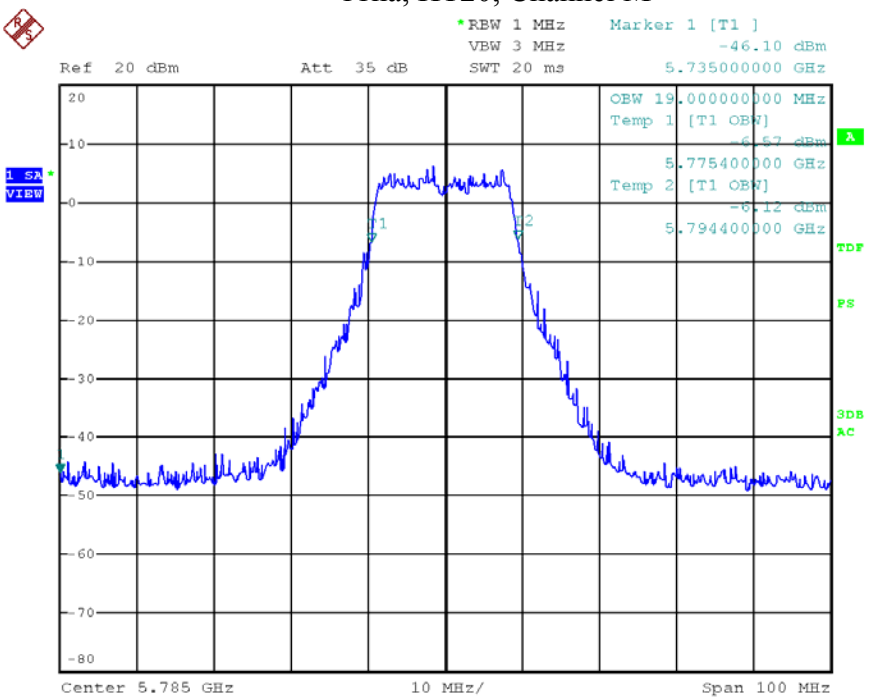
Date: 14.MAR.2012 21:38:03

11na, HT20, Channel L



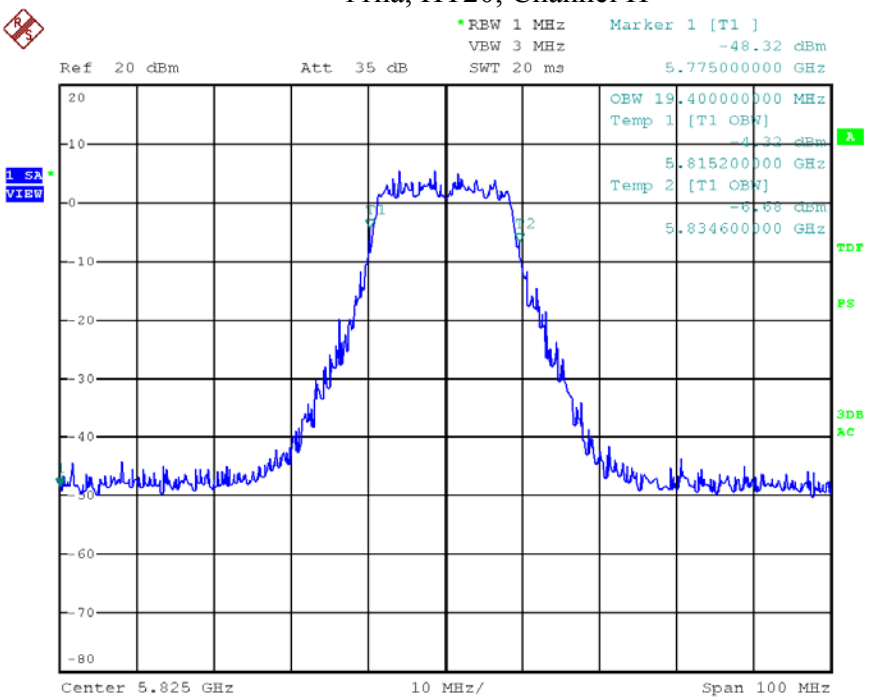
Date: 14.MAR.2012 21:39:31

11na, HT20, Channel M



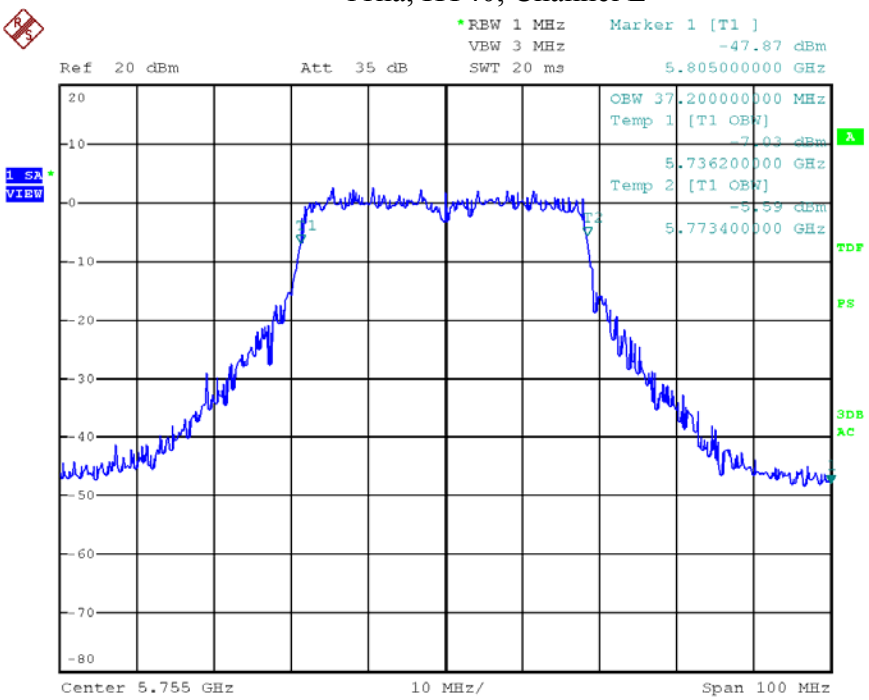
Date: 14.MAR.2012 21:39:07

11na, HT20, Channel H



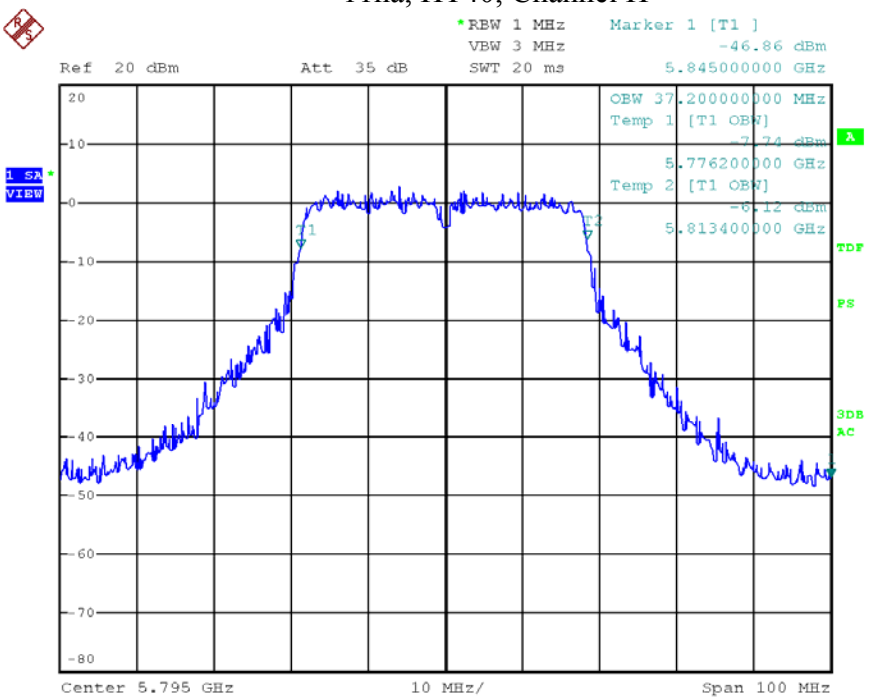
Date: 14.MAR.2012 21:38:31

11na, HT40, Channel L



Date: 14.MAR.2012 21:43:34

11na, HT40, Channel H

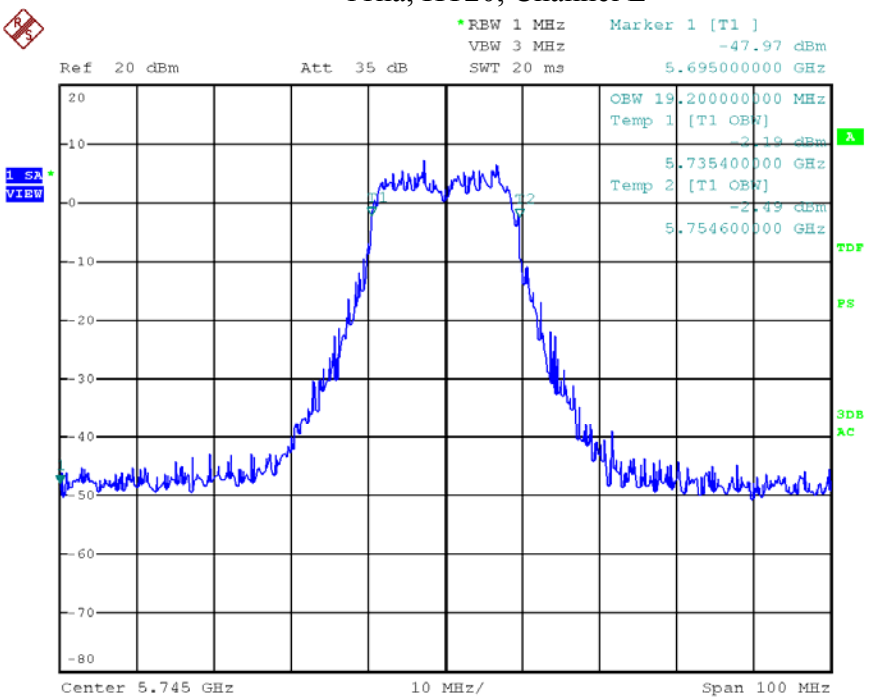


Date: 14.MAR.2012 21:43:05

Dual Chain

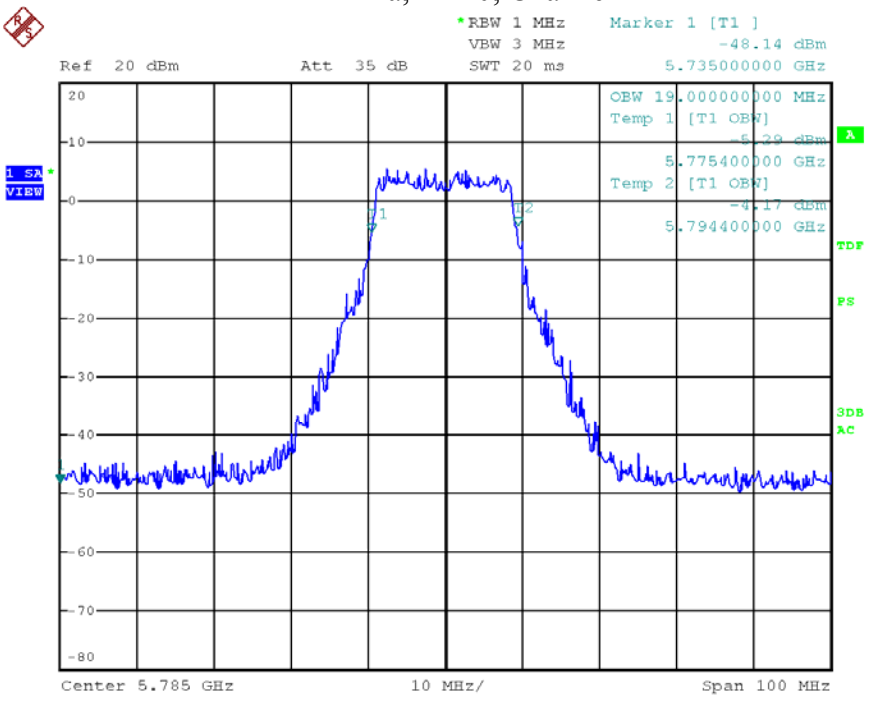
Mode	CH	99% Bandwidth (MHz)
11na, HT20	L	19.20
	M	19.00
	H	19.20
11na, HT40	L	37.20
	H	37.20

