TEST REPORT

Report Number		RAPA15-O-008
Type of Equipment		Wireless Digital Concentrator
Model Name		NDC-I331
FCC ID		2AD28NDCI331
Applicant	Name	NURI Telecom Co., Ltd.
	Logo	nuri TELECOM
	Address	NURI Bld, 750-14, Bangbae-dong, Seocho-gu, Seoul, Korea,137-060,
Manufacturer	Name	NURI Telecom Co., Ltd.
	Address	NURI Bld, 750-14, Bangbae-dong, Seocho-gu, Seoul, Korea,137-060,
Test period		February 09, 2015 to February 12, 2015
Issuing date of report		March 09, 2015
Total page		27 pages (including this page)

SUMMARY

The equipment complies with FCC C F R 4 7 Part 15 subpart C Section 15.247: Operation within the bands 902 MHz to 928 MHz, 2 400 MHz to 2 483.5 MHz and 5 725 MHz to 5 850 MHz.

This test report contains only the results of a single test of the sample supplied for the examination.
It is not a general valid assessment of the features of the respective products of the mass-production.

Date: March 09, 2015

Prepared and tested by Tae Yang Yoon
Manager / TCL of RAPA

Date: March 09, 2015

Reviewed by Sukil Park
Executive Managing Director / TCL of RAPA

CONTENTS

1. General description

1.1 Applicant

- Company name : NURI Telecom Co., Ltd.
- Address : NURI Bld, 750-14 Bangbae-dong, Seocho-gu, Seoul, Korea, 137-060
- Contact person : Sim Yu Seog / Staff
- Phone/Fax : +82-2-781-0733 / +82-2-781-0704

1.2 Manufacturer

- Company name : NURI Telecom Co., Ltd.
- Address : NURI Bld, 750-14 Bangbae-dong, Seocho-gu, Seoul, Korea, 137-060
- Contact person : Sim Yu Seog / Staff
- Phone/Fax : +82-2-781-0733 / +82-2-781-0704

1.3 Basic description of EUT

- Product name : NURI Telecom Co., Ltd.
- Model name : NDC-I331
- Serial number : N/A
- Frequency : 2 405 MHz to 2 480 MHz
- Number of channel(s) : 16 Channels
- Modulation method : O-QPSK
- FCC Rule Part(s) : FCC CFR47 Part 15 Subpart C Section 15.247
- FCC classification : DTS / Digital Transmission System
- Test period : February 09, 2015 to February 12, 2015
- Issuing date of report : March 09, 2015
- Place of test : Head office

  101 & B104, 268, Hagui-ro, Dongan-gu, Anyang-si, Gyeonggi-do, Korea

  Open area test site

  103, Anseok-gil. 138 beon-gil, Hwaseong-si, Gyeonggi-do, Korea

  (FCC OATS Registration Number : 931589)

  (IC Submission Number : 9355B)

  (KCC Designation Number : KR0027)

1.4 Electrical specification

General Specification	
Processor	ARM Cortex-A8 32 Bit RISE Processor
Memory	DDR2 512 MB
	FLASH 1 GB, Serial Flash 16 MB
Interface	LAN/10,100,1000 Mbps, RS-232(Console)
RF Interface(Zigbee)	Async logic level
RF Antenna(Zigbee)	4 dBi Omni-directional
RF Interface(GSM/GPRS)	Async logic level
RF Antenna(GSM/GPRS)	900 MHz : 1 dBi, 1.8 GHz : 4 dBi Omni-directional
Operating Temperature / Humidity	-40 ℃ ~ +70 ℃ / 10 % ~ 95 %
Storage Temperature / Humidity	-40 ℃ ~ +80 ℃ / 10 % ~ 95 %
Power Consumption @ AC 220V / 60 Hz	Normal Operation : 5 W
	Charging state : Max 13 W (Charge Current : 350 mAh)
Back up Battery	Rechargeable Li-Ion Battery 3.7 V (4400 mAh)
RoHS	Comply
Weight (g)	900
Size (mm)	256(L) X 130(W) X 75(D), not include Antenna
AC Main Input	AC 110 V, 50 Hz
Zigbee Interface Specification	
Frequency Range	2.4 GHz ~ 2.4835 GHz
Standard	IEEE Std. 802.15.4
RF Power	20 dBm
Receive Sensitivity	Below -100 dBm
GSM/GPRS Interface Specification	
GPRS Connectivity	Multi-slot Class 10, Mobile station Class B
Frequency Band	Telit Quad Band : GSM850, EGSM900, GSM1800/1900
RX Frequency(MHz)	GSM850 : 869.2~893.8, EGSM900 : 925.2~959.8 GSM1800 : 1805.2~1879.8, GSM1900 : 1930.2~1989.8
TX Frequency(MHz)	GSM850 : 824.2~848.8, EGSM900 : 880.2~914.8 GSM1800 : 1710.2~1784.8, GSM1900 : 1850.2~1909.8
TX Power	Class 4(2W) at EGSM900 and GSM850 Class 2(1W) at GSM1800 and GSM1900
RX Sensitivity	GSM850 : -107dBm, EGSM900 : -107dBm GSM1800 : -106dBm, GSM1900 : -105.5dBm

2. General information of test

2.1 Standards for measurement method

Applied Standard : FCC CFR47 Part 15 Subpart C 15.247			
FCC	**Description of Test**	**Limit**	**Result**
15.247(a)(1)	6 dB Bandwidth	≤ 500 kHz	Pass
15.247(b)(1)	Maximum Peak Output Power	≤ 30 dBm	Pass
15.247(e)	Power spectral density	≤ 8 dBm	Pass
15.247(d)	Conducted band edges and spurious emission	≤ 20 dBc	Pass
15.247(d)	Radiated Band Edges and Radiated Spurious Emission	15.209(a) & 15.247(d)	Pass
15.207	AC Conducted Emission	15.207(a)	Pass
15.203 &15.247(c)	Antenna Requirement	< 6 dBi	Pass

2.2 Description of EUT modification

During the test, there was no mechanical or circuitry modification to improve any RF specification including spurious characteristic, and any RF and spurious suppression device(s) were not added against the device tested.

2.3 Description of test system configuration

• Peripheral equipment used;

Description	Model name	Serial No.	Manufacturer
EUT	NDC-I331	N/A	NURI Telecom Co., Ltd.
Test fixer(JIG)	ISA3	N/A	Silicon Laboratories Inc.
Power Supply	3-5-5001	031031	Daegwang
Control PC	NT-P560-PS3M	ZV1U93MMZA00008	Samsung
Receiver	NZR-O121	FCCID : 2AD28NZRO121	NURI Telecom Co., Ltd.

• Cables used

Device from	Device to	Type of cable	Type of connecter	Length
EUT	Test fixer (JIG)	Non-shielded	Wire	0.30 m
Test fixer (JIG)	Control PC	Non-shielded	USB to USB	2.00 m
Test fixer (JIG)	Control PC	Non-shielded	LAN Cable	2.00 m
EUT	Spectrum analyzer	Shielded	SMA to SMA	1.00 m

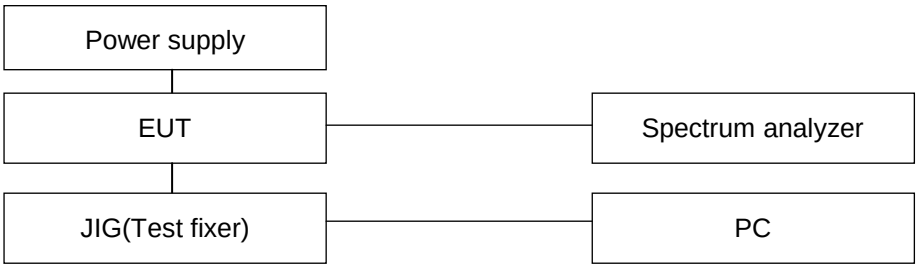
3. Measurement data

3.1 6 dB bandwidth

3.1.1 Specification

• FCC Rules Part 15 Subpart C Section 15.247(a)(2)

3.1.2 Set-up



3.1.3 Test equipment list

Equipment	Model name	Manufacturer
EUT	NDC-I331	NURI Telecom Co., Ltd
Test fixer(JIG)	ISA3	Silicon Laboratories Inc.
Spectrum Analyzer	FSV 30	Rohde & Schwarz
Control PC	NT-P560-PS3M	Samsung
Power Supply	3-5-5001	Daegwang

