CTK Co., Ltd.
(Ho-dong), 113, Yejik-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970 Fax: +82-31-624-9501
www.e-ctk.com

TEST REPORT

According to : FCC 47CFR part 15 subpart C § 15.247

Test Report No.	:	CTK-2014-00957
Date of Issue	:	2014-08-12
FCC ID	:	ORI-ZBNODE
Model/Type No.	:	K-LCS [Node]
Kind of Product	:	ZB Node
Applicant	:	KMW INC.
Applicant Address	:	183-6, Yeongcheon-ro, Dongtan-myeon, Hwaseong-si, Gyeonggi-do, Korea
Manufacturer	:	KMW INC.
Manufacturer Address	:	183-6, Yeongcheon-ro, Dongtan-myeon, Hwaseong-si, Gyeonggi-do, Korea
Contact Person	:	Jeong-Su Park / Manager
Telephone	:	+82–31-370-8833
Received Date	:	2014-07-18
Test period	:	Start : 2014-07-24 End : 2014-08-11
Test Results	:	☒ In Compliance ☐ Not in Compliance

The test results presented in this report relate only to the object tested.

Tested by

Y. T. Lee

Young-taek Lee
Test Engineer
Date: 2014-08-12

Reviewed by

Y. J. Park

Young-Joon, Park
Technical Manager
Date: 2014-08-12

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REPORT REVISION HISTORY

Date	Revision	Page No
2014-08-12	Issued (CTK-2014-00957) The test report was issued because modifying the main board. Revision : Ver. 3.0 → Ver. 4.0	All

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1.0 General Product Description

Equipment model name	: K-LCS [Node]
Serial number	: Prototype
EUT condition	: Pre-production, not damaged
Antenna type	: Planar Inverted F antenna Gain 2.59 dBi
Frequency Range	: 2405 MHz – 2480 MHz (DSSS)
RF output power	: 5.494 dBm Peak Conducted
Number of channels	: 16
Type of Modulation	: OQPSK
Rated Channel spacing	: 5 MHz
Power Source	: DC 15 V

1.1 Tested Frequency

	LOW	MID	HIGH
Frequency (MHz)	2405	2445	2480

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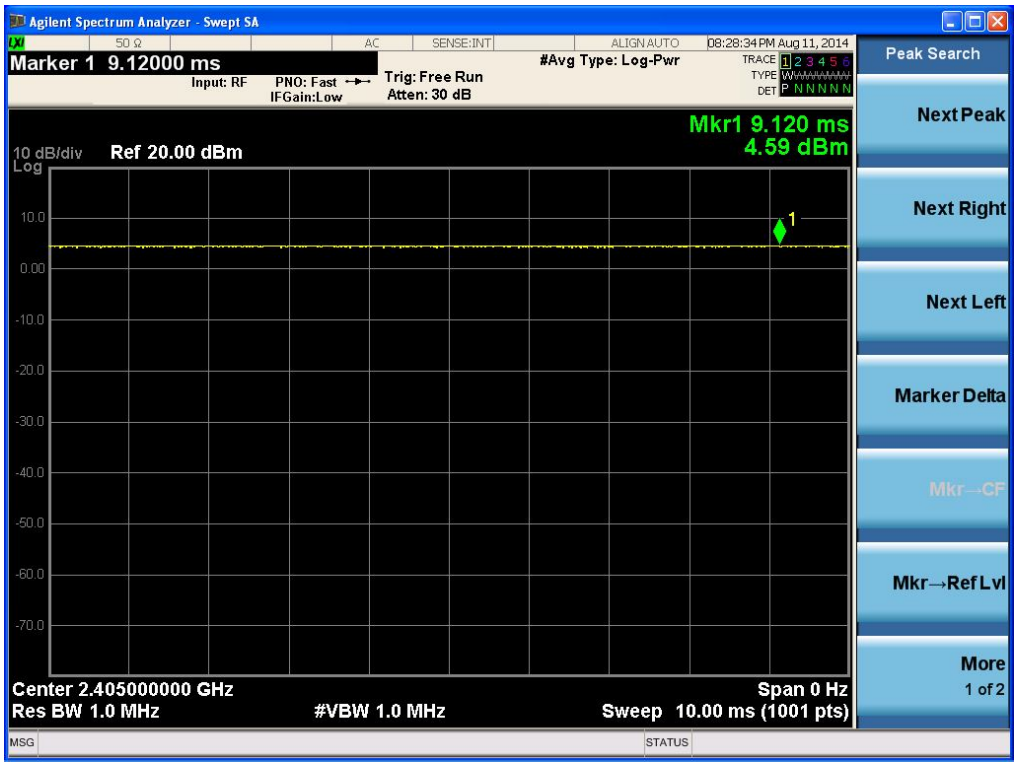
1.2 Duty Cycle

Duty Cycle	100 %



1.3 Model Differences

Not applicable

1.4 Device Modifications

The following modifications were necessary for compliance:

Not applicable

1.5 Peripheral Devices

Device	Manufacturer	Model No.	Serial No.
Notebook Computer	TOSHIBA CORPORATION	PSL48K-00L00K	Z7037782R
AC/DC ADAPTER	TOSHIBA CORPORATION	ADP-75SB	708W15Y01MK

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1.6 Calibration Details of Equipment Used for Measurement

Test equipment and test accessories are calibrated on regular basis. The maximum time between calibrations is one year or what is recommended by the manufacturer, whichever is less. All test equipment calibrations are traceable to the Korea Research Institute of Standards and Science (KRISS), therefore, all test data recorded in this report is traceable to KRISS.

1.7 Test Facility

The measurement facility is located at 113, Yejik-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea. The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.4 and CISPR Publication 22.

1.8 Laboratory Accreditations and Listings

Country	Agency	Scope of Accreditation	Logo
USA	**FCC**	3 m & 10 m SAC and Conducted Test Site to perform FCC Part 15/18 measurements	805871
JAPAN	**VCCI**	3 m & 10 m SAC and Conducted Test Site	C-986, T-1843 R-3627, G-387
KOREA	**KCC**	EMI (3 m & 10 m SAC and Conducted Test Site) EMS (ESD, RS, EFT/Burst, Surge, CS, Magnetic, Dips and Interruptions)	No. 51, KR0025
International	**KOLAS**	EMC	

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2.0 Summary of tests

FCC Part Section(s)	Parameter	Limit	Test Condition	Status (note 1)
15.247(a)	6 dB Bandwidth	> 500 kHz	Conducted	C
15.247(b)	Maximum Output Power	< 1 Watt		C
15.247(d)	Conducted Spurious emission	> 20 dBc		C
15.247(d)	Band Edge	> 20 dBc		C
15.247(e)	Transmitter Power Spectral Density	< 8 dBm @ 3 kHz		C
				C
15.209	Field Strength of Harmonics	15.209(a)	Radiated	C
15.207	AC Conducted Emissions	15.207(a)	Line Conducted	NT

Note 1: C=Complies NC=Not Complies NT=Not Tested NA=Not Applicable

Note 2: The data in this test report are traceable to the national or international standards.