11na, HT20, Channel L



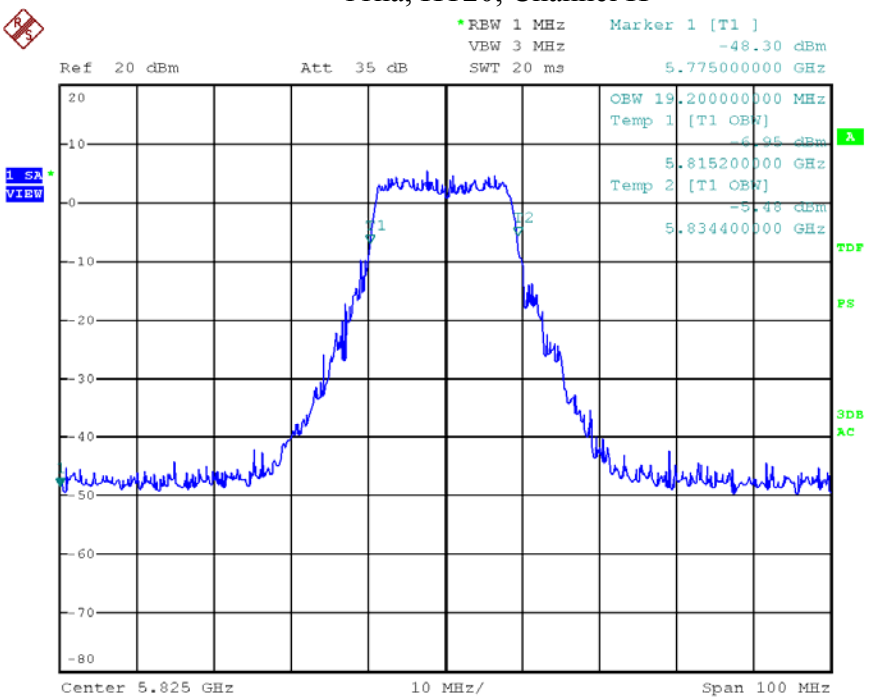
Date: 14.MAR.2012 21:40:06

11na, HT20, Channel M



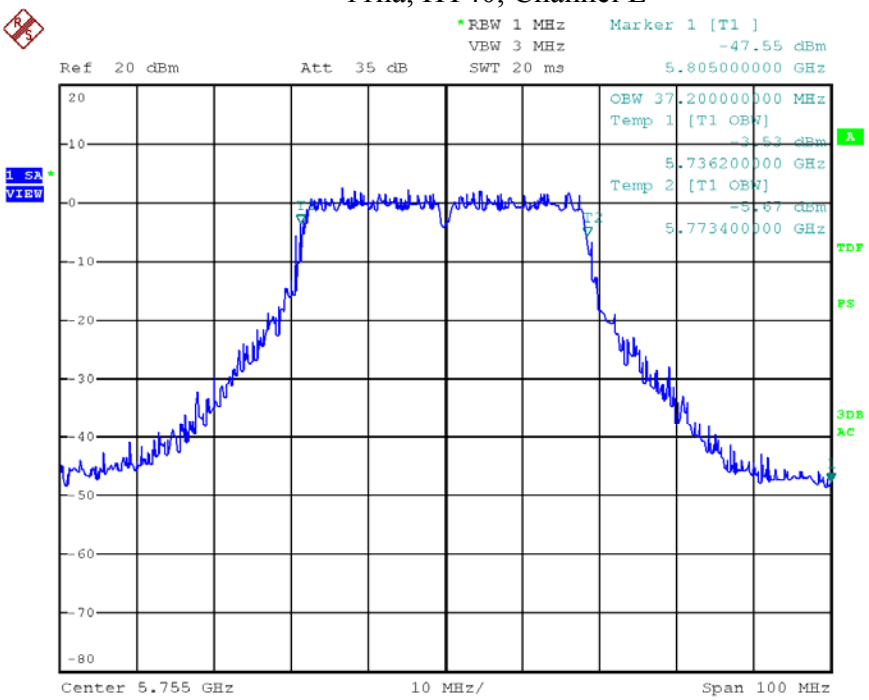
Date: 14.MAR.2012 21:40:36

11na, HT20, Channel H



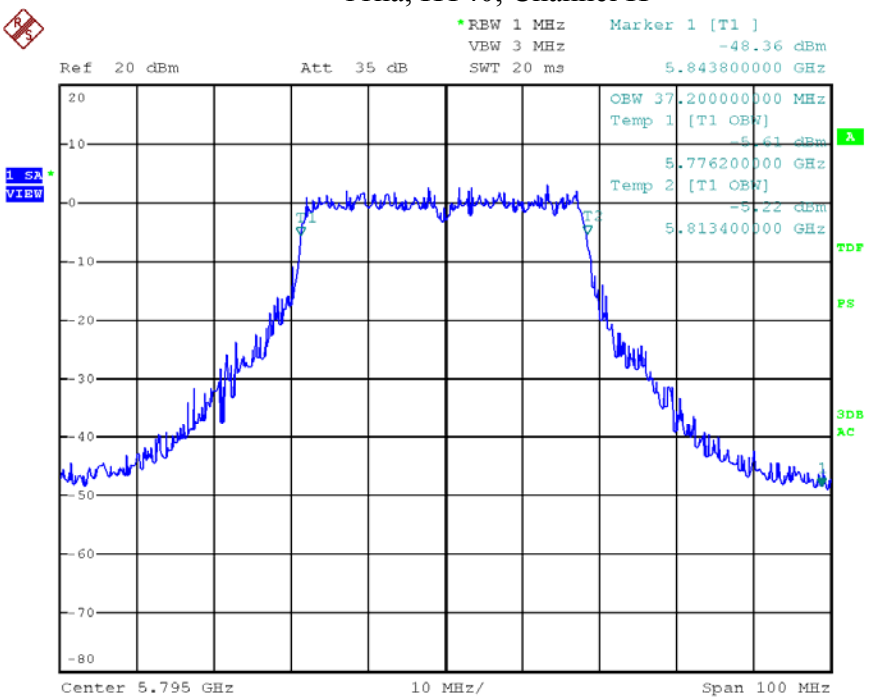
Date: 14.MAR.2012 21:41:06

11na, HT40, Channel L



Date: 14.MAR.2012 21:44:09

11na, HT40, Channel H



Date: 14.MAR.2012 21:44:42

12. Power line conducted emission for Unintentional Radiator

Test result: PASS

12.1 Limits

12.1.1 Limits for conducted disturbance voltage at the mains ports of class A device

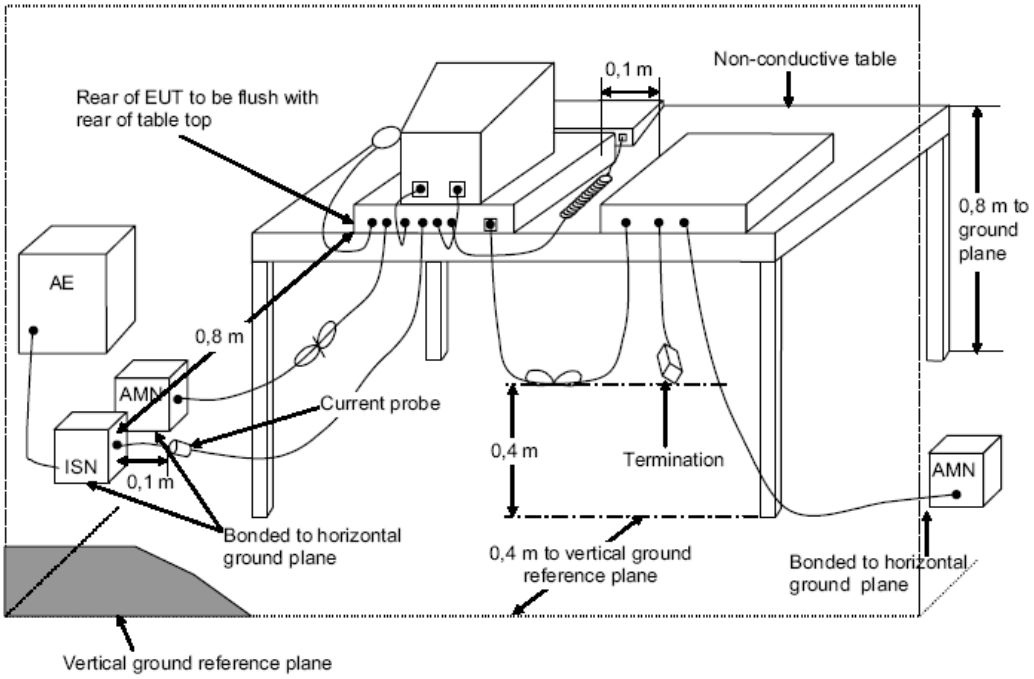
Frequency range (MHz)	Limits dB(μV) Quasi-peak	Average
0.15 ~ 0.5	79	66
0.5 ~ 30	73	60
Note: If the limit for the measurement with the average detector is met when using a receiver with a quasi-peak detector, the equipment under test shall be deemed to meet both limits and the measurement using the receiver with an average detector need not be carried out.		

12.1.2 Limits for conducted disturbance voltage at the mains ports of class B device