3.1.4 Test condition

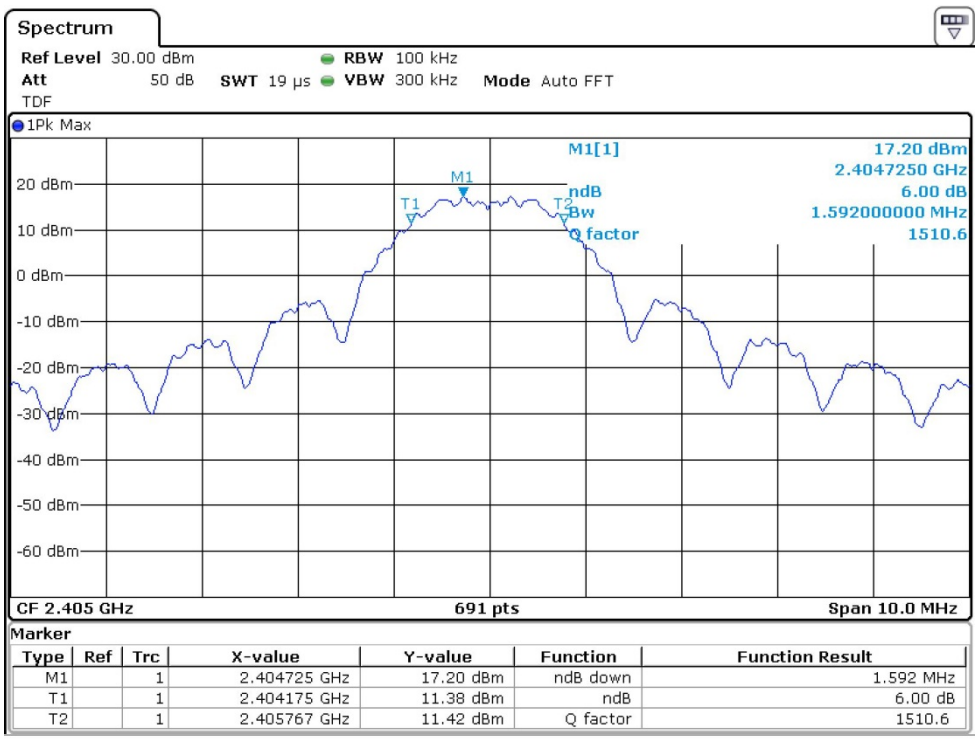
• Test place : Test room
• Test environment : 21.8 °C, 56 % R.H.
• Test mode : Operation at single channel
• Power engaged : AC 110V, 50Hz

3.1.5 Test result

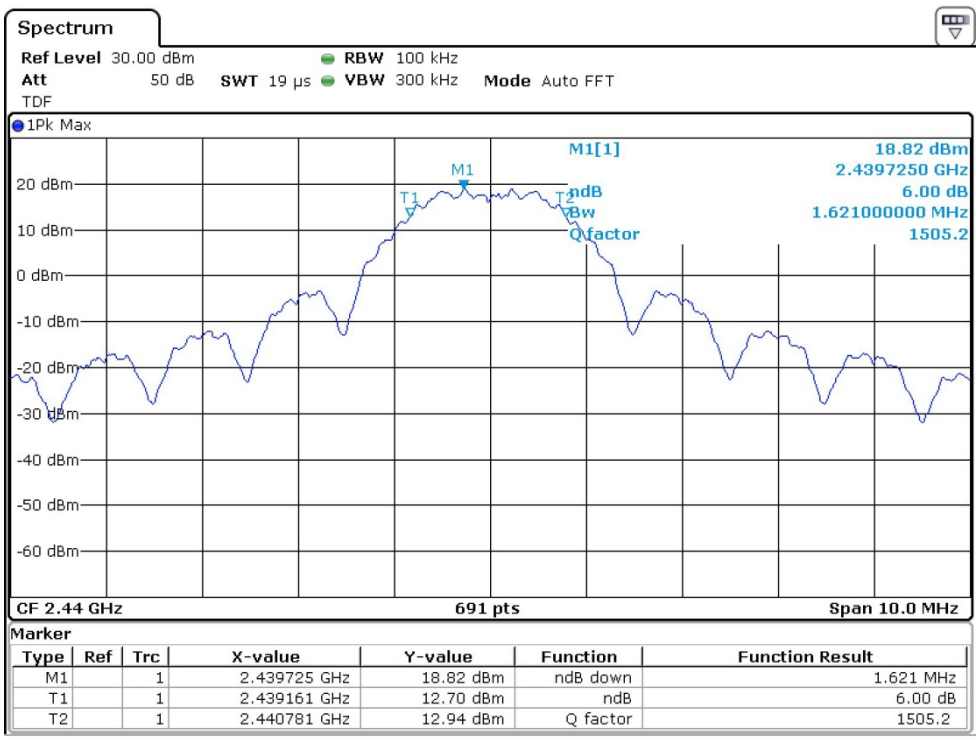
Frequency [MHz]	6 dB Bandwidth [MHz]	Limit [kHz]
2 405	1.592	≥ 500
2 440	1.621	
2 480	1.592	

3.1.6 Plots of 6 dB bandwidth

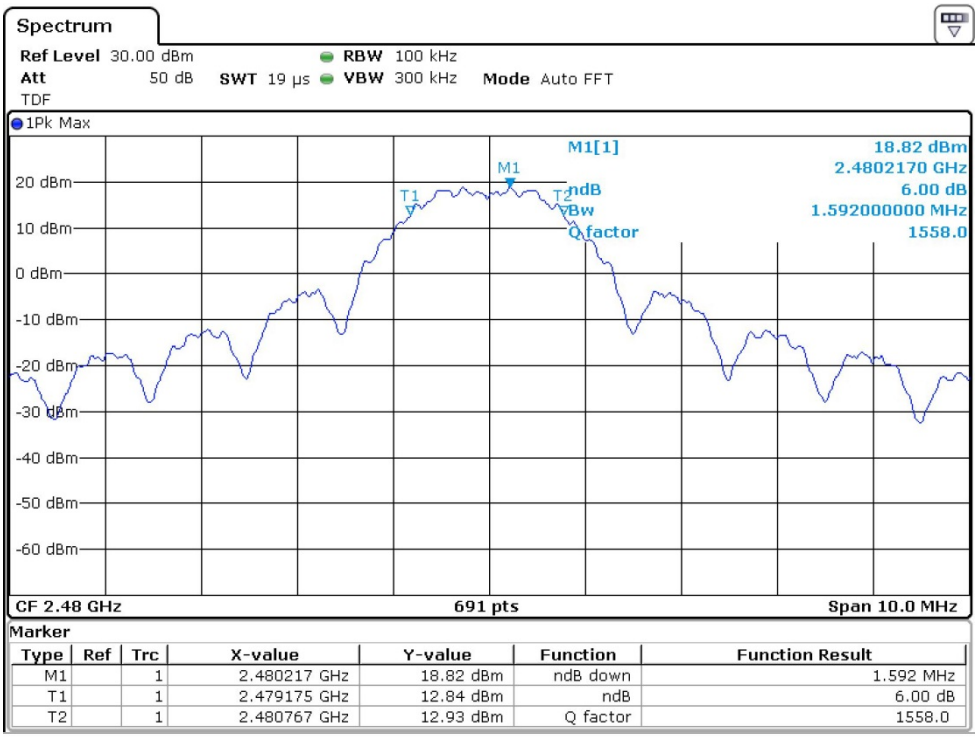
3.1.6.1 Low Channel(2 405 MHz)



3.1.6.2 Middle Channel(2 440 MHz)



3.1.6.3 High Channel(2 480 MHz)

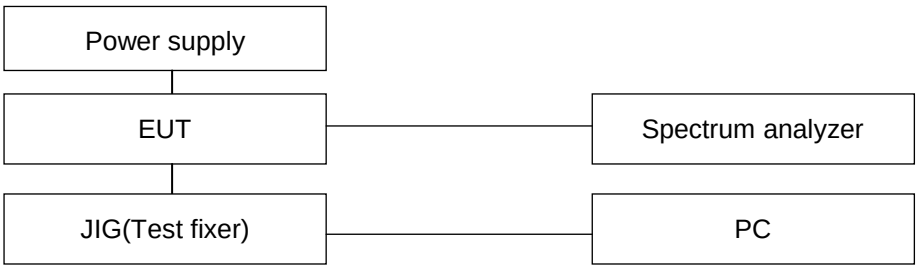


3.2 Maximum peak output power

3.2.1 Specification

• FCC Rules Part 15 Section 15.247(b)(1)

3.2.2 Set-up



3.2.3 Test equipment list

Equipment	Model name	Manufacturer
EUT	NDC-I331	NURI Telecom Co., Ltd
Test fixer(JIG)	ISA3	Silicon Laboratories Inc.
Spectrum Analyzer	FSV 30	Rohde & Schwarz
Control PC	NT-P560-PS3M	Samsung
Power Supply	3-5-5001	Daegwang

