

Report No.: HKES170400096702
Page: 1 of 56

TEST REPORT

Application No.:

HKES1704000967IT

Applicant:

PISMO LABS TECHNOLOGY LIMITED

Address of Applicant:

A8, 5/F, HK Spinners Industrial Building, Phase 6, 481 Castle Peak Road, Cheung Sha Wan, Hong Kong

Manufacturer:

PISMO LABS TECHNOLOGY LIMITED

Address of Manufacturer:

A8, 5/F, HK Spinners Industrial Building, Phase 6, 481 Castle Peak Road, Cheung Sha Wan, Hong Kong

Equipment Under Test (EUT):

PEPWAVE / peplink / PEPXIM Wireless Product

EUT Name:

BLE module; BLE module 2; Pismo013; BLE module - pcb antenna; BLE module 2 - pcb antenna; BT module 2 - pcb antenna; BT module - pcb antenna; BT module; BT module 2 ♣

♣

Please refer to section 2 of this report which indicates which item was actually tested and which were electrically identical.

FCC ID:

U8G-P1013

Standard(s) :

47 CFR Part 15, Subpart C 15.247

Date of Receipt:

2017-04-28

Date of Test:

2019-05-11 to 2019-05-23

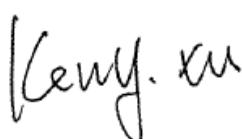
Date of Issue:

2019-07-12

Test Result:

Pass*

* In the configuration tested, the EUT complied with the standards specified above.



Keny Xu
EMC Laboratory Manager



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Revision Record				
Version	Chapter	Date	Modifier	Remark
01		2019-07-12		Original

Authorized for issue by:			
			
		Jacky Li /Project Engineer	
			
		Eric Fu /Reviewer	

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2 Test Summary

Radio Spectrum Technical Requirement				
Item	Standard	Method	Requirement	Result
Antenna Requirement	47 CFR Part 15, Subpart C 15.247	N/A	47 CFR Part 15, Subpart C 15.203 & 15.247(c)	Pass

Radio Spectrum Matter Part				
Item	Standard	Method	Requirement	Result
Conducted Emissions at Mains Terminals (150kHz-30MHz)	47 CFR Part 15, Subpart C	ANSI C63.10 (2013) Section 6.2	47 CFR Part 15, Subpart C 15.207	Pass
Minimum 6dB Bandwidth	47 CFR Part 15, Subpart C	ANSI C63.10 (2013) Section 11.8.1	47 CFR Part 15, Subpart C 15.247a(2)	Pass
Conducted Peak Output Power	47 CFR Part 15, Subpart C	ANSI C63.10 (2013) Section 11.9.1.2	47 CFR Part 15, Subpart C 15.247(b)(3)	Pass
Power Spectrum Density	47 CFR Part 15, Subpart C	ANSI C63.10 (2013) Section 11.10.2	47 CFR Part 15, Subpart C 15.247(e)	Pass
Conducted Band Edges Measurement	47 CFR Part 15, Subpart C	ANSI C63.10 (2013) Section 11.13.3.2	47 CFR Part 15, Subpart C 15.247(d)	Pass
Conducted Spurious Emissions	47 CFR Part 15, Subpart C	ANSI C63.10 (2013) Section 11.11	47 CFR Part 15, Subpart C 15.247(d)	Pass
Radiated Emissions which fall in the restricted bands	47 CFR Part 15, Subpart C	ANSI C63.10 (2013) Section 6.10.5	47 CFR Part 15, Subpart C 15.205 & 15.209	Pass
Radiated Spurious Emissions	47 CFR Part 15, Subpart C	ANSI C63.10 (2013) Section 6.4,6.5,6.6	47 CFR Part 15, Subpart C 15.205 & 15.209	Pass

Declaration of EUT Family Grouping:

Item no.:

BLE module; BLE module 2; Pismo013; BLE module - pcb antenna; BLE module 2 - pcb antenna; BT module 2 - pcb antenna; BT module - pcb antenna; BT module; BT module 2

According to the confirmation from the applicant, the above models are identical in circuitry design, PCB layout, electrical components used, internal wiring and functions, only different markets.

Therefore only the model BLE module 2 - pcb antenna was tested in this report.



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4 General Information

4.1 Details of E.U.T.

Power supply:	DC 3.3V(module power port) Power supply: DC 5.0V
Test voltage:	5.0V
Bluetooth Version:	V 4.0
Frequency Range:	2402-2480MHz
Channel Number:	40
Channel Spacing:	2MHz
Antenna Type:	PCB antenna
Antenna Gain:	5dBi

4.2 Description of Support Units

Description	Manufacturer	Model No.	Serial No.
Laptop	Lenovo	T430u	REF. No. SEA1800
Mouse	IBM	MO28UQ	/
Router	NETGEAR	DGN2200	REF. No. SEA2200

4.3 Measurement Uncertainty

No.	Item	Measurement Uncertainty
1	Radio Frequency	$\pm 7.25 \times 10^{-8}$
2	Duty cycle	$\pm 0.37\%$
3	Occupied Bandwidth	$\pm 3\%$
4	Conduction emission	$\pm 3.0\text{dB}$ (150kHz to 30MHz)
5	RF conducted power	$\pm 0.75\text{dB}$
6	RF power density	$\pm 2.84\text{dB}$
7	Conducted Spurious emissions	$\pm 0.75\text{dB}$
8	RF Radiated power	$\pm 4.5\text{dB}$ (Below 1GHz) $\pm 4.8\text{dB}$ (Above 1GHz)
9	Radiated Spurious emission test	$\pm 4.5\text{dB}$ (Below 1GHz) $\pm 4.8\text{dB}$ (Above 1GHz)
10	Temperature test	$\pm 1^\circ\text{C}$
11	Humidity test	$\pm 3\%$
12	Supply voltages	$\pm 1.5\%$
13	Time	$\pm 3\%$

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4.4 Test Location

All tests were performed at:

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen Branch

No. 1 Workshop, M-10, Middle Section, Science & Technology Park, Shenzhen, Guangdong, China.
518057.