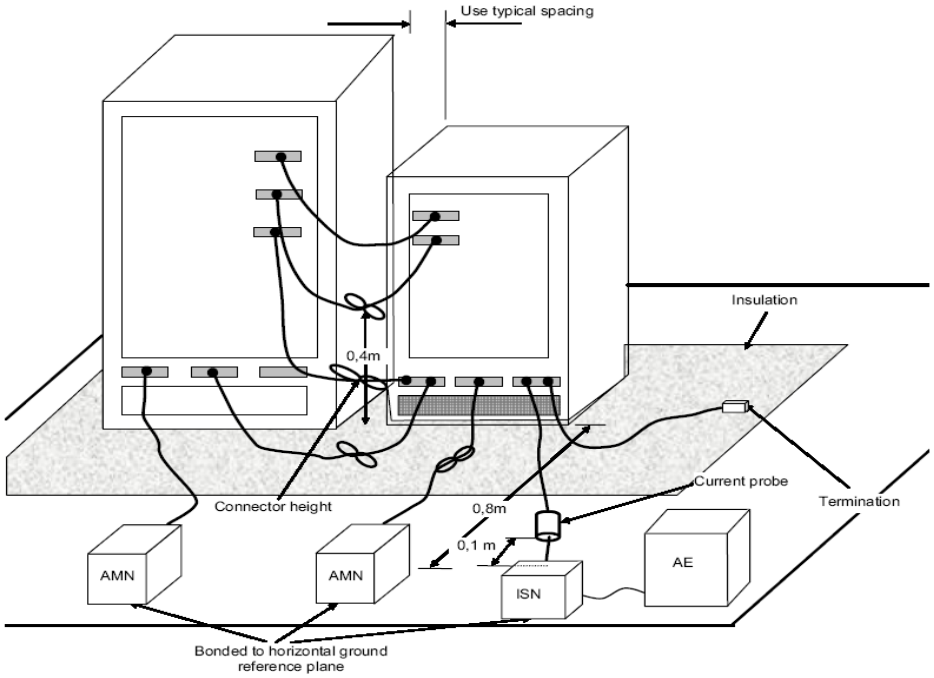
Frequency range (MHz)	Limits dB(μV) Quasi-peak	Average
0.15 ~ 0.5	66 ~ 56 *	56 ~ 46 *
0.5 ~ 5	56	46
5 ~ 30	60	50
Note: 1. * Means the limit decreasing linearly with the logarithm of the frequency in the range 0.15MHz to 0.5MHz 2. If the limit for the measurement with the average detector is met when using a receiver with a quasi-peak detector, the equipment under test shall be deemed to meet both limits and the measurement using the receiver with an average detector need not be carried out.		

12.2 Test setup

☒ For table top equipment



☐ For floor standing equipment



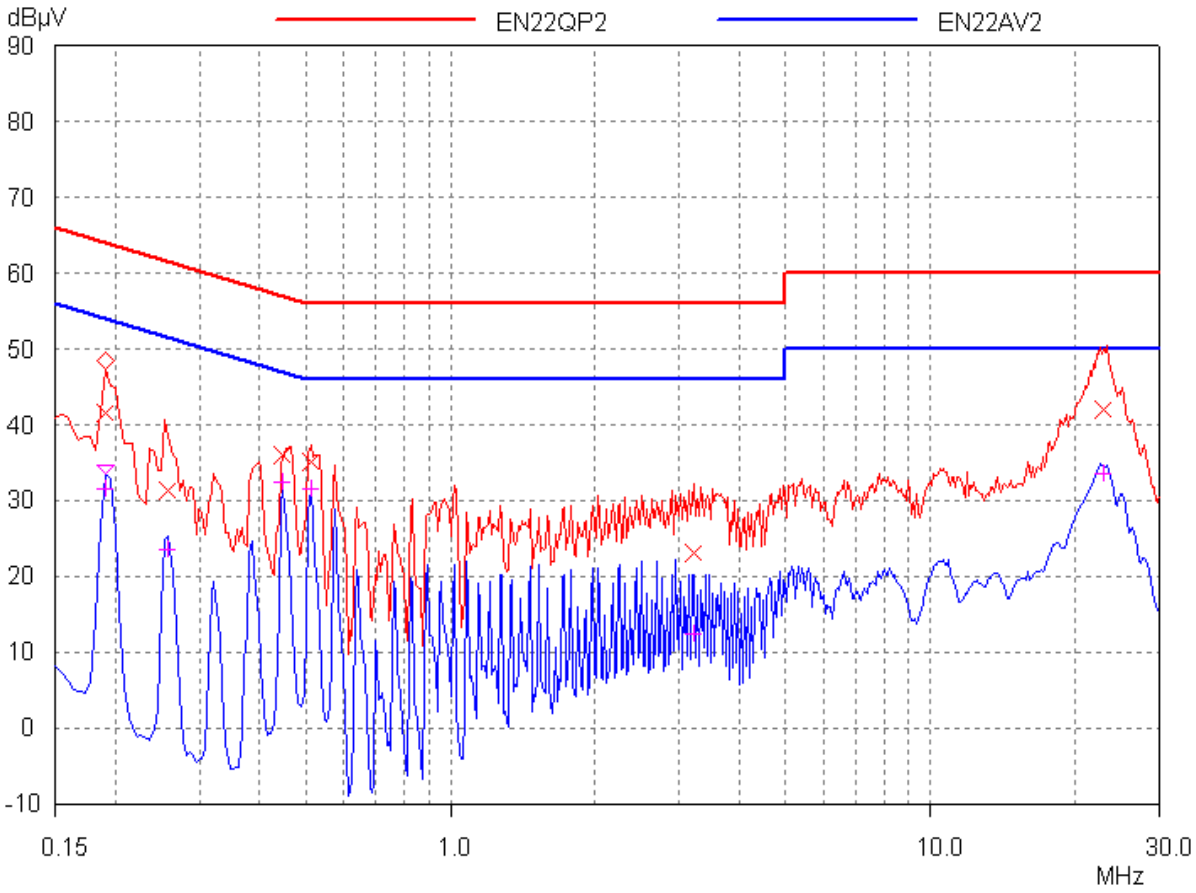
12.3 Test Setup and Test Procedure

Measurement was performed in shielded room, and instruments used were following clause 4 and clause 5 of ANSI 63.4.
Detailed test procedure was following clause 7.2 of ANSI 63.4.
EUT arrangement and operation conditions were according to clause 6 and clause 7 of ANSI 63.4.
Frequency range 150kHz – 30MHz was checked and EMI receiver measurement bandwidth was set to 9 kHz.