The sample was tested according to the following specification:
- FCC Part 15.247, ANSI C63.4-2003

The tests were performed according to the method of measurements prescribed in 558074 D01 DTS Meas Guidance v03r01.

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2.1 Technical Characteristic Test

2.1.1 6dB Bandwidth

Procedure:

The bandwidth at 6dB below the highest in-band spectral density was measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate frequencies.

After the trace being stable, Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 6dB down one side of the emission. Reset the marker-delta function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 6 dB bandwidth of the emission.

The spectrum analyzer is set to:

Center frequency = the highest, middle and the lowest channels

RBW = 100 kHz

VBW = 300 kHz (VBW ≥ 3 x RBW) Sweep = auto

Trace = Max hold Detector function = peak

Measurement Data:

Test mode : Continuous modulated carrier

Frequency (MHz)	Channel No.	Test Results	
		Measured Bandwidth (MHz)	Result
2405	**11**	**1.560**	Complies
2445	**19**	**1.566**	Complies
2480	**26**	**1.565**	Complies

Minimum Standard:

6 dB Bandwidth > 500kHz

See next pages for actual measured spectrum plots.

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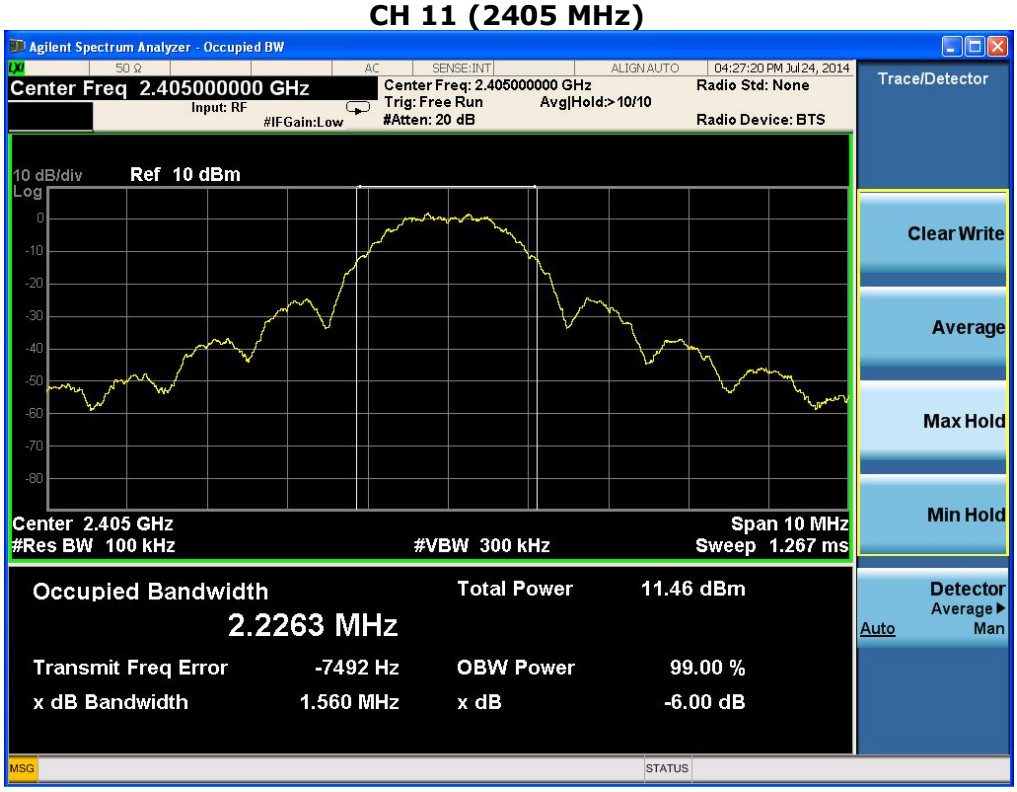
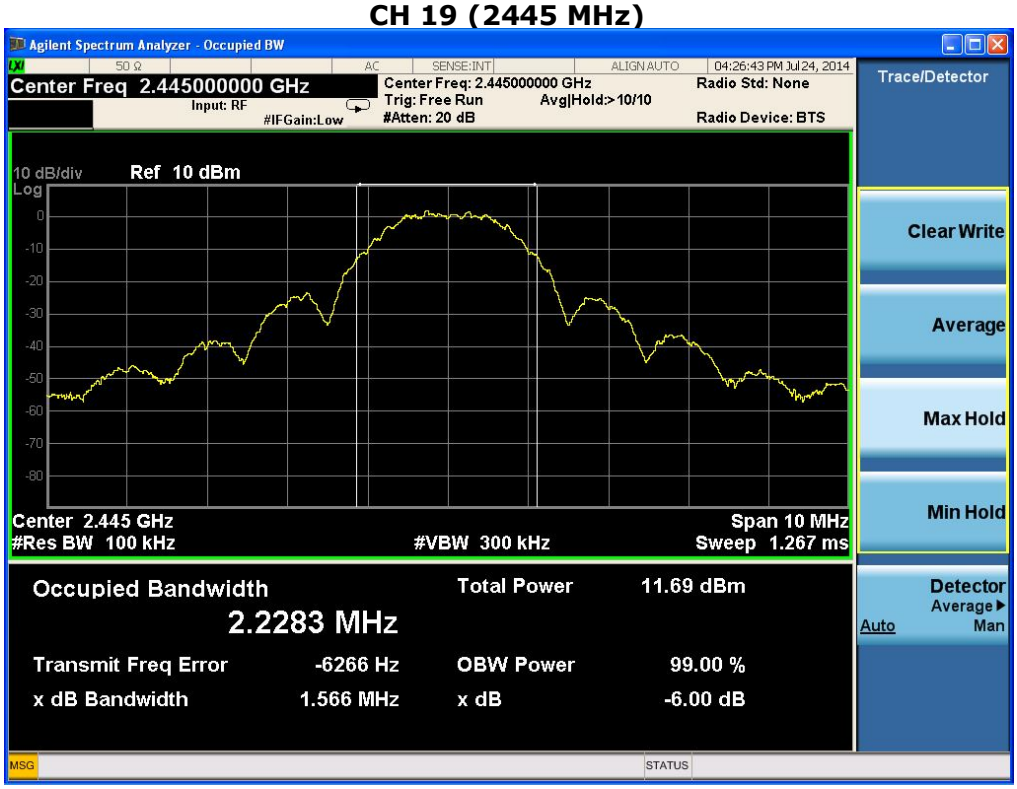
CH 11 (2405 MHz)



CH 19 (2445 MHz)