3.2.4 Test condition

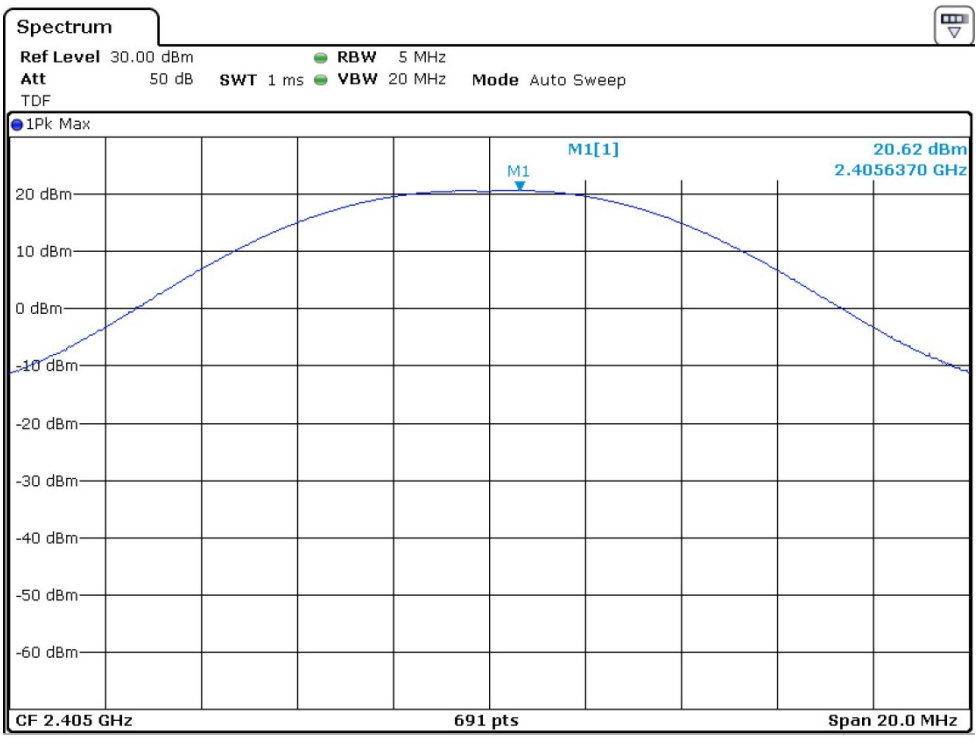
• Test place : Test room
• Test environment : 21.8 °C, 56 % R.H.
• Test mode : Operation at single channel
• Power engaged : AC 110V, 50Hz

3.2.5 Test result

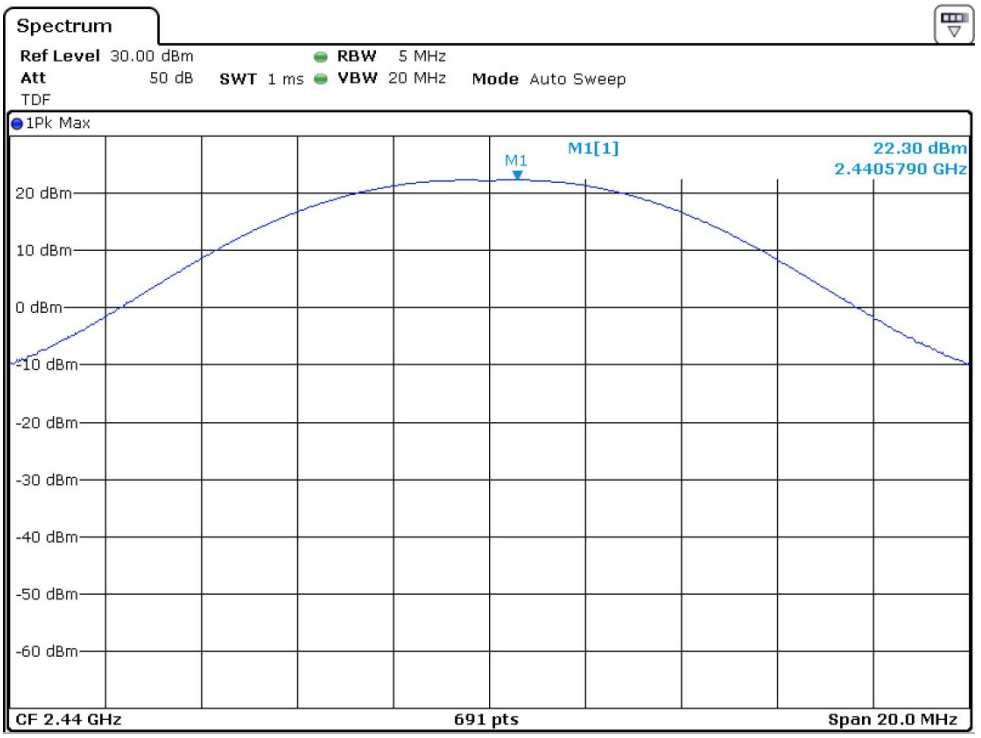
Frequency [MHz]	Peak Power		Average Power		Limit [dBm]
	Output Power [dBm]	Output Power [mW]	Output Power [dBm]	Output Power [mW]	
2 405	20.62	115.34	19.77	94.84	30.00
2 440	22.30	169.82	21.75	149.62	
2 480	22.09	161.80	21.88	154.17	

3.2.6 Plots of maximum peak output power

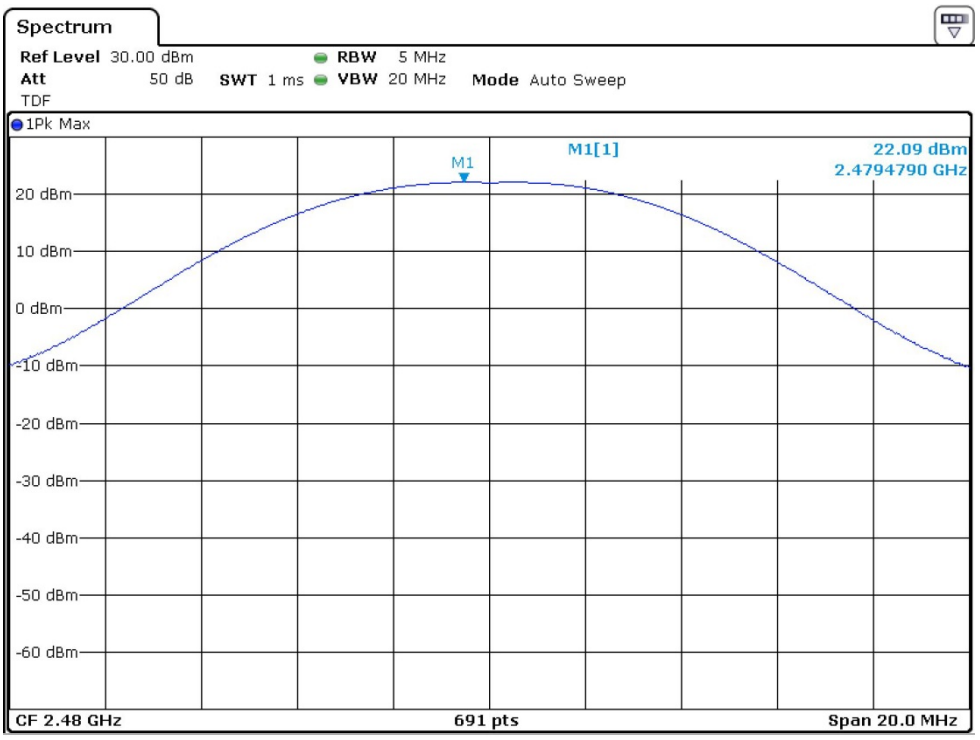
3.2.6.1 Low frequency(2 405 MHz)