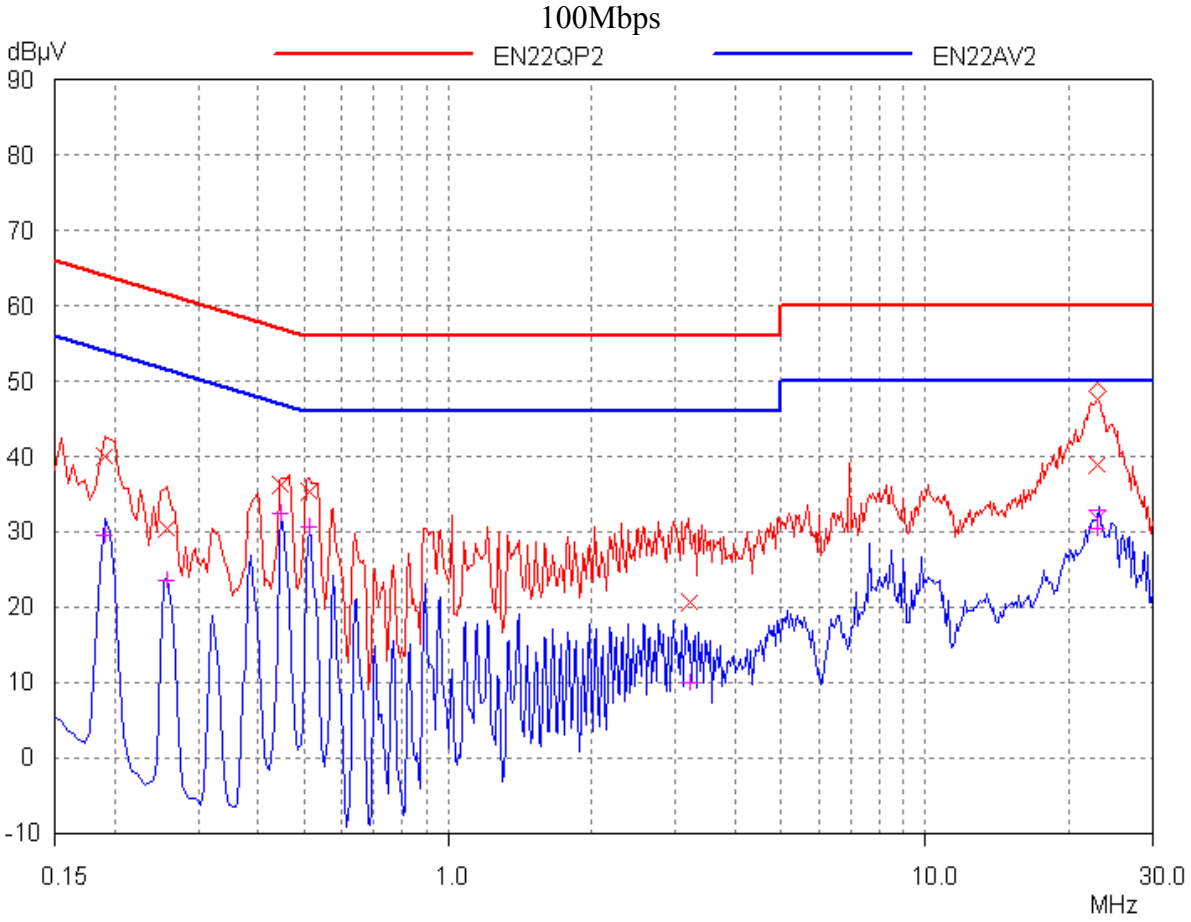
12.4 Test Protocol

Temperature : 22 °C
Relative Humidity : 43 %

10Mbps

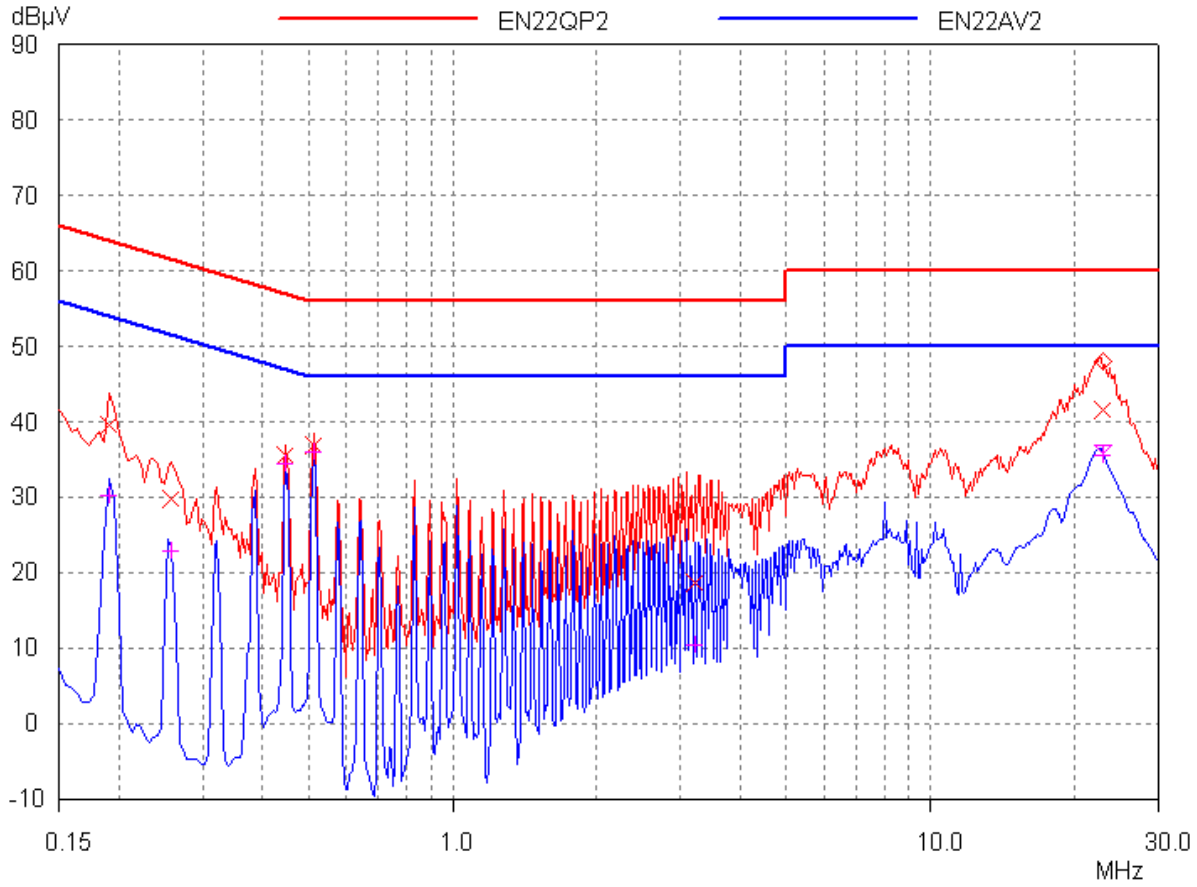


Frequency	Correct Factor (dB)	Corrected Reading (dBuV)		Limit (dBuV)		Margin (dB)	
		QP	AV	QP	AV	QP	AV
0.19 (L)	3.00	45.54	31.44	64.01	54.01	22.47	22.57
0.26 (L)	3.00	31.40	23.60	61.50	51.50	30.10	27.90
0.45 (N)	3.00	35.97	32.49	56.93	46.93	20.96	14.44
0.51 (L)	3.00	35.13	31.52	56.00	46.00	20.87	14.48
3.18 (N)	3.00	23.03	12.39	56.00	46.00	32.97	33.61
22.79 (L)	3.00	41.99	33.53	60.00	50.00	18.01	16.47
Remark: 1. Correction Factor (dB) = LISN Factor (dB) + Cable Loss (dB). 2. Margin (dB) = Limit - Corrected Reading.							