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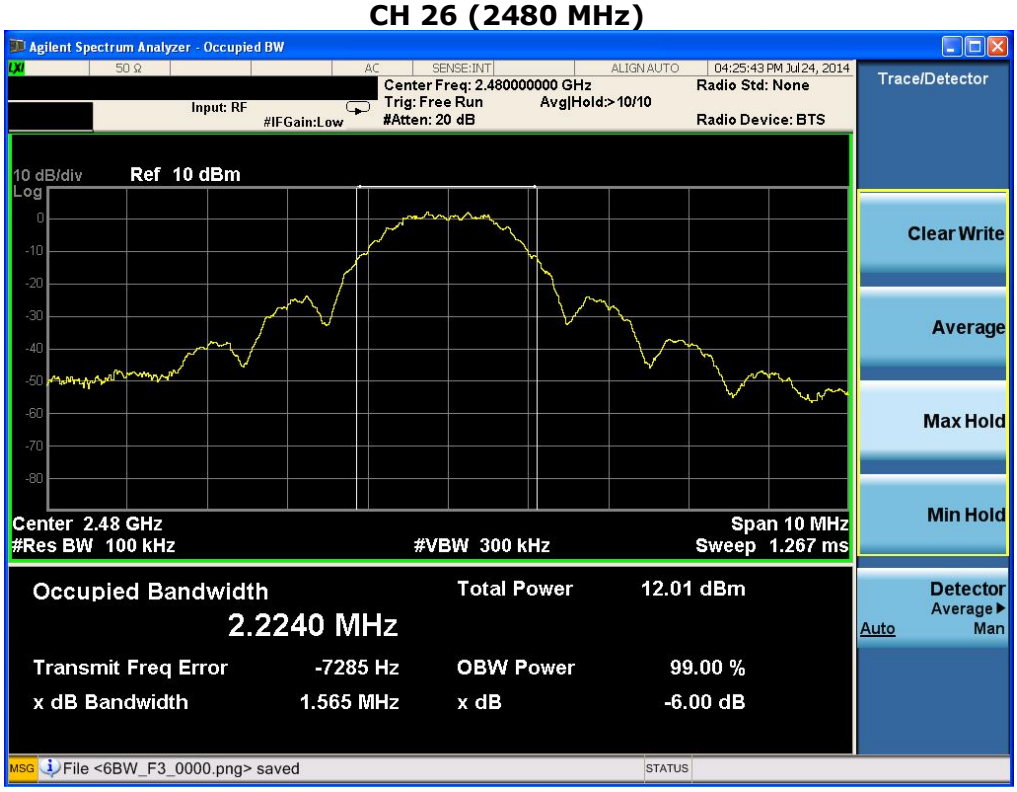
CH 26 (2480 MHz)



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2.1.2 Maximum peak Conducted Output Power

Test Location

RF Test Room

Test Procedures

Maximum Peak Output Power from the EUT were measured according to the dictates power measurement procedure in section 9.1.1 of KDB 558074.

This procedure shall be used when the measurement instrument has available a resolution bandwidth that is greater than the DTS bandwidth.

a) Set the RBW ≥ DTS bandwidth
b) Set the VBW ≥ 3 x RBW
c) Set the span ≥ 3 x RBW
d) Sweep time = auto couple
e) Detector = peak
e) Trace mode= max hold
f) Allow trace to fully stabilize.
g) Use peak marker function to determine the peak amplitude level.

Limit

< 1 W (30 dBm)

Test Results

Test mode : Continuous modulated carrier

Frequency (MHz)	Channel No.	Reading power(dBm)	Cable loss (dB)	Test results	
				Peak output power (dBm)	Result
2405	11	5.340	-	5.340	Complies
2445	19	5.247	-	5.247	Complies
2480	26	5.494	-	5.494	Complies

See next pages for actual measured spectrum plots.

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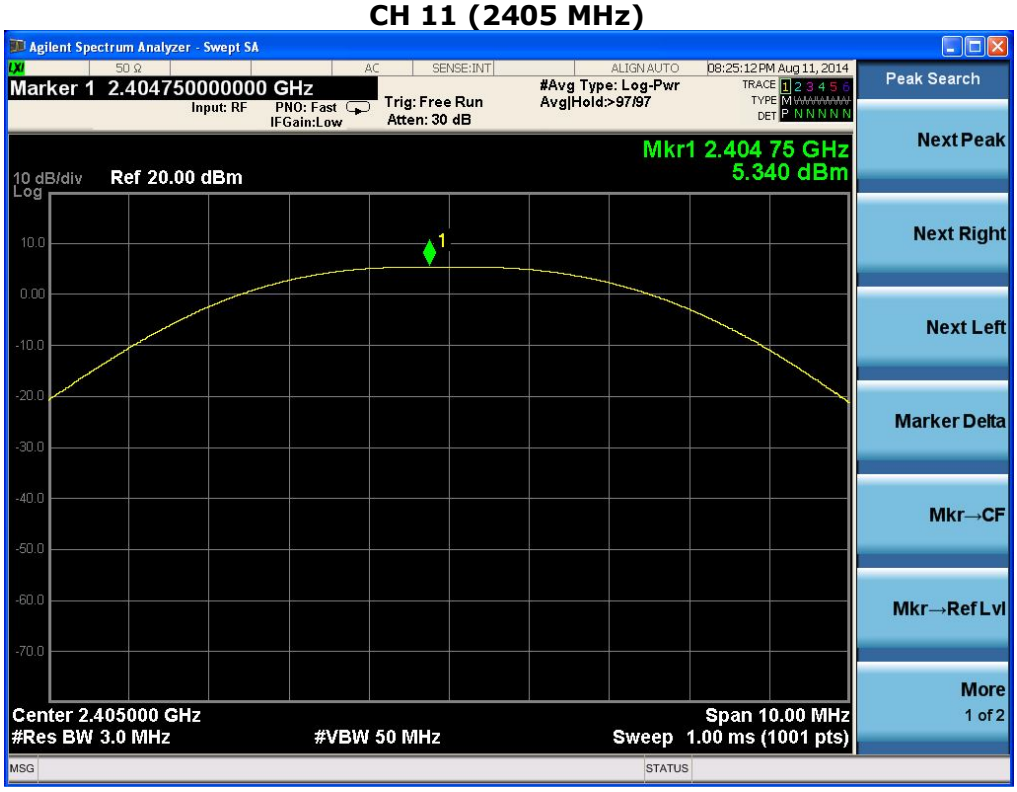
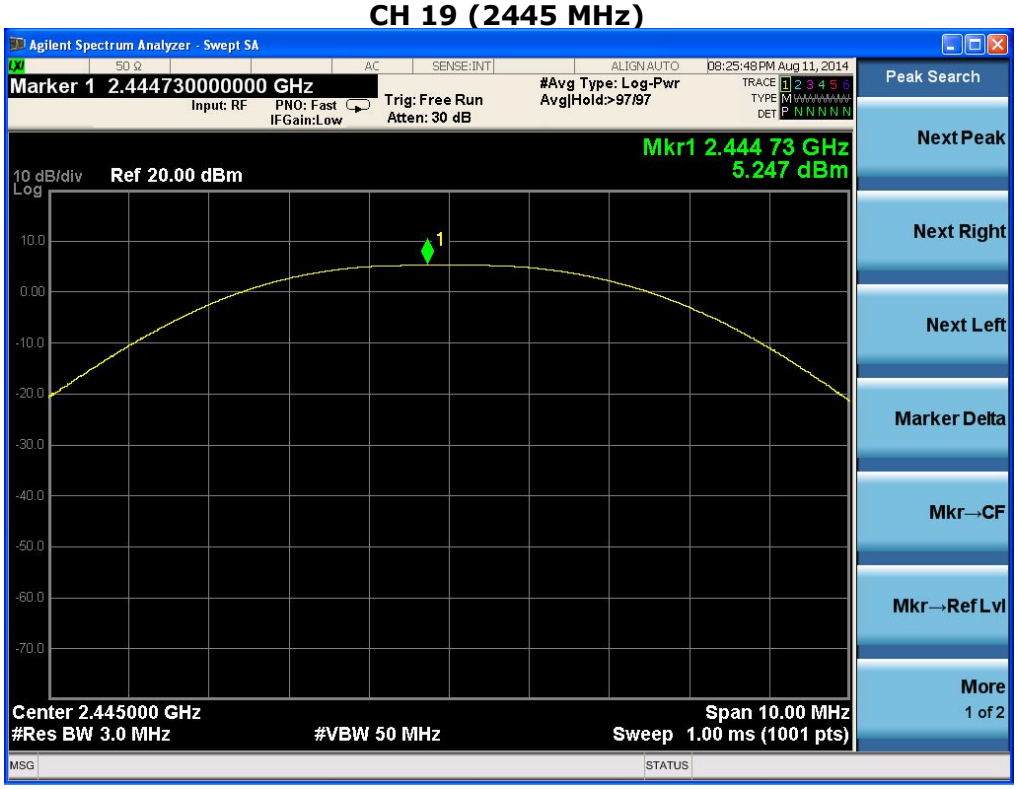
CH 11 (2405 MHz)