Tel: +86 755 2601 2053 Fax: +86 755 2671 0594

No tests were sub-contracted.

4.5 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

- **CNAS (No. CNAS L2929)**

CNAS has accredited SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch EMC Lab to ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories (CNAS-CL01 Accreditation Criteria for the Competence of Testing and Calibration Laboratories) for the competence in the field of testing.

- **A2LA (Certificate No. 3816.01)**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory is accredited by the American Association for Laboratory Accreditation(A2LA). Certificate No. 3816.01.

- **VCCI**

The 3m Fully-anechoic chamber for above 1GHz, 10m Semi-anechoic chamber for below 1GHz, Shielded Room for Mains Port Conducted Interference Measurement and Telecommunication Port Conducted Interference Measurement of SGS-CSTC Standards Technical Services Co., Ltd. have been registered in accordance with the Regulations for Voluntary Control Measures with Registration No.: G-20026, R-14188, C-12383 and T-11153 respectively.

- **FCC –Designation Number: CN1178**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory has been recognized as an accredited testing laboratory.

Designation Number: CN1178. Test Firm Registration Number: 406779.

- **Innovation, Science and Economic Development Canada**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory has been recognized by ISED as an accredited testing laboratory.

CAB identifier: CN0006.

IC#: 4620C.

4.6 Deviation from Standards

None

4.7 Abnormalities from Standard Conditions

None



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5 Equipment List

Conducted Emissions at AC Power Line (150kHz-30MHz)					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
Shielding Room	ZhongYu Electron	GB-88	SEM001-06	2017-05-10	2020-05-09
Measurement Software	AUDIX	e3 V5.4.1221d	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM024-01	2018-07-12	2019-07-11
LISN	Rohde & Schwarz	ENV216	SEM007-01	2018-09-25	2019-09-24
LISN	ETS-LINDGREN	3816/2	SEM007-02	2018-04-01	2019-03-31
				2019-04-01	2020-03-31
EMI Test Receiver	Rohde & Schwarz	ESCI	SEM004-02	2018-04-01	2019-03-31
				2019-04-01	2020-03-31

Minimum 6dB Bandwidth					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
Shielding Room	SAEMC	MSR733	SEM001-09	2019-06-13	2024-06-12
DC Power Supply	ZhaoXin	RXN-305D	SEM011-02	2018-09-25	2019-09-24
Spectrum Analyzer	Rohde & Schwarz	FSU43	SEM004-08	2019-04-01	2020-03-31
Measurement Software	JS Tonscend	JS1120-2 BT/WIFI V2.	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM031-01	2019-07-11	2020-07-10
Attenuator	Weinschel Associates	WA41	SEM021-09	N/A	N/A
Signal Generator	KEYSIGHT	N5173B	SEM006-05	2018-09-27	2019-09-26
Power Meter	Rohde & Schwarz	NRVS	SEM014-02	2018-09-25	2019-09-24

Conducted Peak Output Power					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
Shielding Room	SAEMC	MSR733	SEM001-09	2019-06-13	2024-06-12
DC Power Supply	ZhaoXin	RXN-305D	SEM011-02	2018-09-25	2019-09-24
Spectrum Analyzer	Rohde & Schwarz	FSU43	SEM004-08	2019-04-01	2020-03-31
Measurement Software	JS Tonscend	JS1120-2 BT/WIFI V2.	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM031-01	2019-07-11	2020-07-10
Attenuator	Weinschel Associates	WA41	SEM021-09	N/A	N/A
Signal Generator	KEYSIGHT	N5173B	SEM006-05	2018-09-27	2019-09-26
Power Meter	Rohde & Schwarz	NRVS	SEM014-02	2018-09-25	2019-09-24

Power Spectrum Density					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
Shielding Room	SAEMC	MSR733	SEM001-09	2019-06-13	2024-06-12
DC Power Supply	ZhaoXin	RXN-305D	SEM011-02	2018-09-25	2019-09-24

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Spectrum Analyzer	Rohde & Schwarz	FSU43	SEM004-08	2019-04-01	2020-03-31
Measurement Software	JS Tonscend	JS1120-2 BT/WIFI V2.	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM031-01	2019-07-11	2020-07-10
Attenuator	Weinschel Associates	WA41	SEM021-09	N/A	N/A
Signal Generator	KEYSIGHT	N5173B	SEM006-05	2018-09-27	2019-09-26
Power Meter	Rohde & Schwarz	NRVS	SEM014-02	2018-09-25	2019-09-24

Conducted Band Edges Measurement					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
Shielding Room	SAEMC	MSR733	SEM001-09	2019-06-13	2024-06-12
DC Power Supply	ZhaoXin	RXN-305D	SEM011-02	2018-09-25	2019-09-24
Spectrum Analyzer	Rohde & Schwarz	FSU43	SEM004-08	2019-04-01	2020-03-31
Measurement Software	JS Tonscend	JS1120-2 BT/WIFI V2.	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM031-01	2019-07-11	2020-07-10
Attenuator	Weinschel Associates	WA41	SEM021-09	N/A	N/A
Signal Generator	KEYSIGHT	N5173B	SEM006-05	2018-09-27	2019-09-26
Power Meter	Rohde & Schwarz	NRVS	SEM014-02	2018-09-25	2019-09-24