3.2.6.2 Middle Frequency(2 440 MHz)

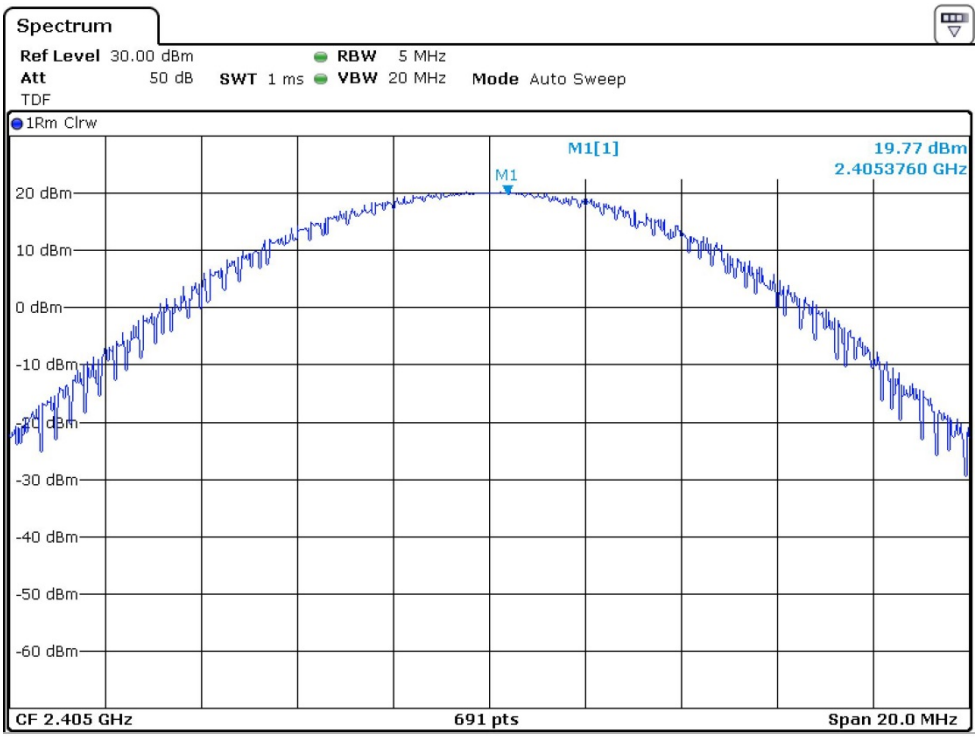


3.2.6.3 High Frequency(2 480 MHz)

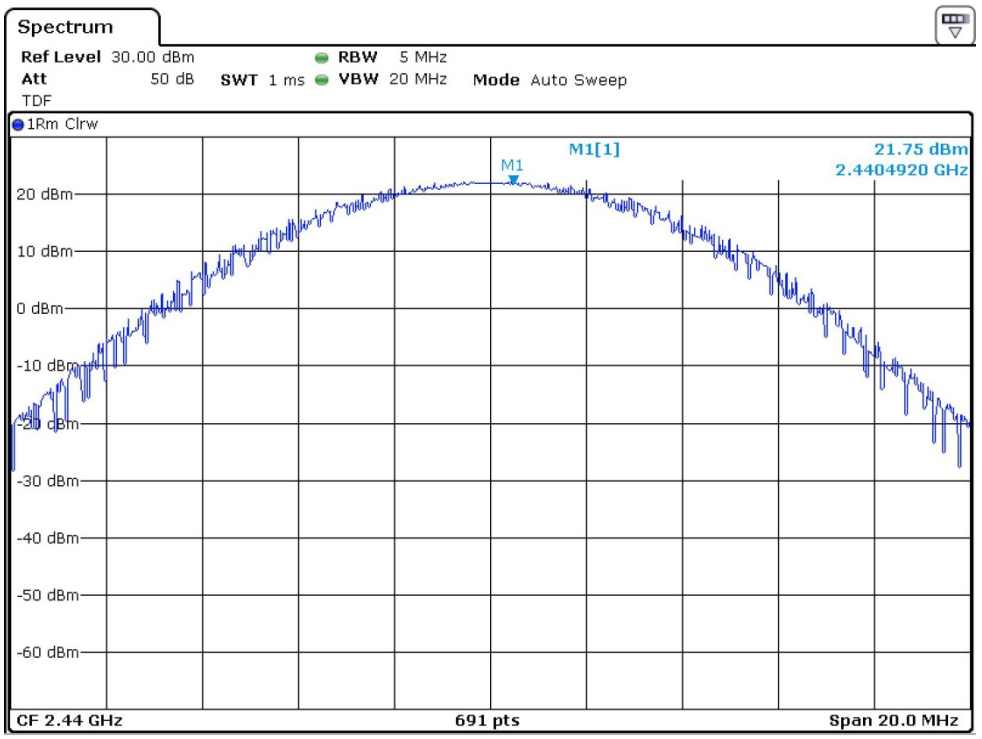


3.2.7 Plots of peak output power at average power

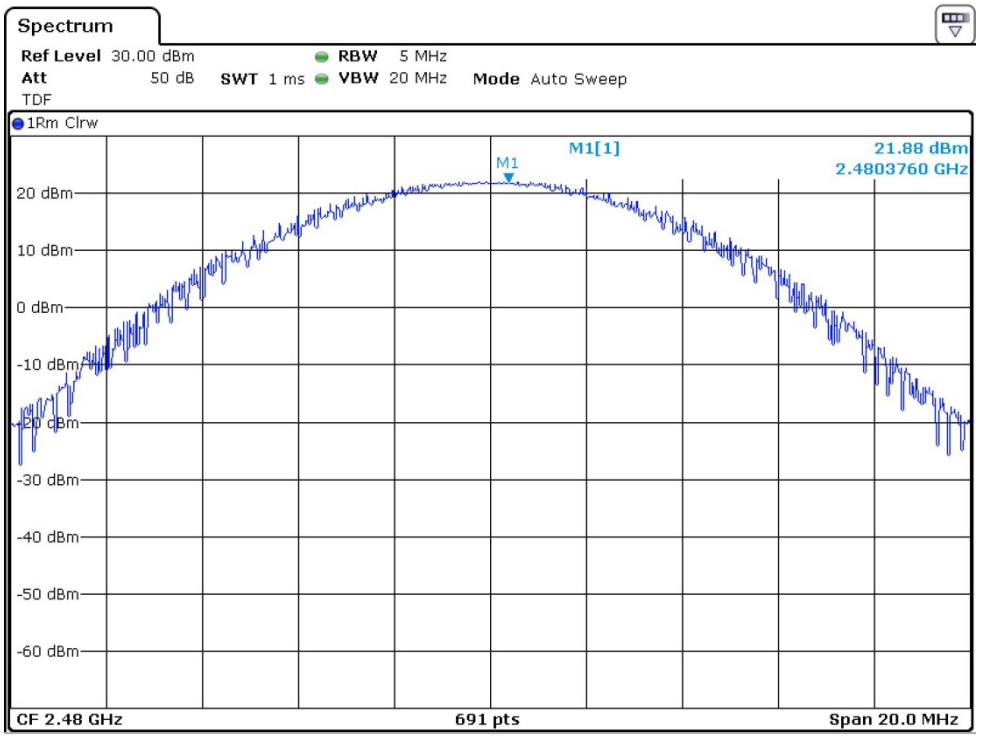
3.2.7.1 Low Frequency(2 405 MHz)



3.2.7.2 Middle Frequency(2 440 MHz)



3.2.7.3 High Frequency(2 480 MHz)

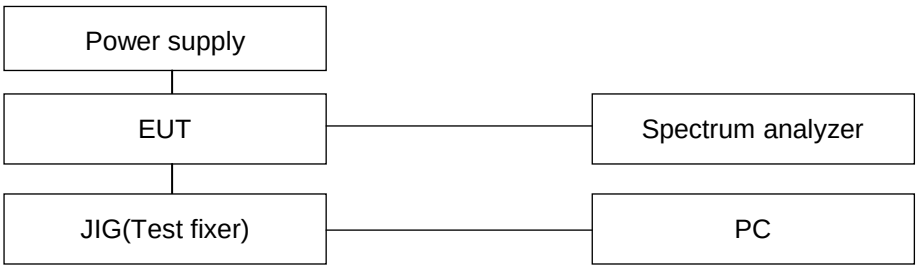


3.3 Power spectral density

3.3.1 Specification

• FCC Rules Part 15 Section 15.247(e)

3.3.2 Set-up



3.3.3 Test equipment list

Equipment	Model name	Manufacturer
EUT	NDC-I331	NURI Telecom Co., Ltd
Test fixer(JIG)	ISA3	Silicon Laboratories Inc.
Spectrum Analyzer	FSV 30	Rohde & Schwarz
Control PC	NT-P560-PS3M	Samsung
Power Supply	3-5-5001	Daegwang

3.3.4 Test condition

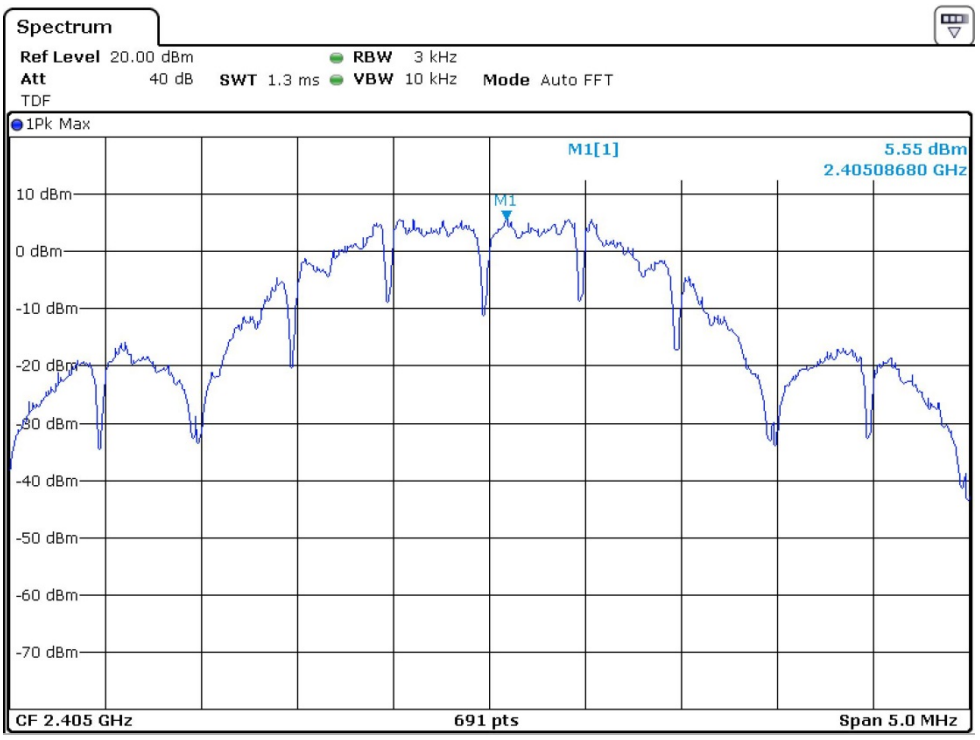
• Test place : Test room
• Test environment : 21.8 °C, 56 % R.H.
• Test mode : Operation at single channel
• Power engaged : AC 110V, 50Hz