Frequency	Correct Factor (dB)	Corrected Reading (dBuV)		Limit (dBuV)		Margin (dB)	
		QP	AV	QP	AV	QP	AV
0.19 (L)	3.00	40.07	29.60	64.01	54.01	23.94	24.41
0.26 (N)	3.00	30.37	23.60	61.50	51.50	31.13	27.90
0.45 (N)	3.00	36.23	32.35	56.93	46.93	20.70	14.58
0.51 (L)	3.00	35.42	30.76	56.00	46.00	20.58	15.24
3.18 (L)	3.00	20.56	9.97	56.00	46.00	35.44	36.03
22.79 (N)	3.00	38.99	30.36	60.00	50.00	21.01	19.64
Remark: 1. Correction Factor (dB) = LISN Factor (dB) + Cable Loss (dB). 2. Margin (dB) = Limit - Corrected Reading.							

1000Mbps



Frequency	Correct Factor (dB)	Corrected Reading (dBuV)		Limit (dBuV)		Margin (dB)	
		QP	AV	QP	AV	QP	AV
0.19 (L)	3.00	39.61	30.32	64.01	54.01	24.40	23.69
0.26 (L)	3.00	29.85	22.92	61.50	51.50	31.65	28.58
0.45 (L)	3.00	35.47	34.44	56.93	46.93	21.46	12.49
0.51 (N)	3.00	36.99	35.98	56.00	46.00	19.01	10.02
3.18 (N)	3.00	18.55	10.42	56.00	46.00	37.45	35.58
22.79 (L)	3.00	41.45	35.57	60.00	50.00	18.55	14.43
Remark: 1. Correction Factor (dB) = LISN Factor (dB) + Cable Loss (dB). 2. Margin (dB) = Limit - Corrected Reading.							

13. Radiated emission for Unintentional Radiator

Test result: Pass

13.1 Radiated emission limits

13.1.1 Limits for radiated disturbance of class A device

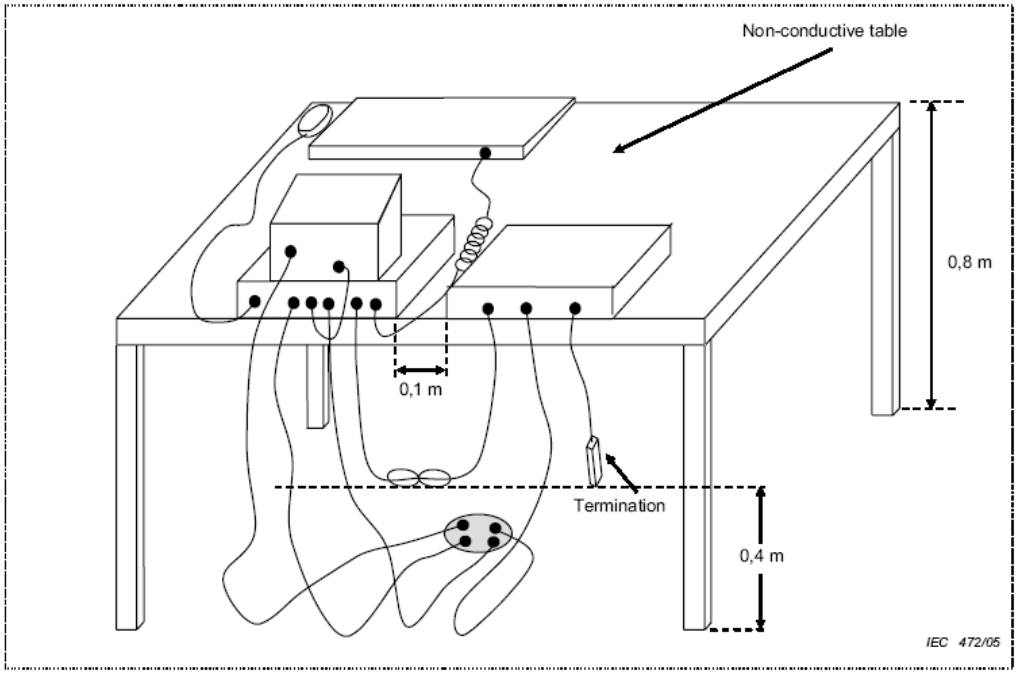
Frequency (MHz)	Permitted limit in dBμV/m (Quasi-peak) of Measurement Distance 10m
30 – 88	39
88 – 216	43.5
216 – 960	46.4
Above 960	49.5
Note: for the measurement distance other than 3m and 10m, the limit is varied according to 20dB/10 decades.	

13.1.1 Limits for radiated disturbance of class B device

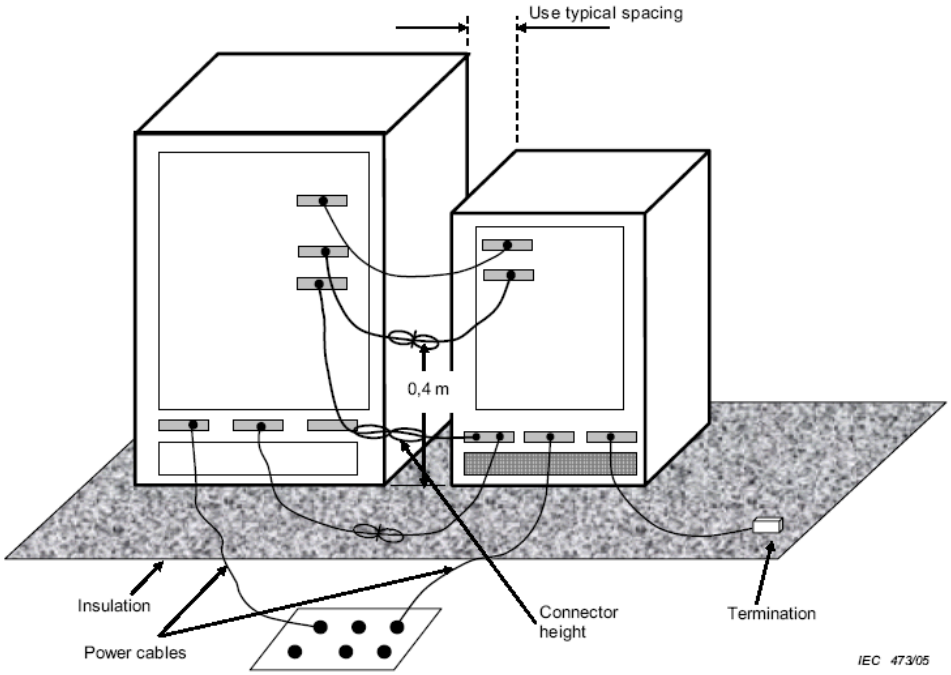
Frequency (MHz)	Permitted limit in dBμV/m (Quasi-peak) of Measurement Distance 3m
30 – 88	40.0
88 – 216	43.5
216 – 960	46.0
Above 960	54.0
Note: for the measurement distance other than 3m and 10m, the limit is varied according to 20dB/10 decades.	