Conducted Spurious Emissions					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
Shielding Room	SAEMC	MSR733	SEM001-09	2019-06-13	2024-06-12
DC Power Supply	ZhaoXin	RXN-305D	SEM011-02	2018-09-25	2019-09-24
Spectrum Analyzer	Rohde & Schwarz	FSU43	SEM004-08	2019-04-01	2020-03-31
Measurement Software	JS Tonscend	JS1120-2 BT/WIFI V2.	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM031-01	2019-07-11	2020-07-10
Attenuator	Weinschel Associates	WA41	SEM021-09	N/A	N/A
Signal Generator	KEYSIGHT	N5173B	SEM006-05	2018-09-27	2019-09-26
Power Meter	Rohde & Schwarz	NRVS	SEM014-02	2018-09-25	2019-09-24

Radiated Emissions which fall in the restricted bands					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
3m Semi-Anechoic Chamber	AUDIX	N/A	SEM001-02	2018-03-13	2021-03-12
Measurement Software	AUDIX	e3 V8.2014-6-27	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM026-01	2019-07-11	2020-07-10
EXA Spectrum Analyzer	AgilentTechnologies Inc	N9010A	SEM004-12	2019-04-12	2020-04-11

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Horn Antenna (1-18GHz)	Rohde & Schwarz	HF907	SEM003-07	2018-04-13	2021-04-12
Horn Antenna (15GHz-40GHz)	Schwarzbeck	BBHA 9170	SEM003-15	2017-10-17	2020-10-16
Pre-Amplifier (0.1-26.5GHz)	Compliance Directions Systems Inc.	PAP-0126	SEM004-11	2018-11-12	2019-11-11
Pre-amplifier (18-26GHz)	Rohde & Schwarz	CH14-H052	SEM005-17	2019-04-01	2020-03-31
Pre-amplifier (26GHz-40GHz)	Compliance Directions Systems Inc.	PAP-2640-50	SEM005-08	2019-04-01	2020-03-31
DC Power Supply	Zhao Xin	RXN-305D	SEM011-02	2018-09-25	2019-09-24
Active Loop Antenna	ETS-Lindgren	6502	SEM003-08	2017-08-22	2020-08-21

RE below 1GHz in Chamber

Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. Date	Cal. Due date
3m Semi-Anechoic Chamber	ETS-LINDGREN	N/A	SEM001-01	2017-08-05	2020-08-04
MXE EMI Receiver (20Hz-8.4GHz)	Agilent Technologies	N9038A	SEM004-05	2018-09-25	2019-09-24
BiConiLog Antenna (26-3000MHz)	ETS-LINDGREN	3142C	SEM003-01	2017-06-27	2020-06-26
Pre-amplifier (0.1-1300MHz)	Agilent Technologies	8447D	SEM005-01	2019-04-01	2020-03-31
Measurement Software	AUDIX	e3 V8.2014-6-27	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM025-01	2018-07-12	2019-07-11

RE above 1GHz in Chamber

Equipment	Manufacturer	Model No.	Inventory No.	Cal Date	Cal Due Date
3m Semi-Anechoic Chamber	AUDIX	N/A	SEM001-02	2018-03-13	2021-03-12
Measurement Software	AUDIX	e3 V8.2014-6-27	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM026-01	2019-07-11	2020-07-10
EXA Spectrum Analyzer	Agilent Technologies Inc	N9010A	SEM004-12	2019-04-12	2020-04-11
Horn Antenna (1-18GHz)	Rohde & Schwarz	HF907	SEM003-07	2018-04-13	2021-04-12
Horn Antenna (15GHz-40GHz)	Schwarzbeck	BBHA 9170	SEM003-15	2017-10-17	2020-10-16

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Pre-Amplifier (0.1-26.5GHz)	Compliance Directions Systems Inc.	PAP-0126	SEM004-11	2018-11-12	2019-11-11
Pre-amplifier (18-26GHz)	Rohde & Schwarz	CH14-H052	SEM005-17	2019-04-01	2020-03-31
Pre-amplifier (26GHz-40GHz)	Compliance Directions Systems Inc.	PAP-2640-50	SEM005-08	2019-04-01	2020-03-31
DC Power Supply	Zhao Xin	RXN-305D	SEM011-02	2018-09-25	2019-09-24
Active Loop Antenna	ETS-Lindgren	6502	SEM003-08	2017-08-22	2020-08-21

General used equipment

Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
Humidity/ Temperature Indicator	Shanghai Meteorological Industry Factory	ZJ1-2B	SEM002-03	2018-09-27	2019-09-26
Humidity/ Temperature Indicator	Shanghai Meteorological Industry Factory	ZJ1-2B	SEM002-04	2018-09-27	2019-09-26
Humidity/ Temperature Indicator	Mingle	N/A	SEM002-08	2018-09-27	2019-09-26
Barometer	Changchun Meteorological Industry Factory	DYM3	SEM002-01	2019-04-04	2020-04-03

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6 Radio Spectrum Technical Requirement

6.1 Antenna Requirement

6.1.1 Test Requirement:

47 CFR Part 15, Subpart C 15.203 & 15.247(c)

6.1.2 Conclusion

Standard Requirement:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

15.247(b) (4) requirement:

The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

EUT Antenna:

The antenna is integrated on the main PCB and no consideration of replacement. The best case gain of the antenna is 5dBi.