3.3.5 Test result

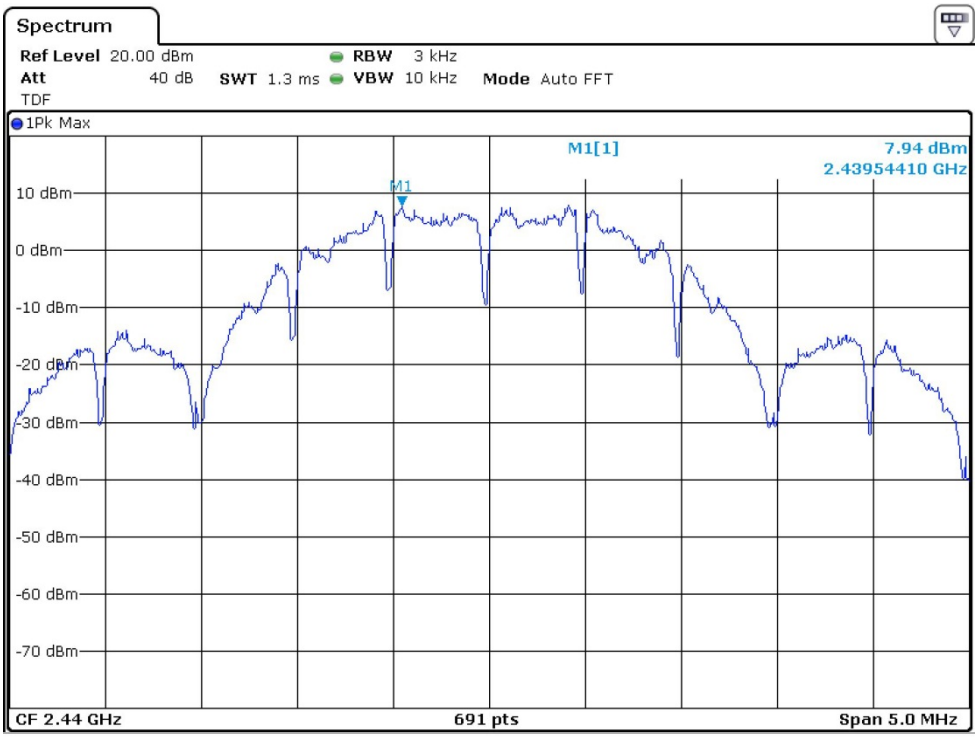
Frequency [MHz]	Measured power density [dBm]	Limit [dBm]
2 405	5.55	8.00
2 440	7.94	
2 480	7.59	

3.3.6 Plots of power spectral density

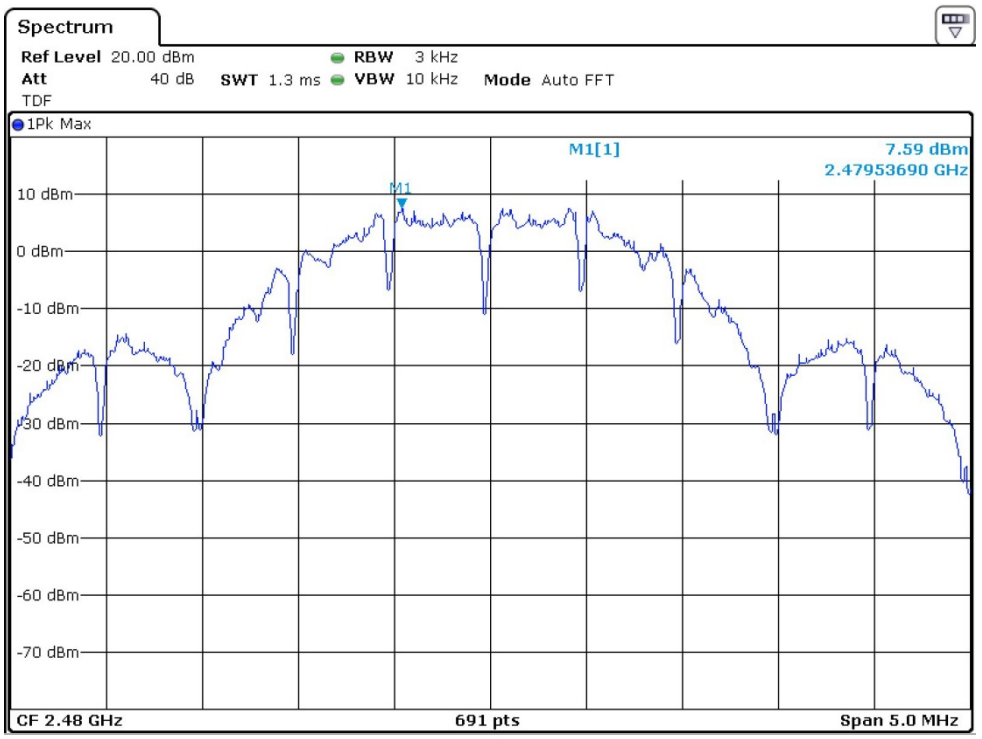
3.3.6.1 Low frequency(2 405 MHz)



3.3.6.2 Middle frequency(2 440 MHz)



3.3.6.3 High frequency(2 480 MHz)

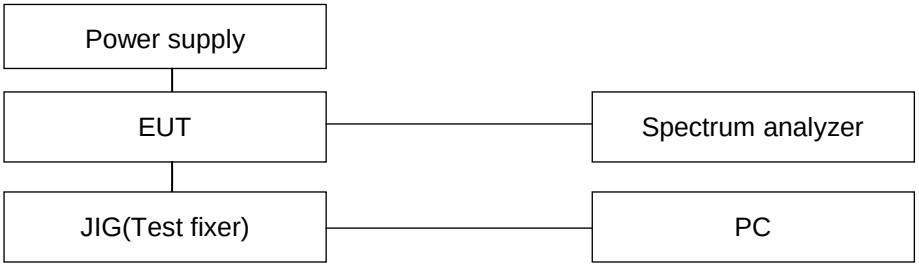


3.4 Conducted band edges and spurious emission

3.4.1 Specification

• FCC Rules Part 15 Section 15.247(d)

3.4.2 Set-up



3.4.3 Test equipment list

Equipment	Model name	Manufacturer
EUT	NDC-I331	NURI Telecom Co., Ltd
Test fixer(JIG)	ISA3	Silicon Laboratories Inc.
Spectrum Analyzer	FSV 30	Rohde & Schwarz
Control PC	NT-P560-PS3M	Samsung
Power Supply	3-5-5001	Daegwang

3.4.4 Test condition

• Test place : Test room
• Test environment : 21.8 °C, 56 % R.H.
• Test mode : Operation at single channel
• Power engaged : AC 110V, 50Hz

3.4.5 Test result at low frequency(2 405 MHz)

Frequency [MHz]	Level [dBm]	Deviation [dBc]	Limit [dBc]	Margin [dB]
2 405	16.27	-	-	-
4 818	-44.63	60.90	20.00	40.90
7 232	-52.33	68.60	20.00	48.60
Calculation formula: [Deviation = Level of fundamental frequency - Level of unwanted emission frequency]				

3.4.6 Test result at middle frequency(2 440 MHz)

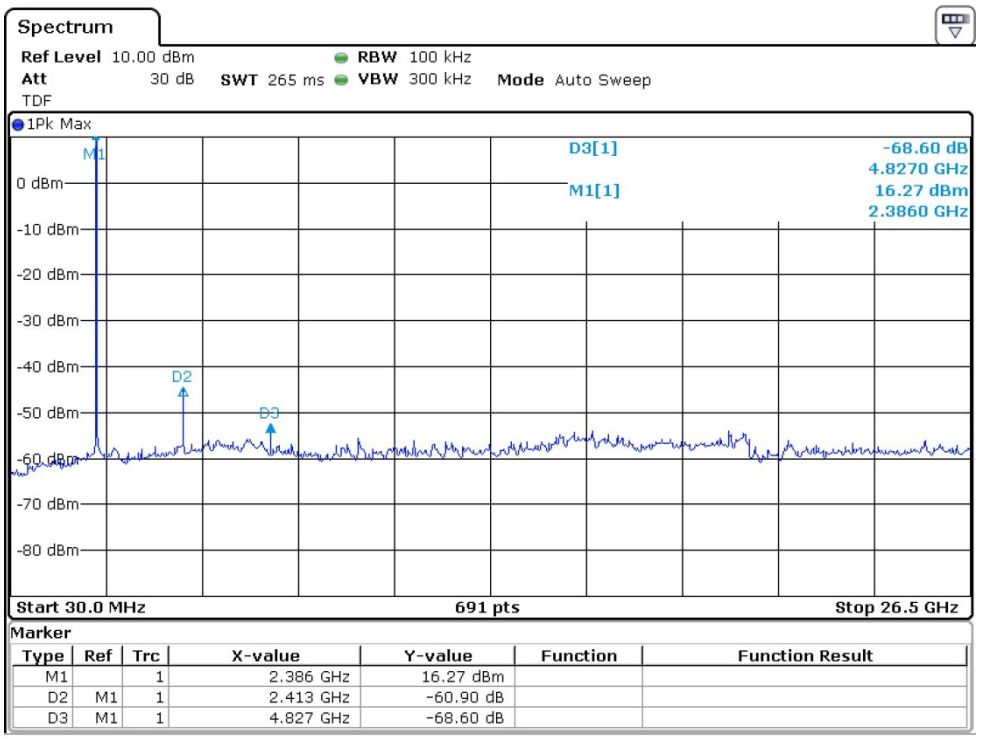
Frequency [MHz]	Level [dBm]	Deviation [dBc]	Limit [dBc]	Margin [dB]
2 440	18.76	-	-	-
4 892	-42.09	60.85	20.00	40.85
7 343	-50.47	69.23	20.00	49.23
Calculation formula: [Deviation = Level of fundamental frequency - Level of unwanted emission frequency]				