13.2 Block diagram and test set up

☒ For table top equipment



☐ For floor standing equipment



13.3 Test Setup and Test Procedure

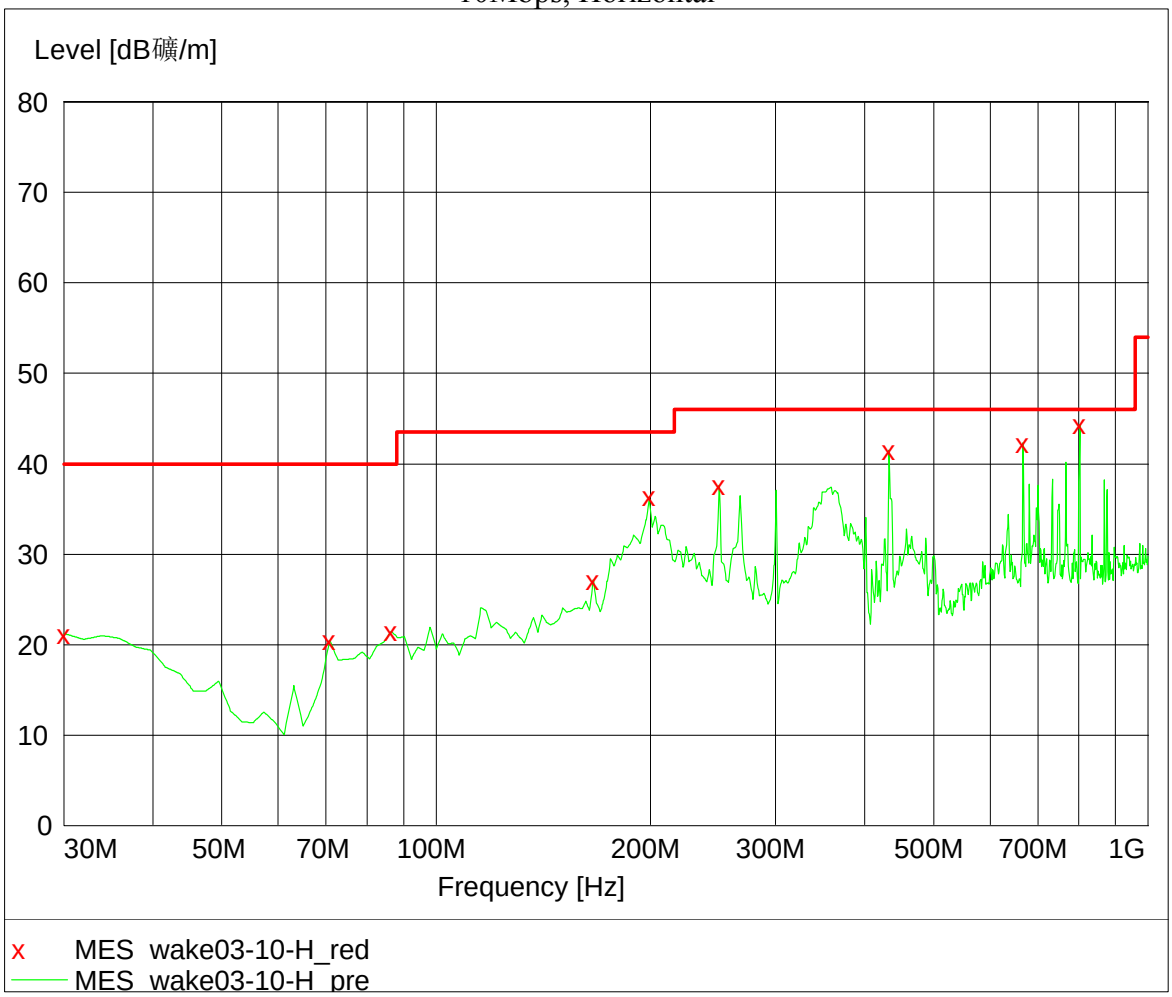
The measurement was performed in a semi-anechoic chamber.
The distance from EUT to receiving antenna is **3** meter.
Measurement was performed according to clause 4 and clause 5 of ANSI 63.4.
Test procedure was according to clause 8.3 of ANSI 63.4.
EUT arrangement and operate condition were according to clause 6 and clause 8 of ANSI 63.4.
The bandwidth setting on R&S Test Receiver ESI26 was 120 kHz.
The required measurement frequency range was checked.

Highest operating frequency (MHz)	Upper frequency of measurement range (MHz)
☐ Below 1.705	30
☐ 1.705–108	1000
☐ 108–500	2000
☐ 500–1000	5000
☒ Above 1000	5th harmonic o or 40 GHz which is lower.