Antenna location: Refer to Appendix (Internal photos)



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7 Radio Spectrum Matter Test Results

7.1 Conducted Emissions at Mains Terminals (150kHz-30MHz)

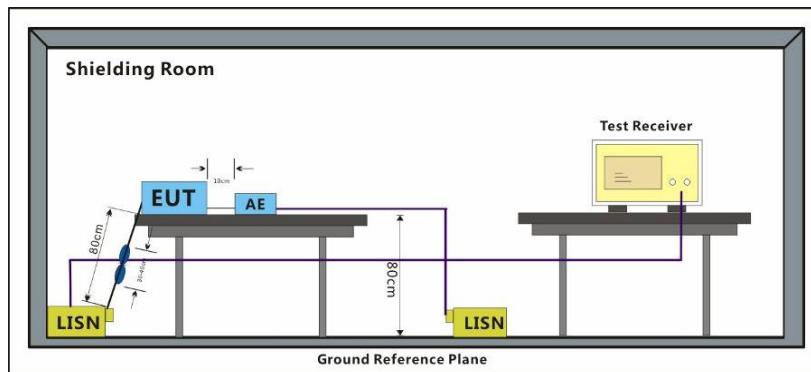
Test Requirement:	47 CFR Part 15,Subpart B
Test Method:	ANSI C63.4
Frequency Range:	150kHz to 30MHz
Limit:	
0.15M-0.5MHz	66dB(μV)-56dB(μV) quasi-peak, 56dB(μV)-46dB(μV) average
0.5M-5MHz	56dB(μV) quasi-peak, 46dB(μV) average
5M-30MHz	60dB(μV) quasi-peak, 50dB(μV) average
Detector:	Peak for pre-scan (9kHz resolution bandwidth) 0.15M to 30MHz

7.1.1 E.U.T. Operation

Operating Environment:

Temperature: 25 °C Humidity: 56 % RH Atmospheric Pressure: 1015 mbar
Test mode a: TX mode _Keep the EUT in continuously transmitting mode with GFSK modulation

7.1.2 Test Setup Diagram



7.1.3 Measurement Data

An initial pre-scan was performed with peak detector. Quasi-Peak or Average measurement were performed at the frequencies with maximized peak emission were detected.



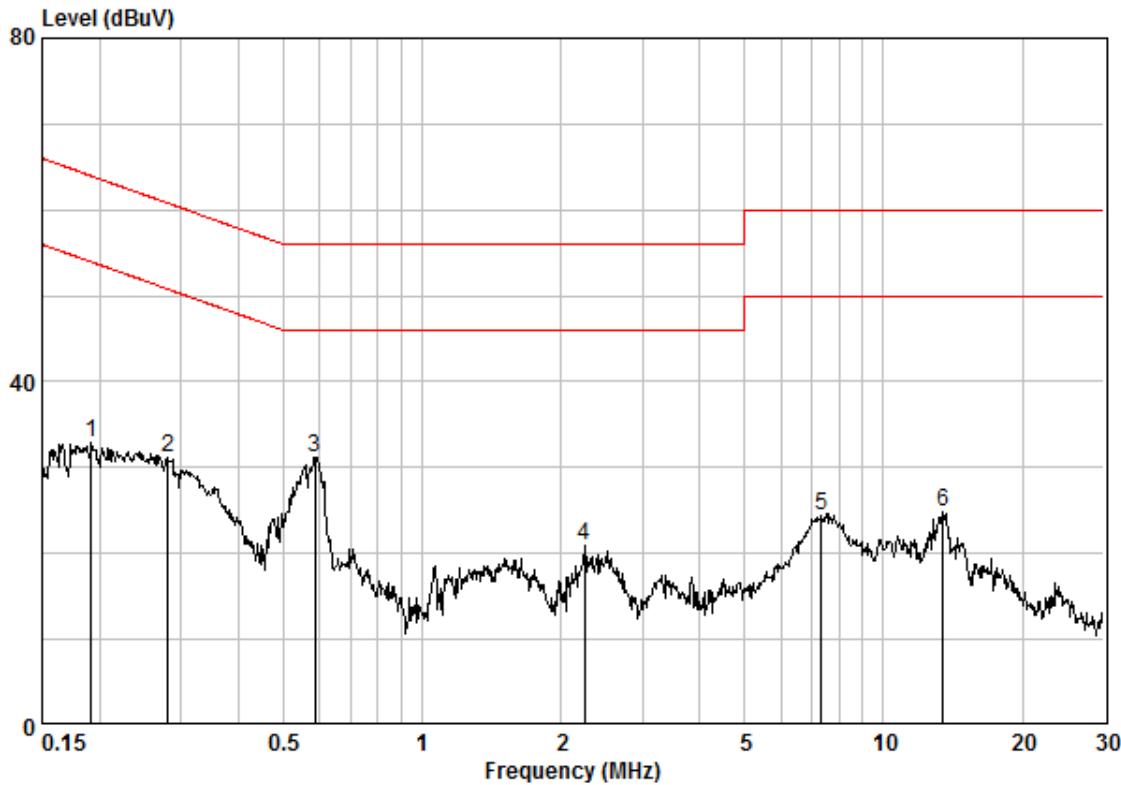
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Mode:a; Line:Live Line



Site : Shielding Room
Condition : CE LINE
Job No. : 00967IT
Test Mode : a

Freq	Cable	LISN	Read	Limit	Over	Remark
	MHz	dB	dB	dBuV	dBuV	
1	0.19140	0.02	9.64	23.19	32.85	53.98 -21.12 Peak
2	0.28178	0.02	9.64	21.52	31.18	50.76 -19.59 Peak
3	0.58540	0.02	9.65	21.58	31.26	46.00 -14.74 Peak
4	2.249	0.03	9.68	11.20	20.91	46.00 -25.09 Peak
5	7.329	0.09	9.80	14.50	24.38	50.00 -25.62 Peak
6	13.479	0.15	9.93	14.84	24.92	50.00 -25.08 Peak