3.4.7 Test result at high frequency(2 480 MHz)

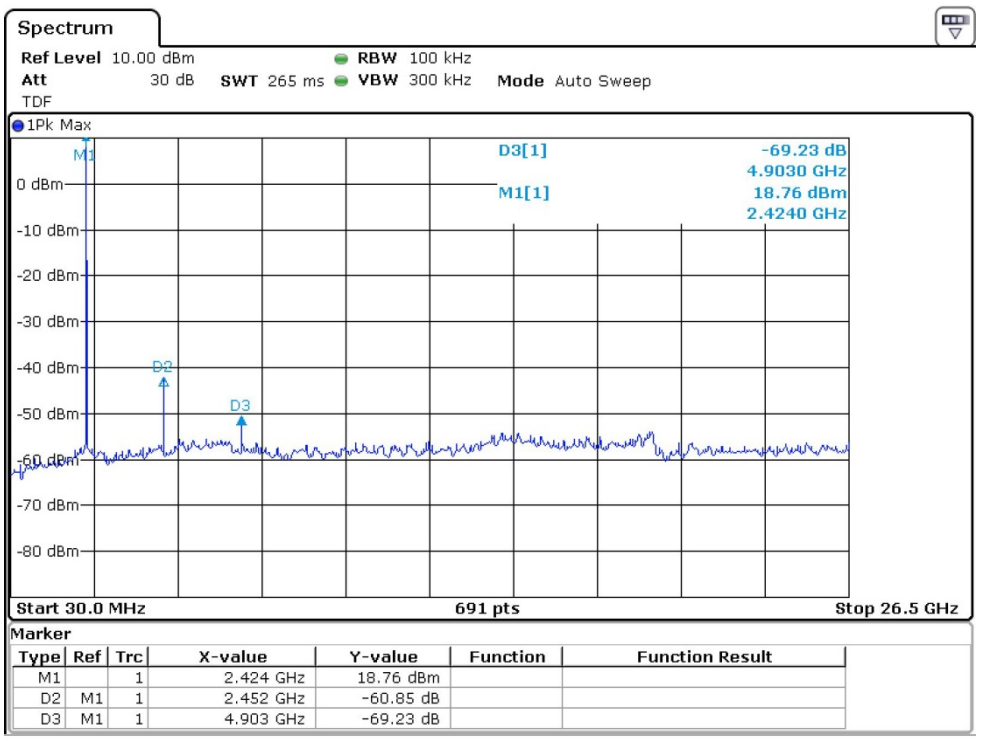
Frequency [MHz]	Level [dBm]	Deviation [dBc]	Limit [dBc]	Margin [dB]
2 480	18.41	-	-	-
4 970	-43.82	62.23	20.00	42.23
7 460	-53.02	71.43	20.00	51.43
Calculation formula: [Deviation = Level of fundamental frequency - Level of unwanted emission frequency]				

3.4.8 Plots of unwanted emission

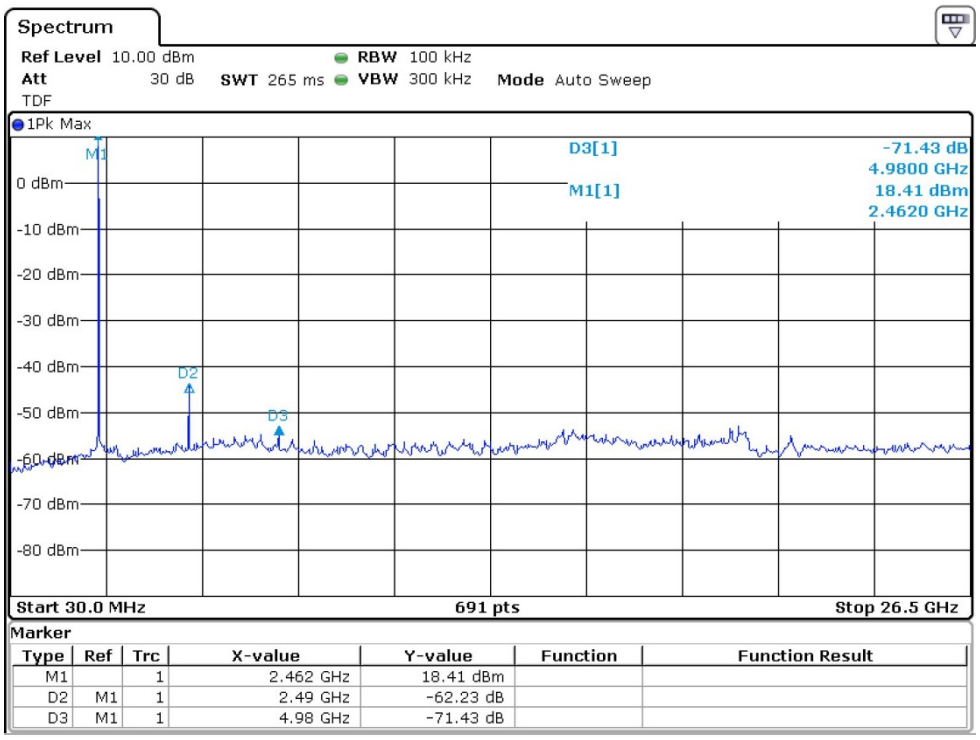
3.4.8.1 Spurious Emission at Low Frequency(2 405 MHz)