CH 19 (2445 MHz)



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CH 26 (2480 MHz)

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2.1.3 Power Spectral Density

Procedure:

Power Spectral Density from the EUT were measured according to the dictates PKPSD measurement procedure in section 10.2 of KDB 558074.

This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance.

a) Set analyzer center frequency to DTS channel center frequecy.
b) Set the span to 1.5 times the DTS bandwidth.
c) Set the RBW to : 3 kHz ≤ RBW ≤ 100 kHz
d) Set the VBW ≥ 3 x RBW
e) Detector = peak
f) Sweep time = auto couple
g) Trace mode = max hold
h) Allow trace to fully stabilize
i) Use the peak marker function to determine the maximum amplitude level within the RBW.
j) If measured value exceed limit, reduce RBW(no less than 3 kHz) and repeat.

Test mode : Continuous modulated carrier

Frequency (MHz)	Ch.	Test Results	
		dBm	Result
2405	11	2.131	Complies
2445	19	2.227	Complies
2480	26	2.264	Complies

Minimum Standard:

Power Spectral Density	< 8dBm @ 3 kHz BW

See next pages for actual measured spectrum plots.

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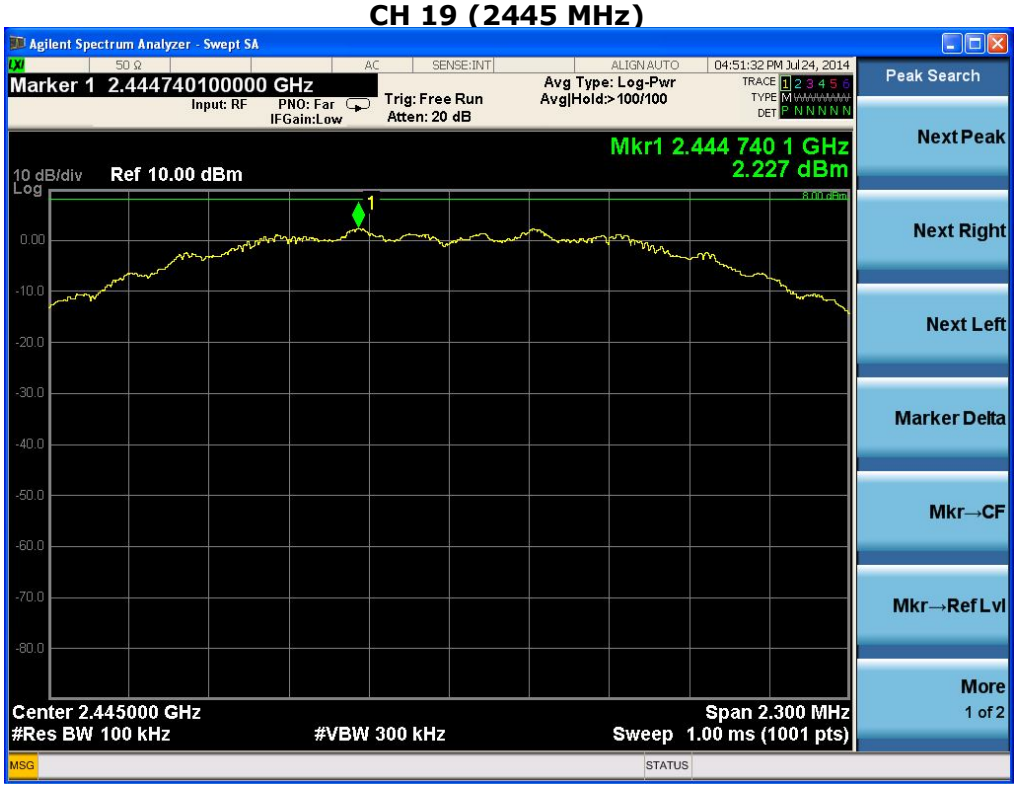
Power Density Measurement

CH 11 (2405 MHz)

CH 19 (2445 MHz)



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CH 26 (2480 MHz)

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2.1.4 Band - edge

Procedure:

The bandwidth at 20dB down from the highest inband spectral density is measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate frequencies.

After the trace being stable, Use the marker-to-peak function to measure 20 dB down both sides of the intentional emission.

The spectrum analyzer is set to:

Center frequency = the highest, middle and the lowest channels

RBW = 100 kHz	VBW = 300 kHz (VBW ≥ 3 x RBW)
Span = 50 MHz	Detector function = peak
Trace = Max hold	Sweep = auto

Measurement Data: Complies

- All conducted emission in any 100kHz bandwidth outside of the spread spectrum band was at least 20dB lower than the highest inband spectral density. Therefore the applying equipment meets the requirement.

Minimum Standard:	> 20 dBc

See next pages for actual measured spectrum plots.