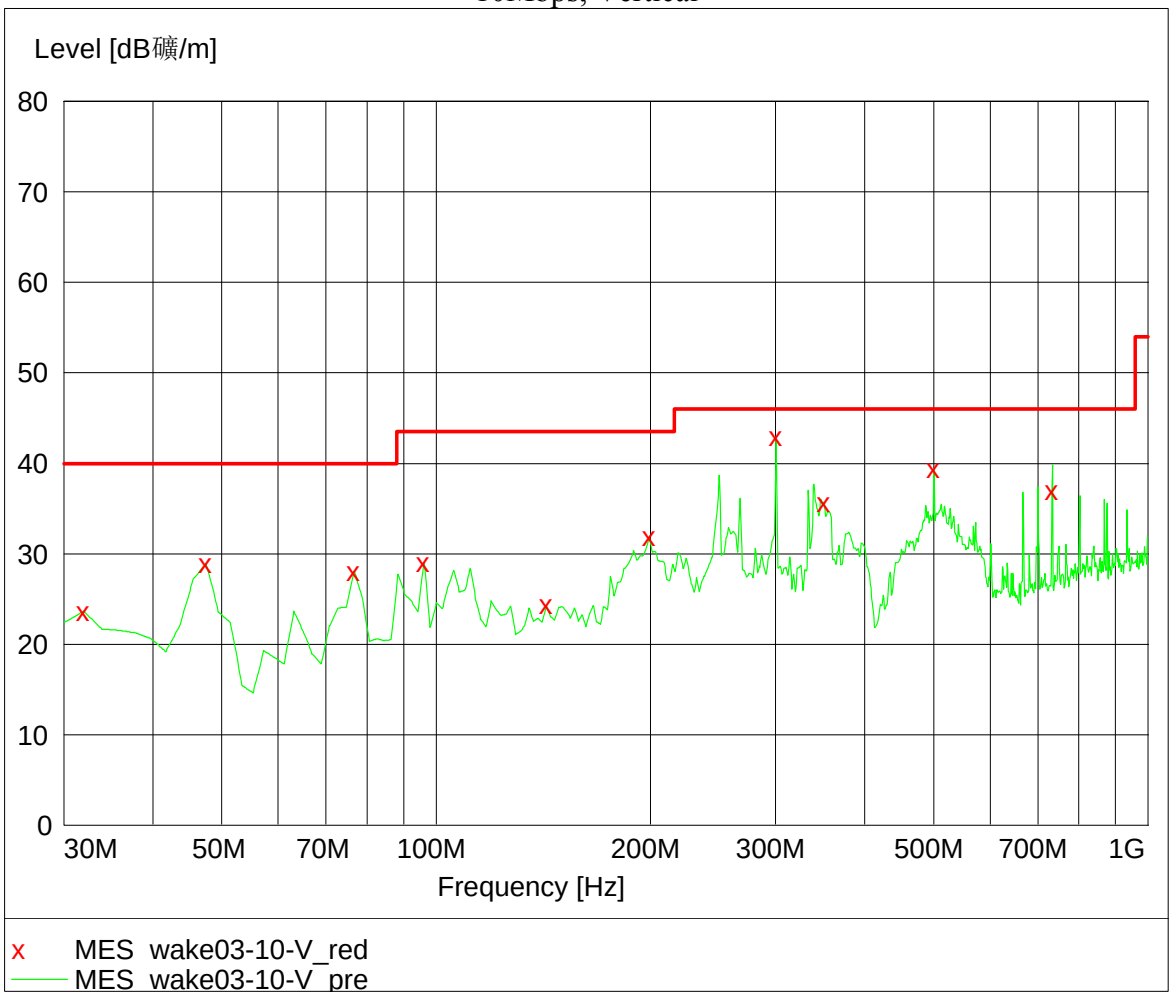
13.4 Test Protocol

Temperature	:	22 °C
Relative Humidity	:	43 %

10Mbps, Horizontal



10Mbps, Vertical

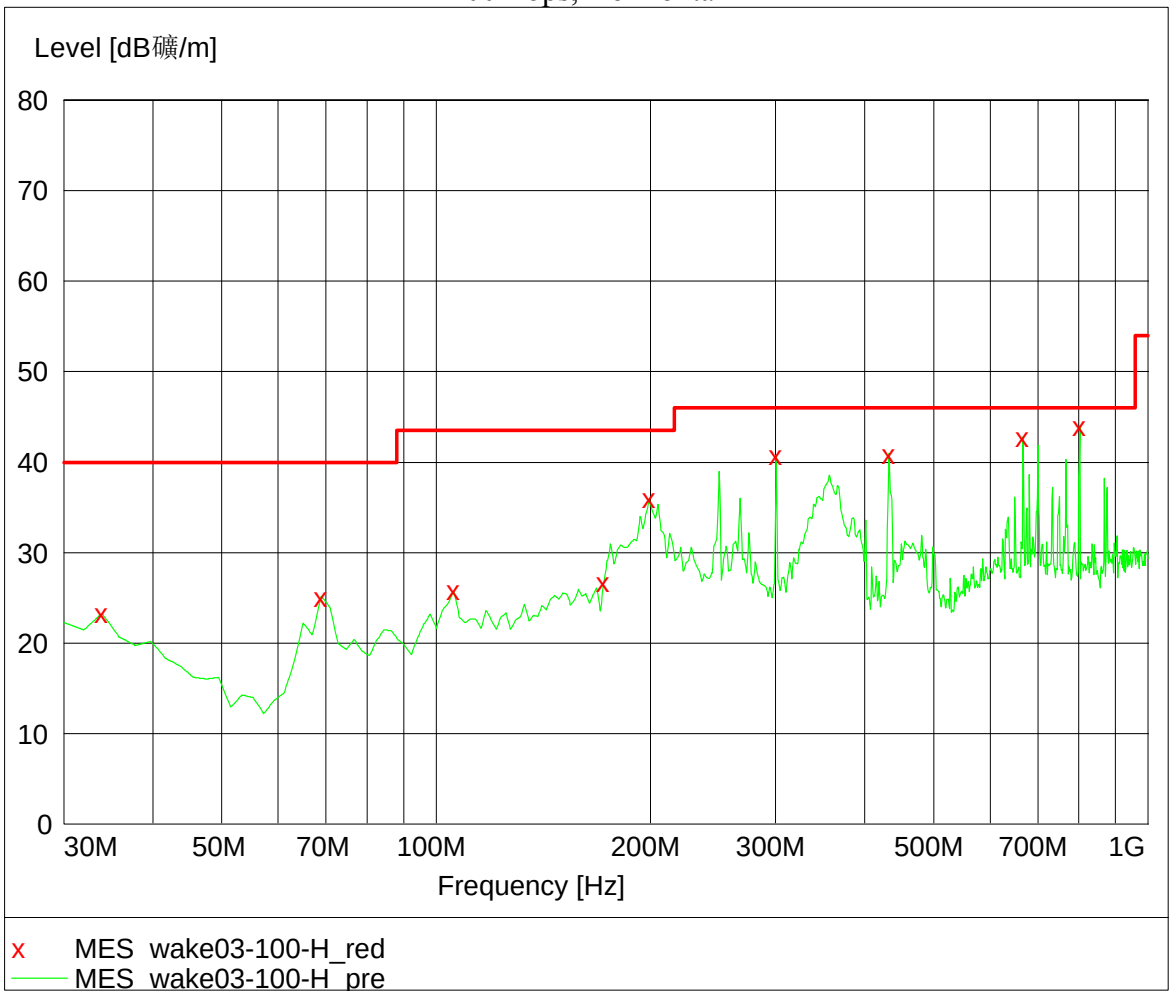


Ant	Frequency (MHz)	Emission level (dBμV/m)	Transducer (dB/m)	Limits (dBμV/m)	Margin (dB)	Detector
H	199.12	36.40	12.50	43.50	7.10	PK
	249.66	37.60	13.00	46.00	8.40	PK
	432.38	41.50	18.70	46.00	4.50	PK
	667.60	42.30	21.70	46.00	3.70	PK
	801.72	43.00	23.10	46.00	3.00	QP
	1250.38	49.50	-13.00	54.00	4.50	PK
V	47.49	28.90	12.30	40.00	11.10	PK
	300.20	42.10	15.00	46.00	3.90	QP
	350.74	35.70	16.70	46.00	10.30	PK
	500.42	39.40	19.70	46.00	6.60	PK
	733.69	37.10	22.30	46.00	8.90	PK
	1250.38	51.00	-13.00	54.00	3.00	PK

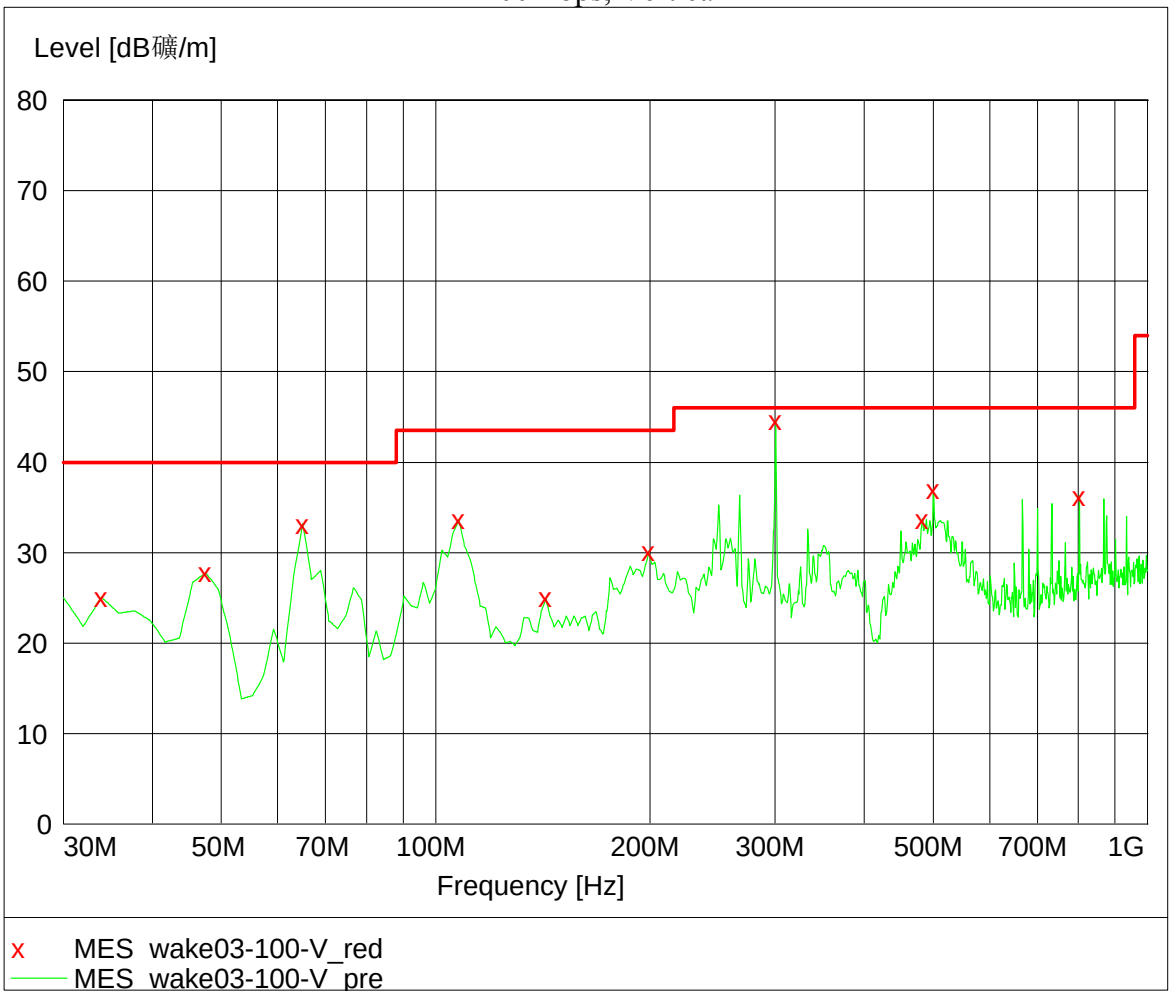
Remark: 1. Transducer = Antenna Factor + Cable Loss (-Amplifier, is employed)
2. Corrected Reading = Original Receiver Reading + Transducer
3. Margin = limit – Corrected Reading
4. The test is performed from 30MHz to 40GHz.
5. For the frequency points assessed with QP detector, it has been confirmed the pulse-repetition frequency of their emission is higher than 20 Hz.

Example: Assuming Antenna Factor = 30.20dB/m, Cable Loss = 2.00dB,
Gain of Preamplifier = 32.00dB, Original Receiver Reading = 10dBuV.
Then Transducer = 30.20 + 2.00 – 32.00 = 0.20dB/m; Corrected Reading = 10dBuV + 0.20dB/m = 10.20dBuV/m
Assuming limit = 54dBuV/m, Corrected Reading = 10.20dBuV/m, then Margin = 54 -10.20 = 43.80dBuV/m