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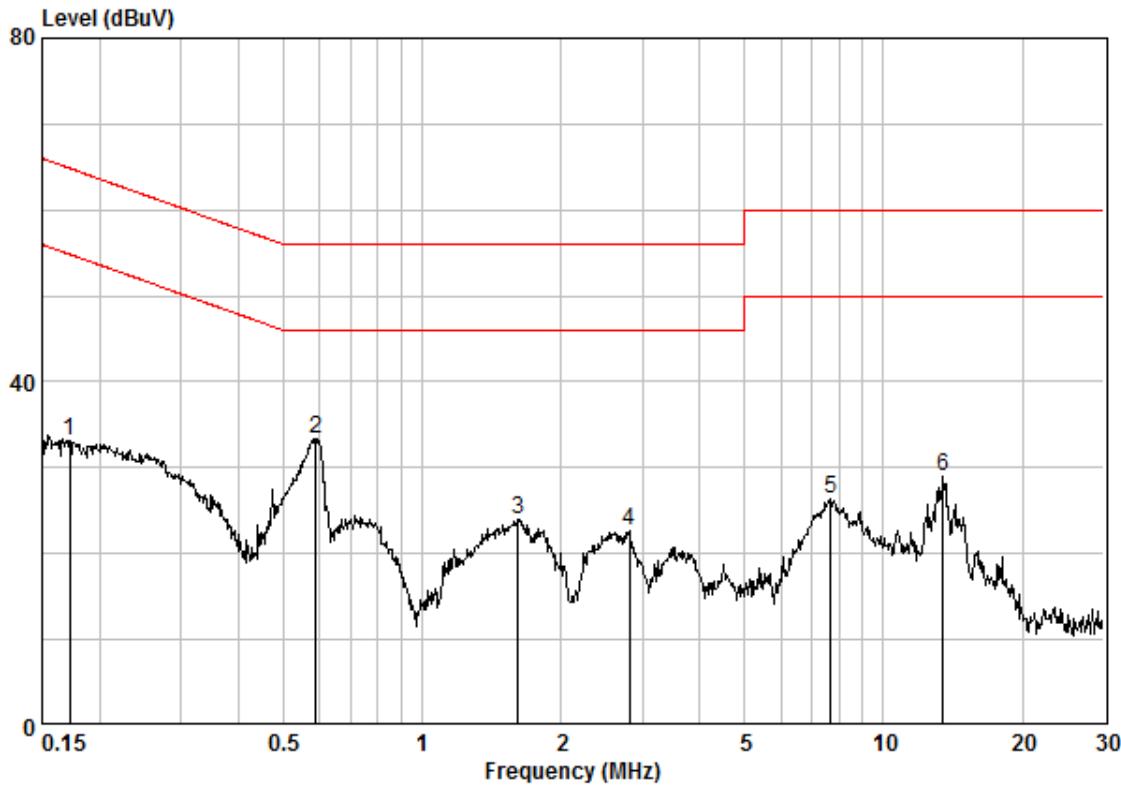
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Mode:a; Line:Neutral Line



Site : Shielding Room
 Condition : CE NEUTRAL
 Job No. : 00967IT
 Test Mode : a

	Freq	Cable	LISN	Read	Limit	Over	Remark
		Loss	Factor	Level	Level	Line	
	MHz	dB	dB	dBuV	dBuV	dBuV	dB
1	0.17215	0.02	9.63	23.59	33.24	54.86	-21.62 Peak
2 @	0.58851	0.02	9.63	23.76	33.41	46.00	-12.59 Peak
3	1.610	0.03	9.65	14.30	23.98	46.00	-22.02 Peak
4	2.809	0.03	9.67	13.01	22.70	46.00	-23.30 Peak
5	7.687	0.09	9.79	16.42	26.30	50.00	-23.70 Peak
6	13.479	0.15	9.93	19.01	29.09	50.00	-20.91 Peak

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7.2 Minimum 6dB Bandwidth

Test Requirement 47 CFR Part 15, Subpart C 15.247a(2)

Test Method: ANSI C63.10 (2013) Section 11.8.1

Limit: ≥ 500 kHz

7.2.1 E.U.T. Operation

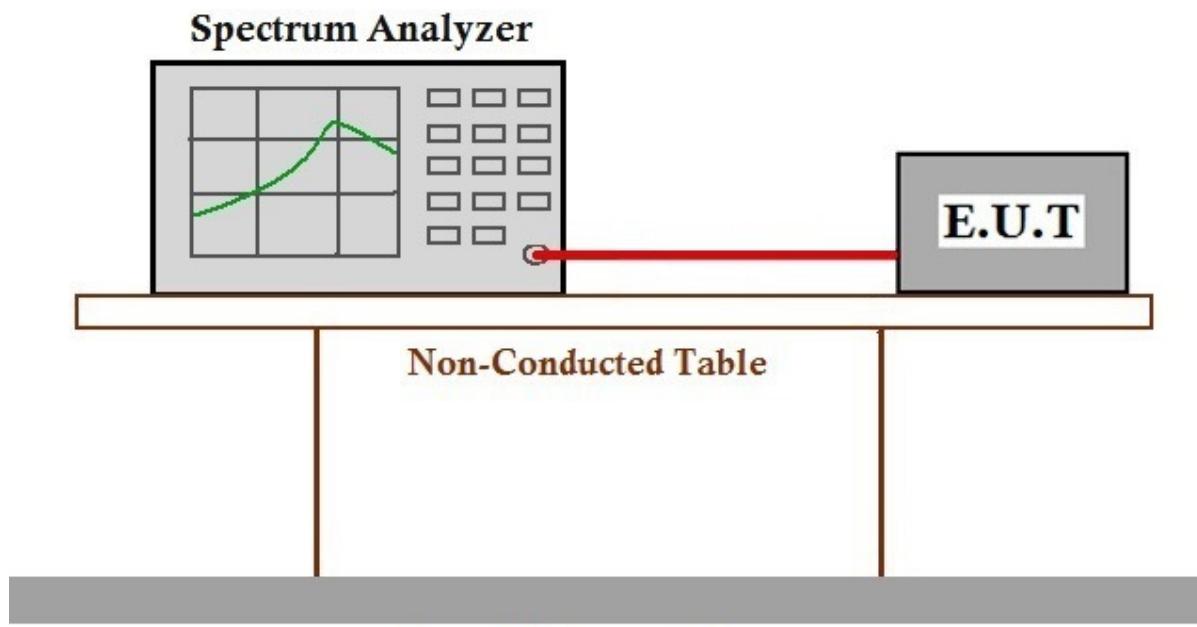
Operating Environment:

Temperature: 23 °C Humidity: 56 % RH Atmospheric Pressure: 1015 mbar

Test mode b:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation

The worst case b:TX mode_Keep the EUT in continuously transmitting mode with GFSK for final test: modulation

7.2.2 Test Setup Diagram



7.2.3 Measurement Procedure and Data

The detailed test data see: Appendix 15.247



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7.3 Conducted Peak Output Power

Test Requirement 47 CFR Part 15, Subpart C 15.247(b)(3)

Test Method: ANSI C63.10 (2013) Section 11.9.1.2

Limit:

Frequency range(MHz)	Output power of the intentional radiator(watt)
902-928	1 for ≥ 50 hopping channels
	0.25 for $25 \leq$ hopping channels < 50
	1 for digital modulation
2400-2483.5	1 for ≥ 75 non-overlapping hopping channels
	0.125 for all other frequency hopping systems
	1 for digital modulation
5725-5850	1 for frequency hopping systems and digital modulation

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7.3.1 E.U.T. Operation

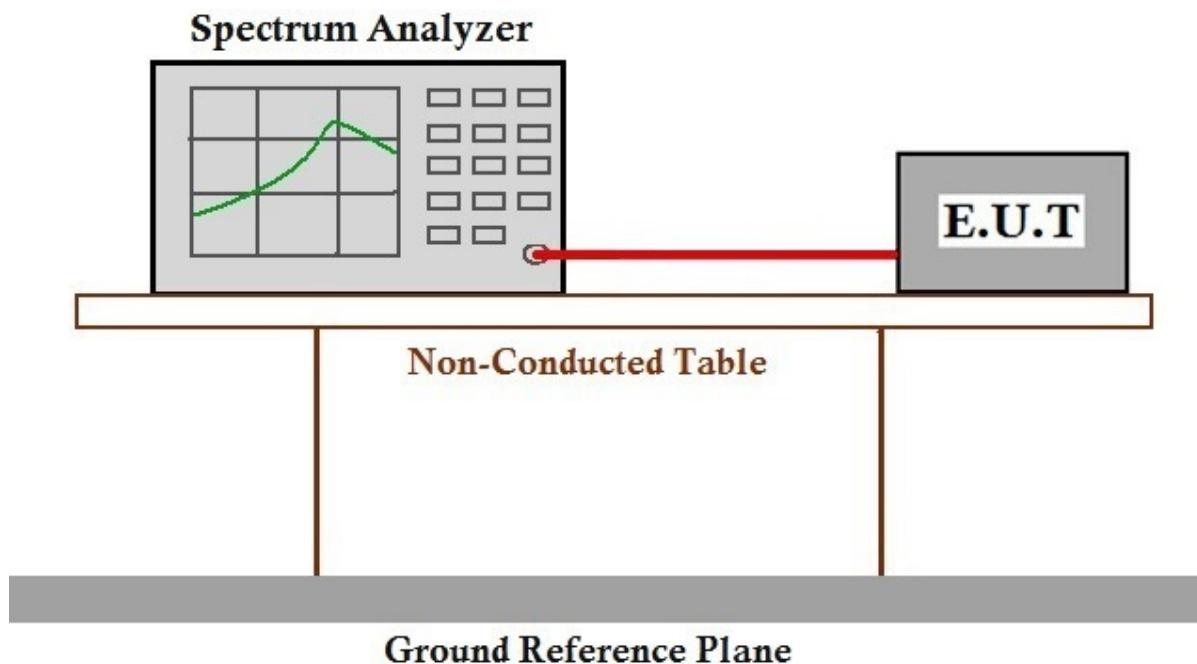
Operating Environment:

Temperature: 23 °C Humidity: 56 % RH Atmospheric Pressure: 1015 mbar

Test mode b:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation

The worst case b:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation
for final test:

7.3.2 Test Setup Diagram



7.3.3 Measurement Procedure and Data

The detailed test data see: Appendix 15.247



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7.4 Power Spectrum Density

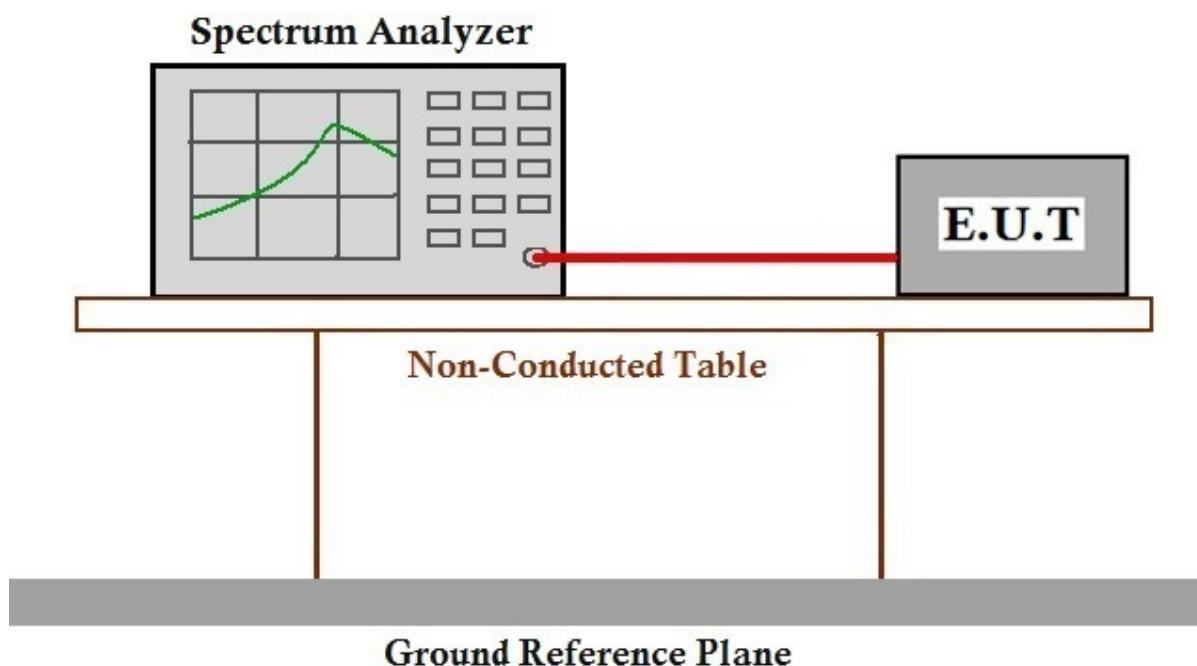
Test Requirement 47 CFR Part 15, Subpart C 15.247(e)
Test Method: ANSI C63.10 (2013) Section 11.10.2
Limit: ≤8dBm in any 3 kHz band during any time interval of continuous transmission

7.4.1 E.U.T. Operation

Operating Environment:

Temperature: 23 °C Humidity: 56 % RH Atmospheric Pressure: 1015 mbar
Test mode b:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation
The worst case for final test: b:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation

7.4.2 Test Setup Diagram



7.4.3 Measurement Procedure and Data

The detailed test data see: Appendix 15.247



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7.5 Conducted Band Edges Measurement

Test Requirement	47 CFR Part 15, Subpart C 15.247(d)
Test Method:	ANSI C63.10 (2013) Section 11.13.3.2
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated 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, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, 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) (see §15.205(c))



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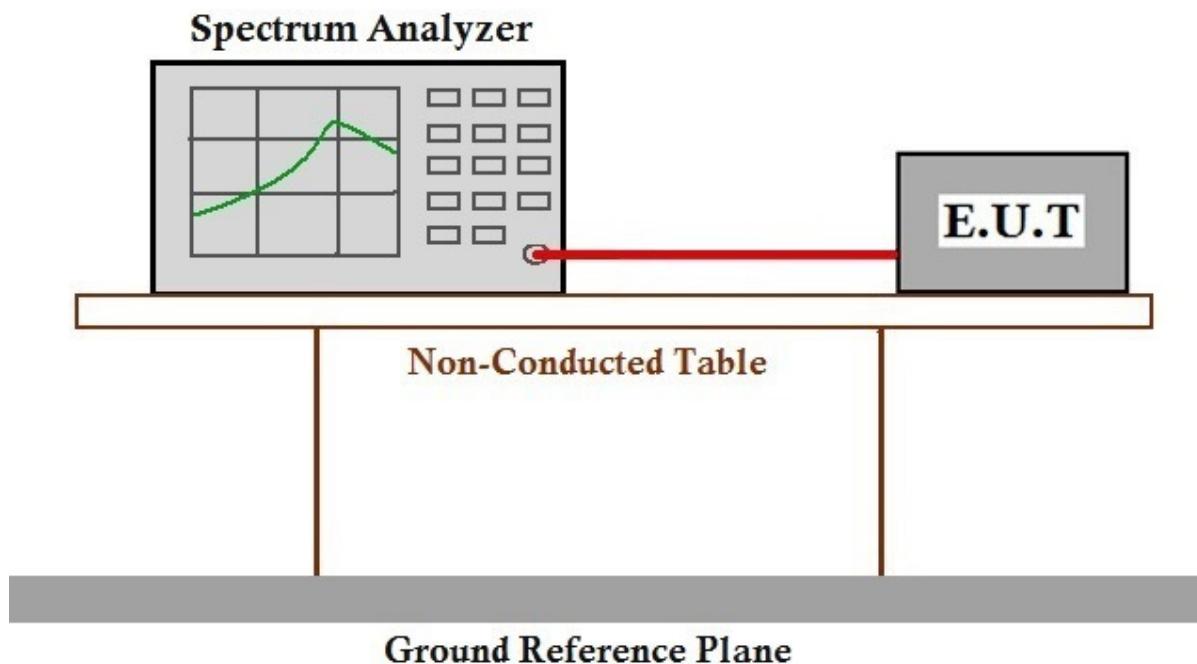
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7.5.1 E.U.T. Operation

Operating Environment:

Temperature: 23 °C Humidity: 56 % RH Atmospheric Pressure: 1015 mbar

Test mode b:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation

The worst case b:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation
for final test:**7.5.2 Test Setup Diagram****7.5.3 Measurement Procedure and Data**

The detailed test data see: Appendix 15.247

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7.6 Conducted Spurious Emissions

Test Requirement	47 CFR Part 15, Subpart C 15.247(d)
Test Method:	ANSI C63.10 (2013) Section 11.11
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated 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, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, 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) (see §15.205(c))