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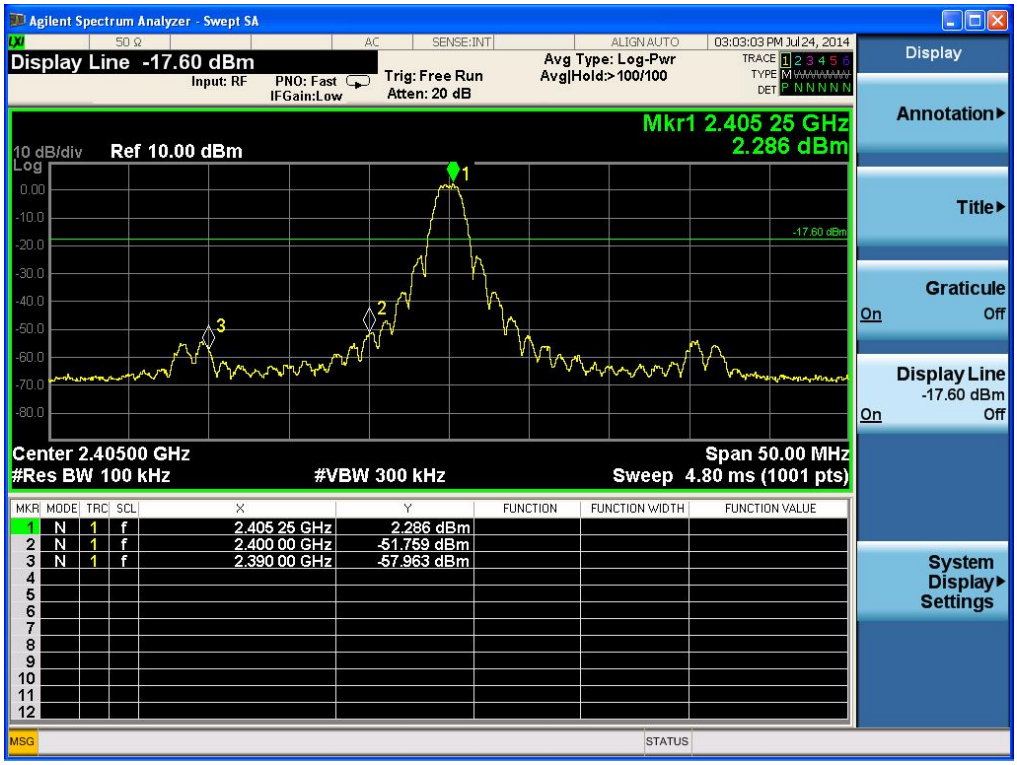
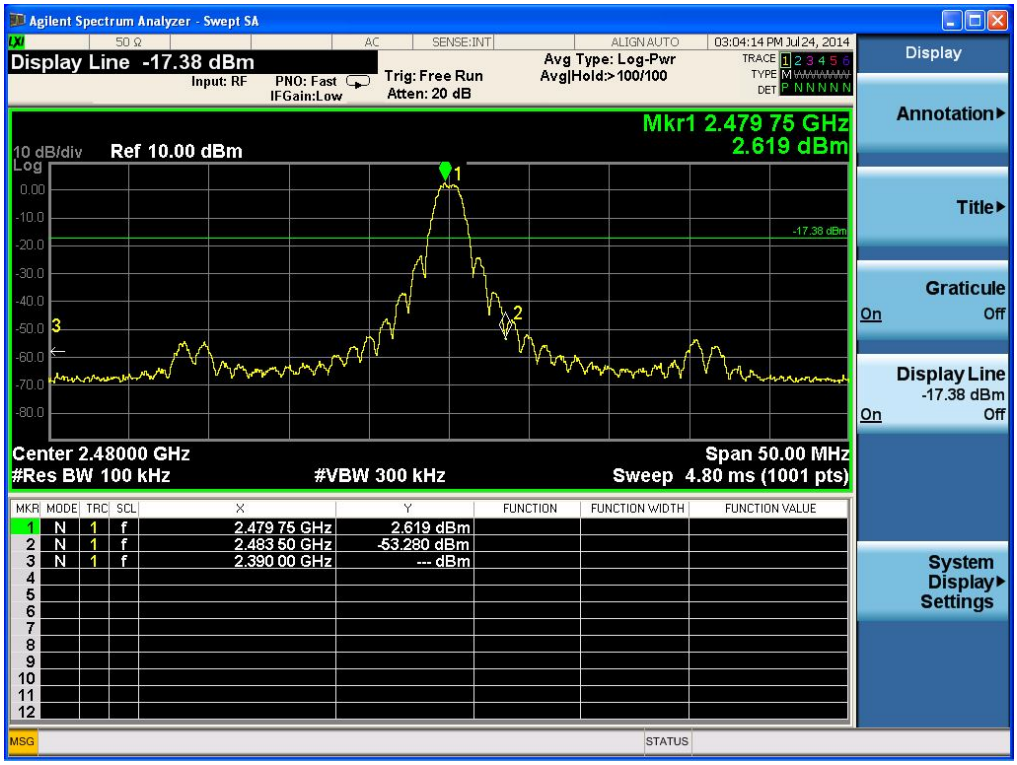
Band–edge Measurements





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Band – edge (at 20 dB blow) – Low channel(11)
Frequency Range = 30 MHz ~ 10th harmonic

Peak Table

	Frequency (GHz)	dBm
1	2.39	1.14
2	1.94	-38.07
3	3.37	-47.03
4	1.45	-47.39
5	2.88	-47.89
6	0.96	-53.73
7	7.22	-54.46
8	0.48	-58.31
9	3.85	-62.15
10	4.82	-63.34
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

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Band – edge (at 20 dB blow) – Mid channel(19)
Frequency Range = 30 MHz ~ 10th harmonic

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Band – edge (at 20 dB blow) – High channel(26)
Frequency Range = 30 MHz ~ 10th harmonic

Peak Table

	Frequency (GHz)	dBm
1	2.47	0.80
2	1.99	-34.65
3	1.48	-47.12
4	2.99	-48.42
5	0.99	-51.22
6	3.47	-51.81
7	7.44	-53.85
8	0.51	-57.58
9	4.96	-61.68
10	3.96	-64.47
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

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2.1.5 Field Strength of Emissions

Test Location

☒ 10 m SAC (test distance : ☐ 10 m, ☒ 3 m)
☒ 3 m SAC (test distance : 3 m)

Test Procedures

1) In the frequency range of 9 kHz to 30 MHz, magnetic field is measured with Loop Antenna. The Test Antenna is positioned with its plane vertical at 1m distance from the EUT. The center of the Loop Test Antenna is 1m above the ground. During the measurement the Loop Test Antenna rotates about its vertical axis for maximum response at each azimuth about the EUT.
2) In the frequency rage above 30 MHz, Bi-Log Test Antenna(30 MHz to 1 GHz) and Horn Test Antenna(above 1 GHz) are used. Test Antenna is 3m away from the EUT. Test Antenna height is carried from 1m to 4m above the ground to determine the maximum value of the field strength. The emissions levels at both horizontal and vertical polarizations should be tested.