3.4.8.2 Spurious Emission at Middle Frequency(2 440 MHz)

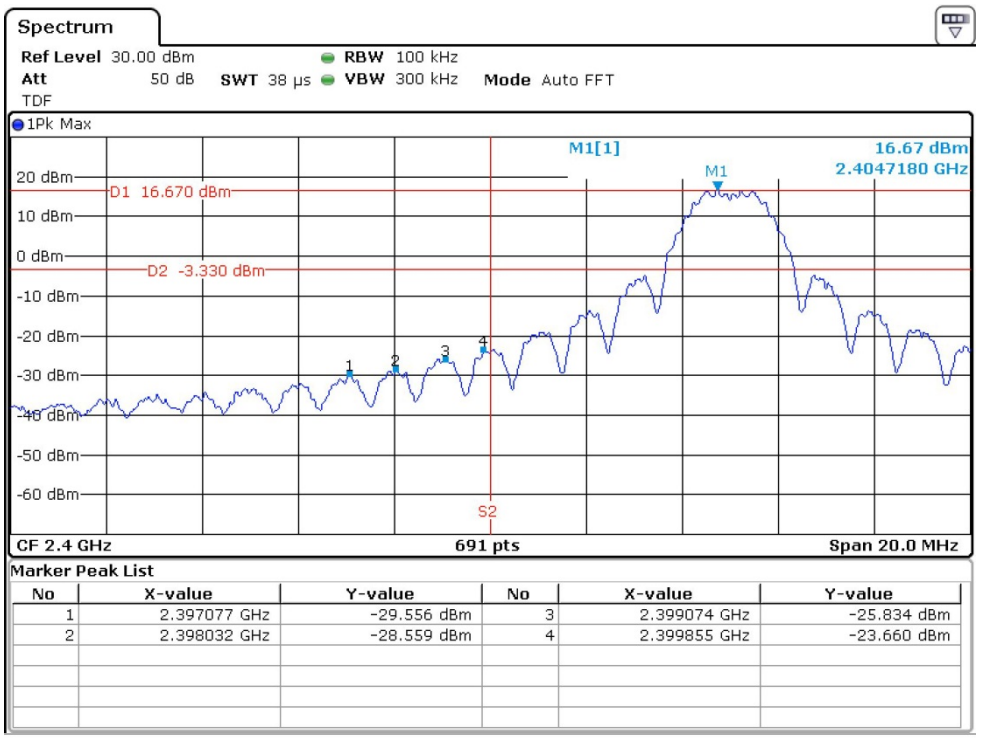


3.4.8.3 Spurious Emission at High Frequency(2 480 MHz)



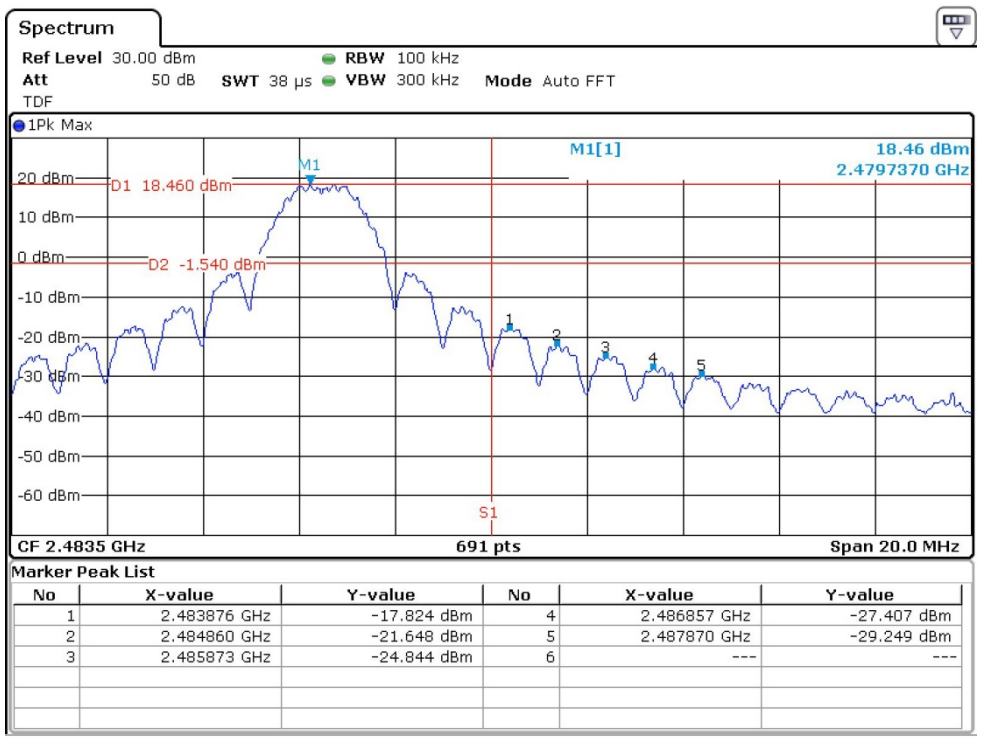
3.4.9 Plots of band edge emission

3.4.9.1 Band Edge Emission at Low Frequency



No	X-value	Y-value	No	X-value	Y-value
1	2.397077 GHz	-29.556 dBm	3	2.399074 GHz	-25.834 dBm
2	2.398032 GHz	-28.559 dBm	4	2.399855 GHz	-23.660 dBm

3.4.9.2 Band Edge Emission at High Frequency



No	X-value	Y-value	No	X-value	Y-value
1	2.483876 GHz	-17.824 dBm	4	2.486857 GHz	-27.407 dBm
2	2.484860 GHz	-21.648 dBm	5	2.487870 GHz	-29.249 dBm
3	2.485873 GHz	-24.844 dBm	6	---	---

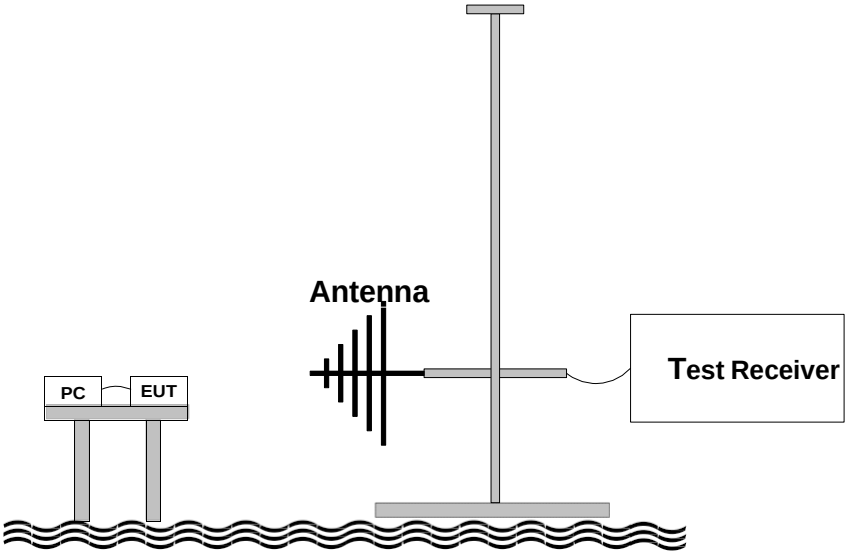
3.5 Radiated band edges and spurious emission

3.5.1 Specification

• FCC Rules Part 15 Section 15.247(d)

• ANSI C63.4-2009

3.5.2 Set-up



3.5.3 Test equipment list

Equipment	Model name	Manufacturer
EUT	NDC-I331	NURI Telecom Co., Ltd.
Test Receiver	ESCI 7	Rohde & Schwarz
Spectrum Analyzer	FSV 30	Rohde & Schwarz
Power supply	3-5-5001	Daegwang
Control PC	NT-P560-PS3M	Samsung
Test fixer(JIG)	ISA3	Silicon Laboratories Inc.
Control PC	NT-P560-PS3M	Samsung
Loop antenna	EMCO 6502	EMCO
Bi-conical antenna	VHA9103	Schwarzbeck
Log periodic antenna	VULP9118A	Schwarzbeck
Horn Antenna	BBHA-9120D	Schwarzbeck
Horn Antenna	FR6517	ORBIT

3.5.4 Test procedure

The EUT is placed on a turntable, which is 0.8 meter high above ground. The turntable rotates 360 degrees to determine the position of the maximum emission level.

EUT is set 3.0 meters away from the receiving antenna, broadband antenna, which is mounted on an antenna mast. The antenna moved up and down between 1 meter and 4 meters to find out the maximum emission level form the EUT. Both horizontal and vertical polarizations of the antenna are set on measurement.

In order to find out the maximum emission levels, all of the EUT location was manipulated according to ANSI 63.4-2009 during the radiated emission measurement. The EUT was tested to 3 orthogonal planes.

The RBW of test receiver is 120 kHz between 30 to 1 000 MHz, and 1 MHz above 1 GHz. For measurement peak mode, VBW is set to 3 times of RBW. For measurement average mode, VBW is set to 10 Hz.

3.5.5 Test condition

- Test place : Open area test site
- Test environment : 9.5 °C, 42 % R.H.
- Test mode : Operation at single channel
- Power engaged : AC 110V, 50Hz

3.5.6 Limit

Frequency [MHz]	Field Strength [μV/m]	Field Strength [dBμV/m]	Measurement Distance [m]
0.009 – 0.490	2 400 / F(kHz)	48.52 to 13.80	300
0.490 – 1.705	2 4000 / F(kHz)	33.80 to 22.97	30
1.705 – 30.0	30	29.54	30
30 – 88	100	40.00	3
88 – 216	150	43.52	3
216 – 960	200	46.02	3
Above 960	500	53.98	3

§15.205 and RSS-210(2.7 Table 1) : Restrict Band of Operation : Only spurious emissions are permitted in any of the frequency bands listed below ;

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
1) 0.495 - 0.505**	16.69475 - 16.69525	608 -614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 -1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 -38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 -6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 -6.26825	108 - 121.94	1718.8 -1722.2	13.25 - 13.4
6.31175 -6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.4142 5 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	Above 38.6

1) Until February 1, 1999, this restricted band shall be 0.490–0.510 MHz.

3.5.7 Test result

3.5.7.1 Transmitter

Frequency [MHz]	Pol. [H/V]	Plane [X/Y/Z]	Detect mode [Peak/AVG]	Reading [dBμV]	Antenna factor [dB/m]	Cable loss [dB]	Pre-amp gain [dB]	Emission level [dBμV]	Limit [dBμV]	Margin [dB]
Operation Low Channel										
*2 327	H	X	Peak	25.40	27.14	2.55	-	55.09	74.0	18.91
	H	X	AVG	13.26	27.14	2.55	-	42.95	54.0	11.05
2 405	H	X	Peak	83.19	28.33	2.70	-	144.22	-	-
	H	X	AVG	66.89	28.33	2.70	-	97.92	-	-
*4 815	V	X	Peak	32.56	32.61	5.54	-	70.71	74.0	3.29
	H	X	AVG	13.84	32.61	5.54		51.99	54.0	2.01
Operation Middle Channel										
2 440	H	X	Peak	83.98	28.42	2.73	-	115.13	-	-
	H	X	AVG	67.02	28.42	2.73	-	98.17	-	-
*4 880	H	X	Peak	29.22	32.73	5.61	-	67.56	74.0	6.44
	H	X	AVG	13.08	32.73	5.61	-	41.42	54.0	2.58
Operation High Channel										
2 480	H	X	Peak	83.99	28.51	2.77	-	115.27	-	-
	V	X	AVG	69.81	28.51	2.77	-	101.09	-	-
*2 484	H	X	Peak	25.22	28.90	2.81	-	56.93	74.0	17.07
	H	X	AVG	13.01	28.90	2.81	-	44.72	54.0	9.28
*4 960	H	X	Peak	29.62	33.07	5.79	-	68.48	74.0	5.52
	H	X	AVG	13.38	33.07	5.79	-	52.24	54.0	1.76
The other emissions were not detected.										