100Mbps, Horizontal



100Mbps, Vertical

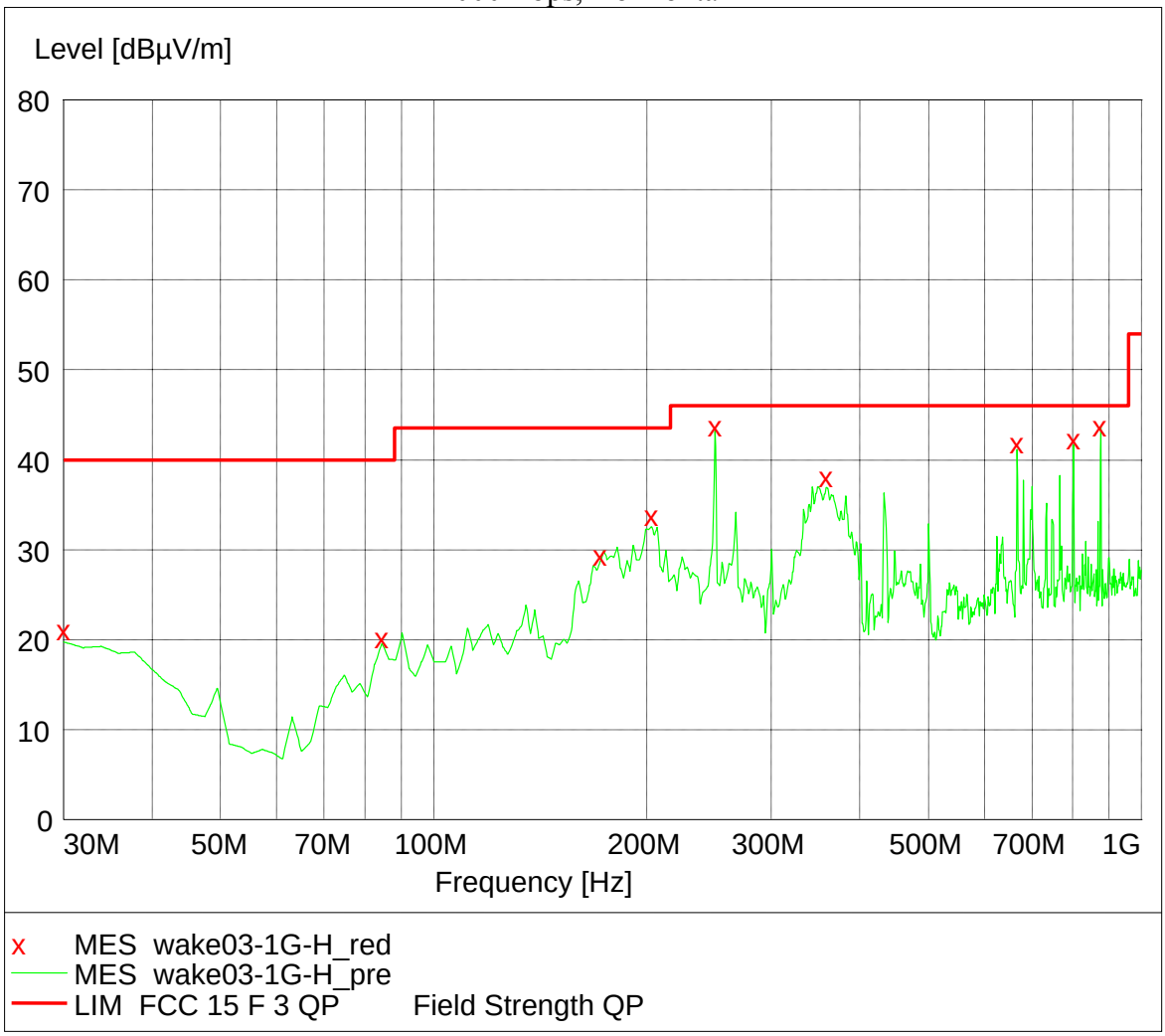


Ant	Frequency (MHz)	Emission level (dBμV/m)	Transducer (dB/m)	Limits (dBμV/m)	Margin (dB)	Detector
H	199.12	36.00	12.50	43.50	7.50	PK
	300.20	40.80	15.00	46.00	5.20	PK
	432.38	40.90	18.70	46.00	5.10	PK
	667.60	42.80	21.70	46.00	3.20	PK
	801.72	43.20	23.10	46.00	2.80	QP
	1250.38	49.70	-13.00	54.00	4.30	PK
V	64.99	33.20	8.10	40.00	6.80	PK
	107.76	33.70	15.00	43.50	9.80	PK
	300.20	43.30	15.00	46.00	2.70	QP
	500.42	37.00	19.70	46.00	9.00	PK
	801.72	36.30	23.10	46.00	9.70	PK
	1250.38	50.60	-13.00	54.00	3.40	PK

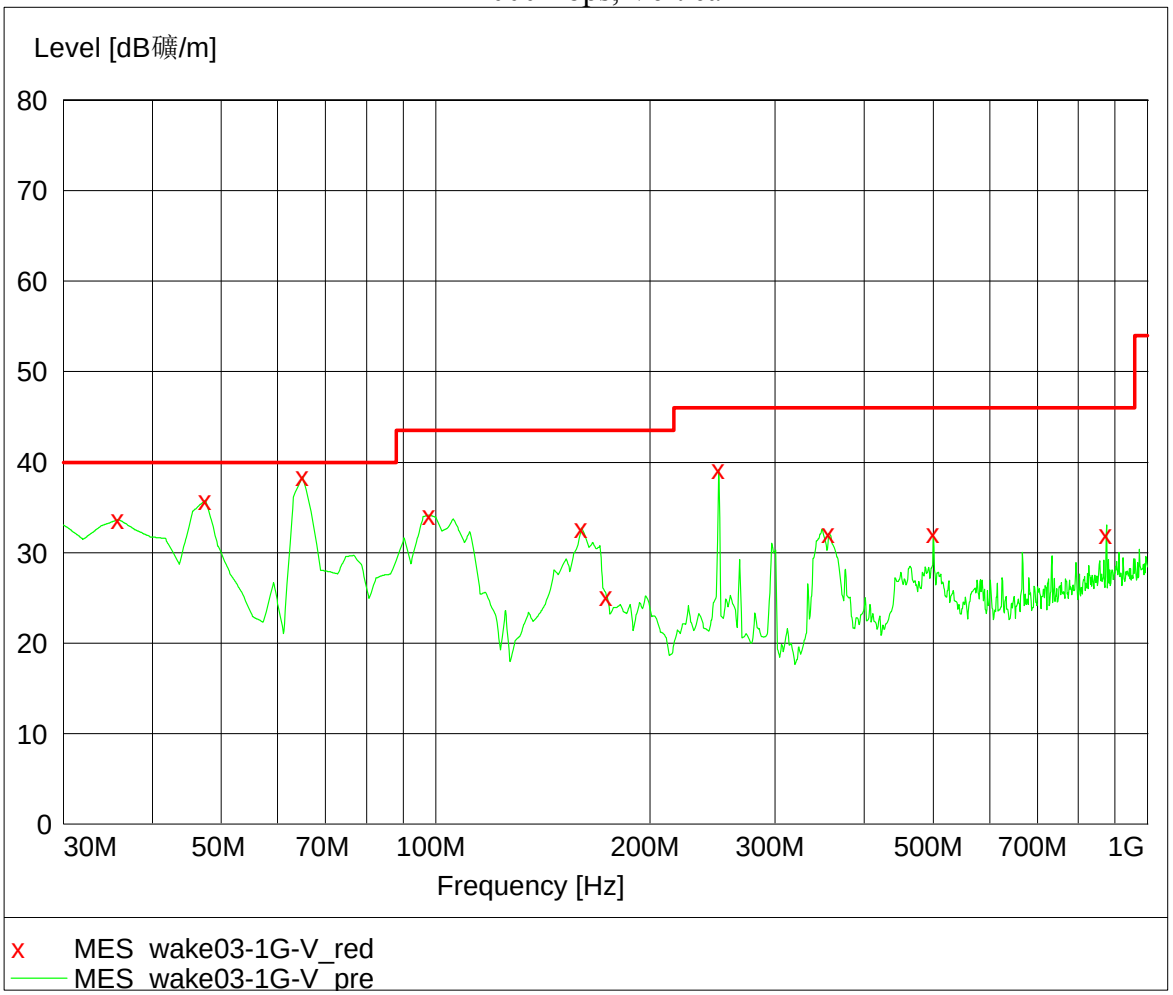
Remark: 1. Transducer = Antenna Factor + Cable Loss (-Amplifier, is employed)
2. Corrected Reading = Original Receiver Reading + Transducer
3. Margin = limit – Corrected Reading
4. The test is performed from 30MHz to 40GHz.
5. For the frequency points assessed with QP detector, it has been confirmed the pulse-repetition frequency of their emission is higher than 20 Hz.

Example: Assuming Antenna Factor = 30.20dB/m, Cable Loss = 2.00dB,
Gain of Preamplifier = 32.00dB, Original Receiver Reading = 10dBuV.
Then Transducer = 30.20 + 2.00 – 32.00 = 0.20dB/m; Corrected Reading = 10dBuV + 0.20dB/m = 10.20dBuV/m
Assuming limit = 54dBuV/m, Corrected Reading = 10.20dBuV/m, then Margin = 54 -10.20 = 43.80dBuV/m

1000Mbps, Horizontal



1000Mbps, Vertical



Ant	Frequency (MHz)	Emission level (dBμV/m)	Transducer (dB/m)	Limits (dBμV/m)	Margin (dB)	Detector
H	249.66	43.40	13.00	46.00	2.60	QP
	358.52	38.30	17.00	46.00	7.70	PK
	667.60	42.60	21.70	46.00	3.40	PK
	801.72	42.70	23.10	46.00	3.30	QP
	875.59	43.50	23.60	46.00	2.50	QP
	1250.38	49.90	-13.00	54.00	4.10	PK
V	35.83	33.70	19.20	40.00	6.30	PK
	47.49	35.80	12.30	40.00	4.20	PK
	64.99	36.90	8.10	40.00	3.10	QP
	160.24	32.70	13.30	43.50	10.80	PK
	249.66	39.20	13.30	46.00	6.80	PK
	1250.38	51.50	-13.00	54.00	2.50	PK

Remark: 1. Transducer = Antenna Factor + Cable Loss (-Amplifier, is employed)
2. Corrected Reading = Original Receiver Reading + Transducer
3. Margin = limit – Corrected Reading
4. The test is performed from 30MHz to 40GHz.
5. For the frequency points assessed with QP detector, it has been confirmed the pulse-repetition frequency of their emission is higher than 20 Hz.

Example: Assuming Antenna Factor = 30.20dB/m, Cable Loss = 2.00dB,
Gain of Preamplifier = 32.00dB, Original Receiver Reading = 10dBuV.
Then Transducer = 30.20 + 2.00 – 32.00 = 0.20dB/m; Corrected Reading = 10dBuV + 0.20dB/m = 10.20dBuV/m
Assuming limit = 54dBuV/m, Corrected Reading = 10.20dBuV/m, then Margin = 54 -10.20 = 43.80dBuV/m