<u>The spectrum analyzer is set to:</u>

Frequency Range = 9 kHz ~ 25 GHz (2.4 GHz 10th harmonic)
RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz, 9 kHz for f < 30 MHz
VBW ≥ RBW
Sweep = auto

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Limit

§ 15.205 (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	MHz	MHz	GHz
0.09-0.11	8.37626-8.38675	73-74.6	399.9-410	2690-2900	10.6-12.7
[1]0.495-0.505	8.41425-8.41475	74.8-75.2	608-614	3260-3267	13.25-13.4
2.1735-2.1905	12.29-12.293	108-121.94	960-1240	3332-3339	14.47-14.5
4.125-4.128	12.51975-12.52025	123-138	1300-1427	3345.8-3358	15.35-16.2
4.17725-4.17775	12.57675-12.57725	149.9-150.05	1435-1626.5	3600-4400	17.7-21.4
4.20725-4.20775	13.36-13.41	156.52475-156.52525	1645.5-1646.5	4500-5150	22.01-23.12
6.215-6.218	16.42-16.423	156.7-156.9	1660-1710	5350-5460	23.6-24
6.26775-6.26825	16.69475-16.69525	162.0125-167.17	1718.8-1722.2	7250-7750	31.2-31.8
6.31175-6.31225	16.80425-16.80475	167.72-173.2	2200-2300	8025-8500	36.43-36.5
8.291-8.294	25.5-25.67	240-285	2310-2390	9000-9200	[2]Above 38.6
8.362-8.366	37.5-38.25	322-335.4	2483.5-2500	9300-9500	

[1] Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

[2] Above 38.6

§ 15.205 (b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown is Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

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§ 15.209 (a) Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table :

Frequency(MHz)	Field Strength uV/m@3m	Field Strength dBuV/m@3m	Deasurement Distance (meters)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	30
1.705-30	30	-	30
30-88	100**	40	3
88-216	150**	43.5	3
216-960	200**	46	3
Above 960	500	54	3

** Except as provided in 15.209(g).fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72MHz, 76-88MHz, 174-216MHz, 470-806MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g.15.231 and 15.241.

Note :
1) For above 1 GHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit.
2) For above 1 GHz, limit field strength of harmonics : 54 dBuV/m@3m (AV) and 74 dBuV/m@3m (PK)
3) For measurement above 1GHz, the resolution bandwidth is set to 1 MHz and video bandwidth is set to 1 MHz for peak measurement and 10 Hz for average measurement.

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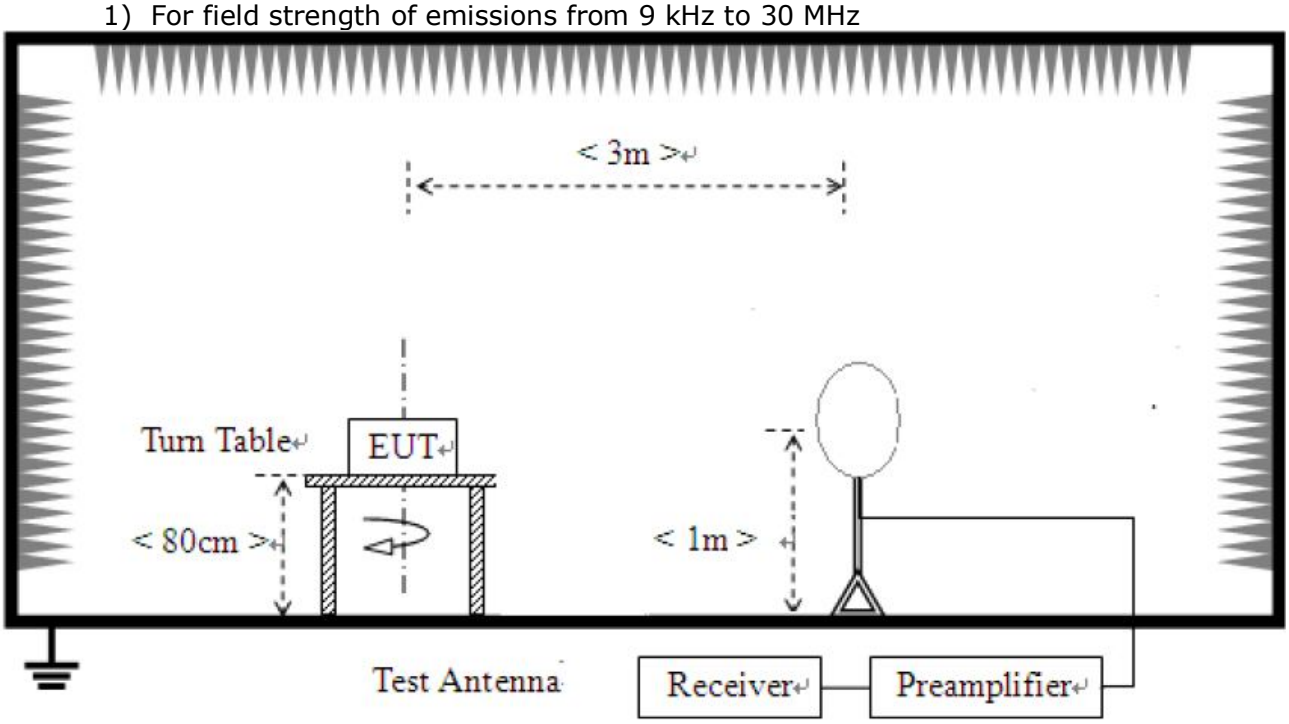
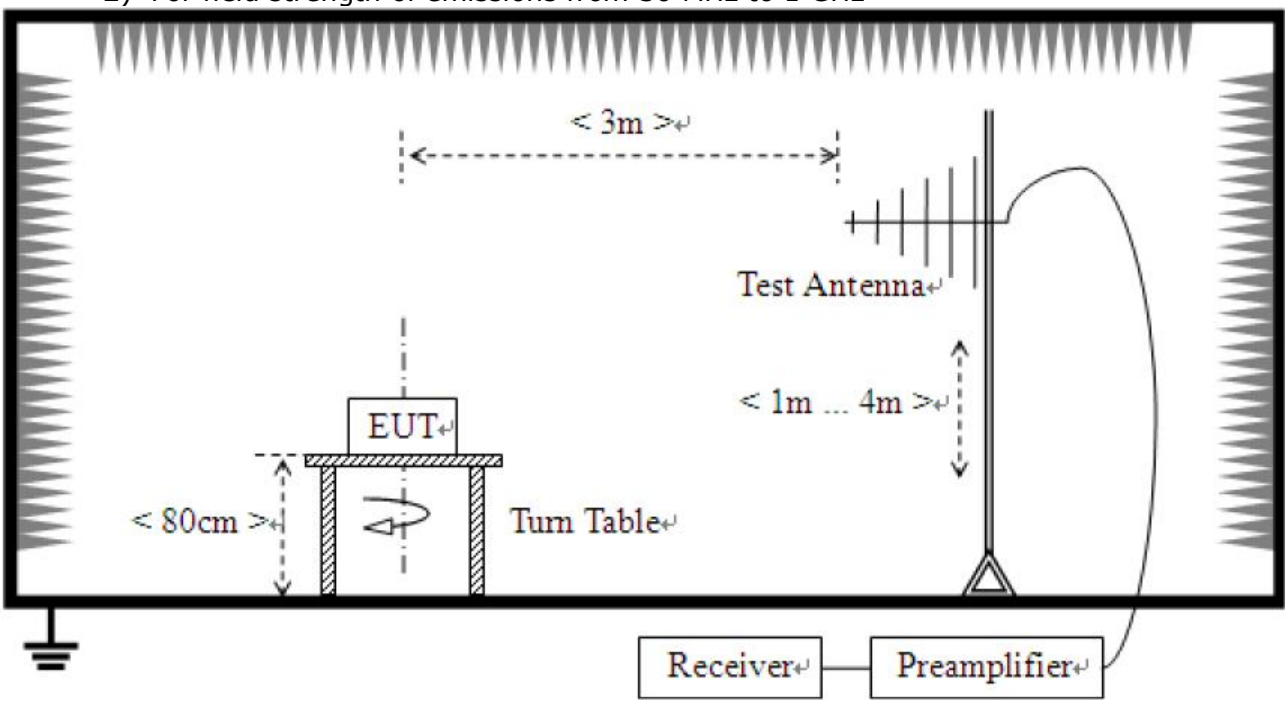
Test Setup:

1) For field strength of emissions from 9 kHz to 30 MHz



2) For field field strength of emissions from 30 MHz to 1 GHz



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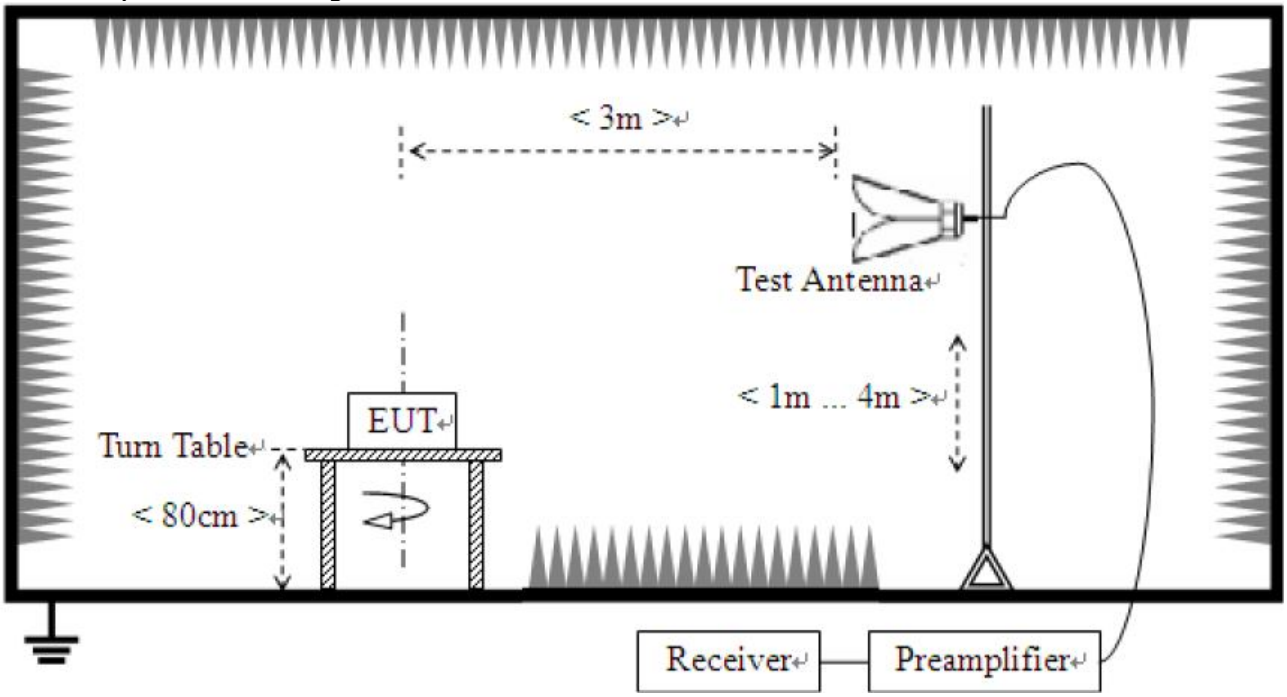
3) For field strength of emissions above 1 GHz



Test Results

1) 9 kHz to 30 MHz

EUT	ZB Node	Measurement Detail	
Model	K-LCS [Node]	Frequency Range	9 kHz – 30 MHz
Test mode	Continuous modulated carrier	Detector function	Quasi-Peak

The requirements are:

☒ Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
-	-	-	See note

Note :
The amplitude of spurious emissions that are attenuated by more than 20 dB below the permissible value has no need to be reported.

Distance extrapolation factor = 40 log (specific distance / test distance) (dB)

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2) 30 MHz to 1 GHz

Test mode : Continuous modulated carrier, Channel 19

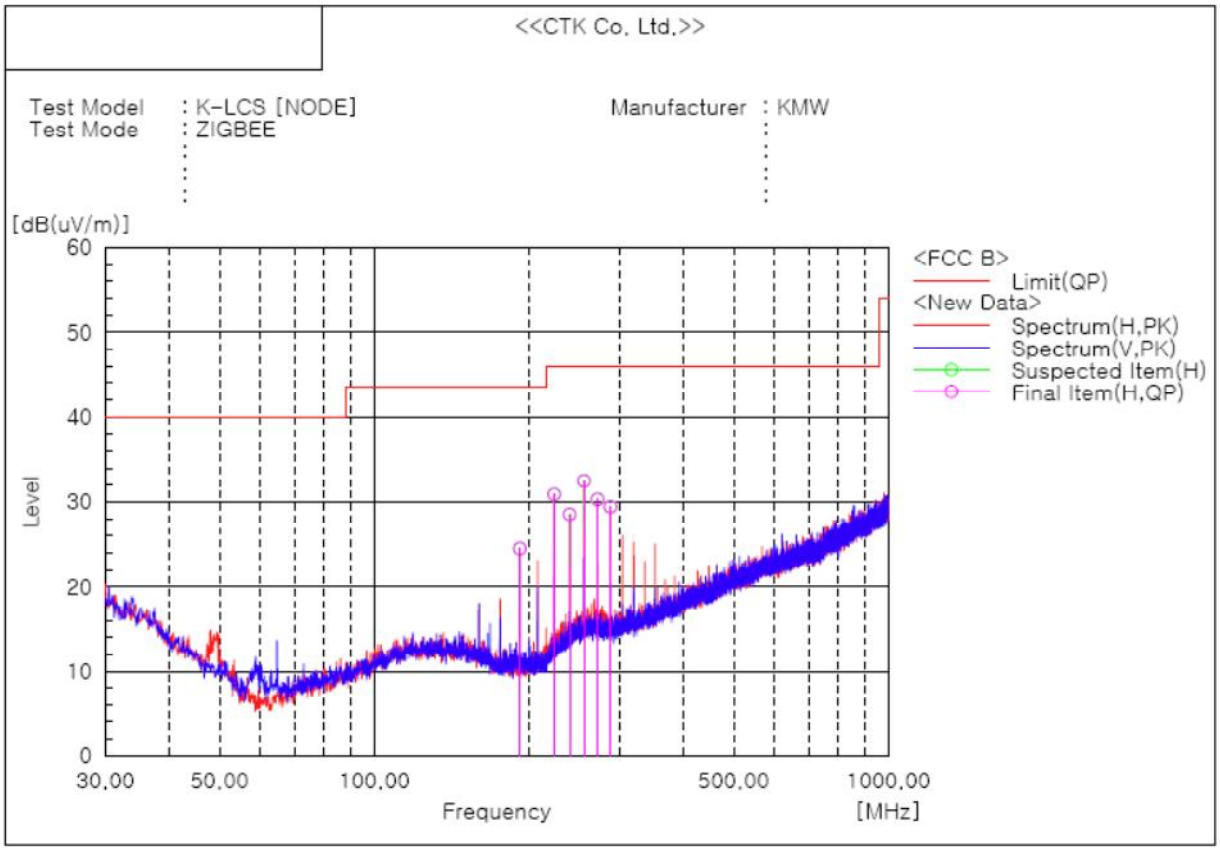
EUT	ZB Node	Measurement Detail	
Model	K-LCS [Node]	Frequency Range	Below 1000MHz
Mode	Continuous modulated carrier	Detector function	Quasi-Peak