Here, * is restricted frequency.

Note :

1. The device was tested from 30 MHz to the tenth harmonic of the highest fundamental frequency per 15.33.

2. Duty Cycle : 100%

3.5.7.2 Receiver

Frequency [MHz]	Pol. [H/V]	Plane [X/Y/Z]	Detect mode [Peak/AVG]	Reading [dBμV]	Antenna factor [dB/m]	Cable loss [dB]	Pre-amp gain [dB]	Emission level [dBμV]	Limit [dBμV]	Margin [dB]
Receiver emissions were not detected.										

3.6 AC Conducted Emission

3.6.1 Specification

• FCC Rules Part 15 Section 15.207

3.6.2 Test equipment list

Equipment	Model name	Manufacturer
EUT	NDC-I331	NURI Telecom Co., Ltd.
Test Receiver	ESCI 7	Rohde & Schwarz
Control PC	NT-P560-PS3M	Samsung
Test fixer(JIG)	ISA3	Silicon Laboratories Inc.
Control PC	NT-P560-PS3M	Samsung
Loop antenna	EMCO 6502	EMCO
Bi-conical antenna	VHA9103	Schwarzbeck

3.6.3 Test Procedure

The EUT was placed on a wooden table with 0.8 m height above the floor. The EUT was connected to AC power supply and the input power was supplied through a 50 Ω/ 50 μH ± 5 Ω Artificial Mains Network (AMN). The ground plane was electrically bonded to the reference ground system and all power lines were filtered from ambient.

3.6.4 Test condition

• Test place : Shield room
• Test environment : 20 ℃, 45 % R.H.
• Test mode : Operation at single channel
• Power engaged : AC 110V, 50Hz

3.6.5 Limit

Frequency of emission [MHz]	Conducted limit [dB μV]	
	Quasi-peak	Average
0.15 – 0.5	66 to 56	56 to 46
0.5 – 5	56	46
5 - 30	60	50

3.6.6 Test result

• Result of conducted emission test

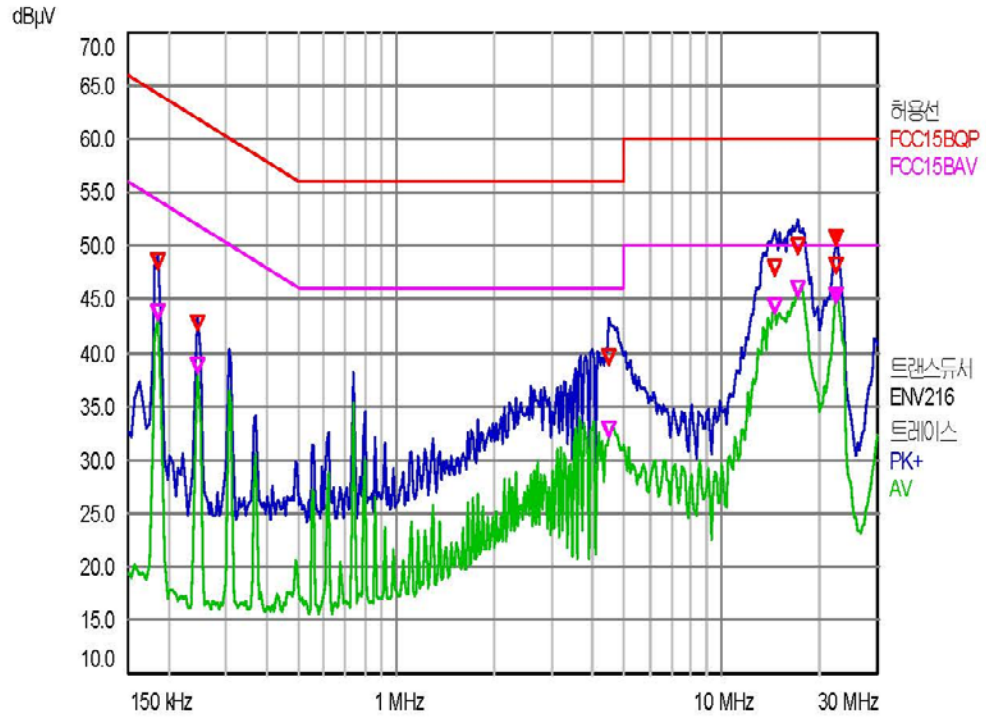
Frequency (MHz)	Factor(dB)		Line	Quasi-Peak			Average		
	LISN	Cable		Emission Level (dBμV)	Limits (dBμV)	Margin (dB)	Emission Level (dBμV)	Limits (dBμV)	Margin (dB)
0.19	9.84	9.84	H	48.09	64.21	16.12	45.21	54.21	9.10
0.25	9.85	9.85	N	42.09	61.89	19.80	38.13	51.89	13.76
4.61	9.91	9.86	H	41.49	56.00	14.51	37.16	46.00	8.84
12.67	9.96	9.89	H	48.97	60.00	11.03	45.66	50.00	4.34
17.09	9.98	9.91	N	49.18	60.00	10.82	45.33	50.00	4.67
22.25	10.01	9.94	N	47.46	60.00	12.54	44.78	50.00	5.22

Here, “H”: Live Line or Positive Line, “N”: Neutral Line or Negative Line.

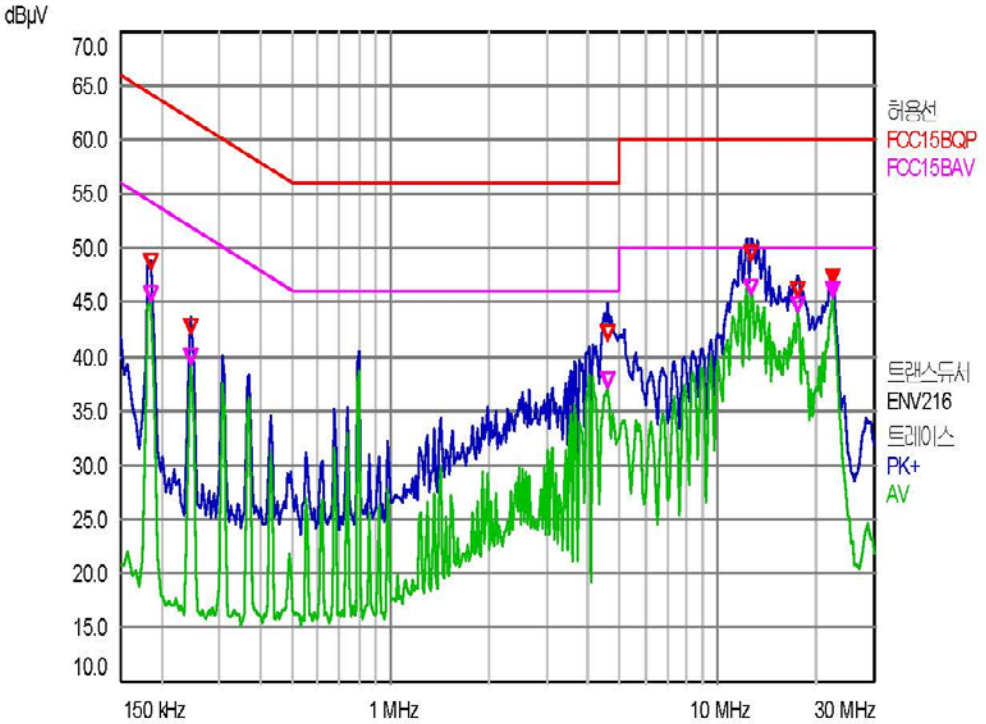
Line Conducted Emission Tabulated Data

See next page for an overview sweep performed with quasi-peak and average detector.

• Plots of conducted emission test



HOT LINE



NEUTRAL LINE

4. Test equipment list

The listing below denotes the test equipment for the test(s).

No.	Equipment	Model	Manufacturer	Serial Number	Calibration Due date
1	Spectrum analyzer	FSV	Rohde & Schwarz	101673	01/20/16
2	Test receiver	ESPI	Rohde & Schwarz	101002	01/20/16
3	Power supply	3-5-5001	Daegwang	031031	01/21/16
4	Loop antenna	6502	EMCO	9609-9087	01/31/16
5	Biconical antenna	VHA9103	Schwarzbeck	2217	11/15/15
6	Log-Periodic antenna	VULP9118A	Schwarzbeck	382	11/15/15
7	Horn antenna	BBHA 9120 D	Schwarzbeck	395	08/06/16
8	Horn antenna	FR6517	ORBIT	0511106	08/07/16
9	Turn table	ALL1.5TT	Air Link Lab	N/A	N/A
10	Antenna mast	ALL2.2MA	Air Link Lab	N/A	N/A
11	Controller	ALL-TC-V1.0	Air Link Lab	AAA69813111	N/A