The requirements are:

☒ Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
256.010	32.5	13.5	Quasi-peak

Test Data



Final Result

No.	Frequency [MHz]	(P)	Reading QP [dB(uV)]	c.f [dB(1/m)]	Result QP [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]
1	191.990	H	38.8	-14.3	24.5	43.5	19.0	100.0	10.0
2	224.000	H	42.9	-12.0	30.9	46.0	15.1	207.0	0.0
3	240.005	H	38.8	-10.3	28.5	46.0	17.5	100.0	10.0
4	256.010	H	42.4	-9.9	32.5	46.0	13.5	100.0	10.0
5	272.015	H	39.9	-9.6	30.3	46.0	15.7	100.0	234.0
6	288.020	H	38.6	-9.2	29.4	46.0	16.6	100.0	197.0

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3) above 1 GHz

EUT	ZB Node	Measurement Detail	
Model	K-LCS [Node]	Frequency Range	1-25GHz
Channel	Channel 11 (2405 MHz)	Detector function	Average / Peak

Remarks

We have tested three mode (X, Y, Z). The worst mode (X axis) for final test.

The requirements are:

☒ Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
1924.0	38.3	15.7	Average

Test Data

Frequency [MHz]	Reading [dBuV/m] AV / Peak		Pol.	Height [m]	Correction Factor Antenna + Amp. Gain + Cable	Limits [dBuV/m] AV / Peak		Result [dBuV/m] AV / Peak		Margin [dB] AV / Peak	
1924.00	31.8	41.8	V	1.0	6.5	54.0	74.0	38.3	48.3	15.7	25.7

Restricted band edge test data

Measured frequency range : 2310-2390 MHz, 2483.5-2500 MHz

Frequency [MHz]	Reading [dBuV/m] AV / Peak		Pol.	Height [m]	Correction Factor Antenna + Amp. Gain + Cable	Limits [dBuV/m] AV / Peak		Result [dBuV/m] AV / Peak		Margin [dB] AV / Peak	
2390.00	25.1	38.2	V	1.0	8.2	54.0	74.0	33.3	46.4	20.7	27.6

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EUT	ZB Node	Measurement Detail	
Model	K-LCS [Node]	Frequency Range	1-25GHz
Channel	Channel 19 (2445 MHz)	Detector function	Average / Peak

Remarks

We have tested three mode (X, Y, Z). The worst mode (X axis) for final test.

The requirements are:

☒ Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
1956.0	41.1	12.9	Average

Test Data

Frequency [MHz]	Reading [dBuV/m] AV / Peak		Pol.	Height [m]	Correction Factor Antenna + Amp. Gain + Cable	Limits [dBuV/m] AV / Peak		Result [dBuV/m] AV / Peak		Margin [dB] AV / Peak	
1956.00	34.4	43.4	V	1.0	6.7	54.0	74.0	41.1	50.1	12.9	23.9

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EUT	ZB Node	Measurement Detail	
Model	K-LCS [Node]	Frequency Range	1-25GHz
Channel	Channel 26 (2480 MHz)	Detector function	Average / Peak

Remarks

We have tested three mode (X, Y, Z). The worst mode (X axis) for final test.

The requirements are:

☒ Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
1984.0	46.2	7.8	Average

Test Data

Frequency [MHz]	Reading [dBuV/m] AV / Peak		Pol.	Height [m]	Correction Factor Antenna + Amp. Gain + Cable	Limits [dBuV/m] AV / Peak		Result [dBuV/m] AV / Peak		Margin [dB] AV / Peak	
1984.00	39.3	46.8	V	1.0	6.9	54.0	74.0	46.2	53.7	7.8	20.3

Restricted band edge test data

Measured frequency range : 2310-2390 MHz, 2483.5-2500 MHz

Frequency [MHz]	Reading [dBuV/m] AV / Peak		Pol.	Height [m]	Correction Factor Antenna + Amp. Gain + Cable	Limits [dBuV/m] AV / Peak		Result [dBuV/m] AV / Peak		Margin [dB] AV / Peak	
2483.50	32.9	46.3	V	1.0	8.3	54.0	74.0	41.2	54.6	12.8	19.4

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2.1.6 AC Conducted Emissions

Test Location
Shielded Room

Frequency Range of Measurement
150 kHz to 30 MHz

Instrument Settings
IF Band Width: 9 kHz

Test Procedures

The EUT was placed on a non-metallic table 0.8m above the metallic, grounded floor and 0.4m from the reference ground plane wall. The distance to other metallic surfaces was at least 0.8m.
Amplitude measurements were performed with a quasi-peak detector and an average detector.

Limit

- 15.207(a)

Frequency (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 Results
The requirements are:

☒ Not Tested

Test mode :

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
The power line is not changed.			

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Test Data

[L1]

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[NEUTRAL]

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APPENDIX A – Test Equipment Used For Tests

	Name of Equipment	Manufacturer	Model No.	Serial No.	Date of Calibration	Due Date
1	Signal Analyzer	Agilent	N9020A	MY48011598	2013-11-08	2014-11-08
2	EMI Test Receiver	Rohde & Schwarz	ESCI7	100814	2012-12-14	2014-12-06
3	EMI Test Receiver	Rohde & Schwarz	ESCI7	100816	2012-12-14	2014-12-06
4	EMI Test Receiver	Rohde & Schwarz	ESU40	100336	2014-05-15	2015-05-15
5	Bilog Antenna	Schaffner	CBL6111C	2551	2014-05-08	2016-05-08
6	Double Ridged Guide Antenna	ETS-Lindgren	3117	00154525	2013-07-03	2015-07-03
7	Double Ridged Guide Antenna	ETS-Lindgren	3116	00062916	2013-03-20	2015-03-20
8	Active Loop Antenna	SCHWARZBECK	FMZB 1513	1513-126	2014-05-19	2016-05-19
9	Attenuator	Rohde & Schwarz	DNF	272.4110.50	2013-11-12	2014-11-12
10	PREAMPLIFIER	Agilent	8449B	3008A02307	2013-11-08	2014-11-08
11	AMPLIFIER	Sonoma Instrument Co.	310	291721	2013-03-21	2015-02-06
12	Band Reject Filter	Wainwright Instruments GmbH	WRCGV 2400/2483-2375/2505-50/10EE	2	2013-09-09	2014-09-09
13	Signal Generator	Agilent	E4432B	US40054094	2013-11-08	2014-11-08
14	Signal Generator	HP	8341B	2819A01563	2013-11-08	2014-11-08
15	DC Power Supply	Topward	6303D	711196	2014-03-20	2015-03-20

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