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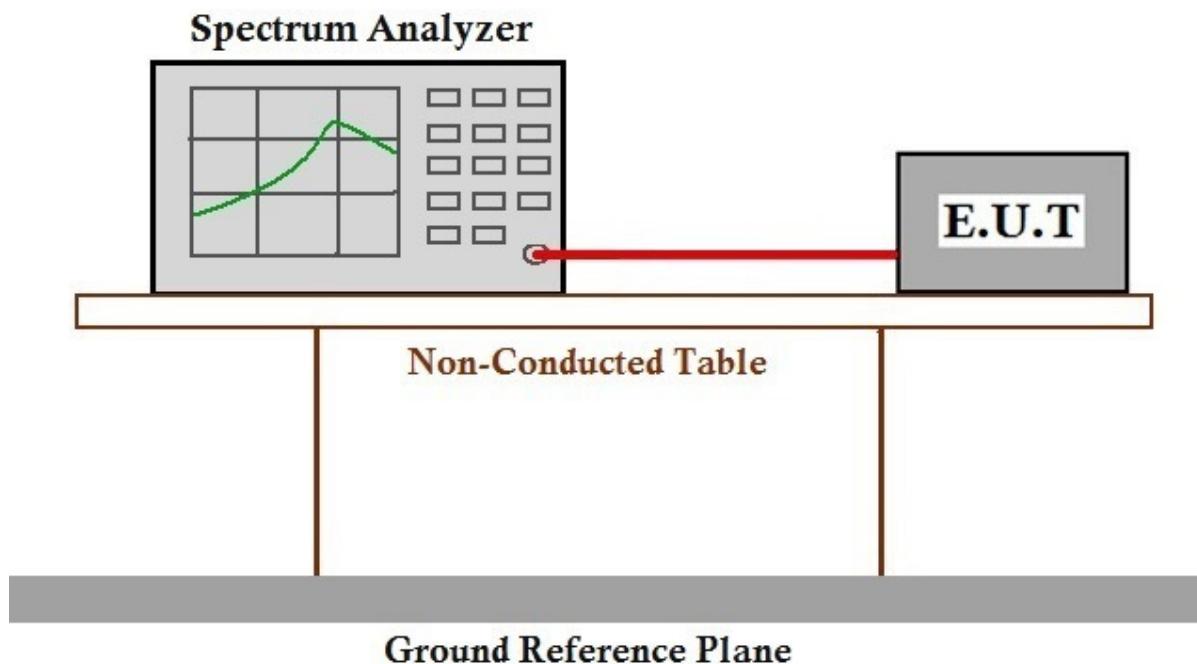
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7.6.1 E.U.T. Operation

Operating Environment:

Temperature: 23 °C Humidity: 56 % RH Atmospheric Pressure: 1015 mbar

Test mode b:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation

The worst case b:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation
for final test:**7.6.2 Test Setup Diagram****7.6.3 Measurement Procedure and Data**

The detailed test data see: Appendix 15.247



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7.7 Radiated Emissions which fall in the restricted bands

Test Requirement 47 CFR Part 15, Subpart C 15.205 & 15.209

Test Method: ANSI C63.10 (2013) Section 6.10.5

Measurement Distance: 3m

Limit:

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

Remark: The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90kHz, 110-490kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

7.7.1 E.U.T. Operation

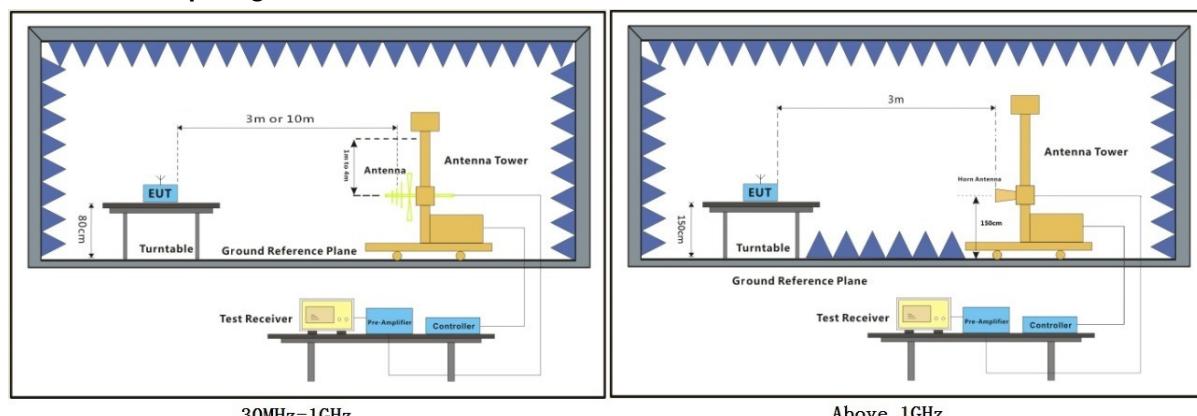
Operating Environment:

Temperature: 23 °C Humidity: 54 % RH Atmospheric Pressure: 1015 mbar

Test mode b:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation

The worst case b:TX mode_Keep the EUT in continuously transmitting mode with GFSK for final test: modulation

7.7.2 Test Setup Diagram



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7.7.3 Measurement Procedure and Data

- a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter fully-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- d. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- e. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- g. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.
- h. Test the EUT in the lowest channel, the middle channel, the Highest channel.
- i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case.
- j. Repeat above procedures until all frequencies measured was complete.

Remark 1: Level= Read Level+ Cable Loss+ Antenna Factor- Preamp Factor

Remark 2: For frequencies above 1GHz, the field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For the emissions whose peak level is lower than the average limit, only the peak measurement is shown in the report.



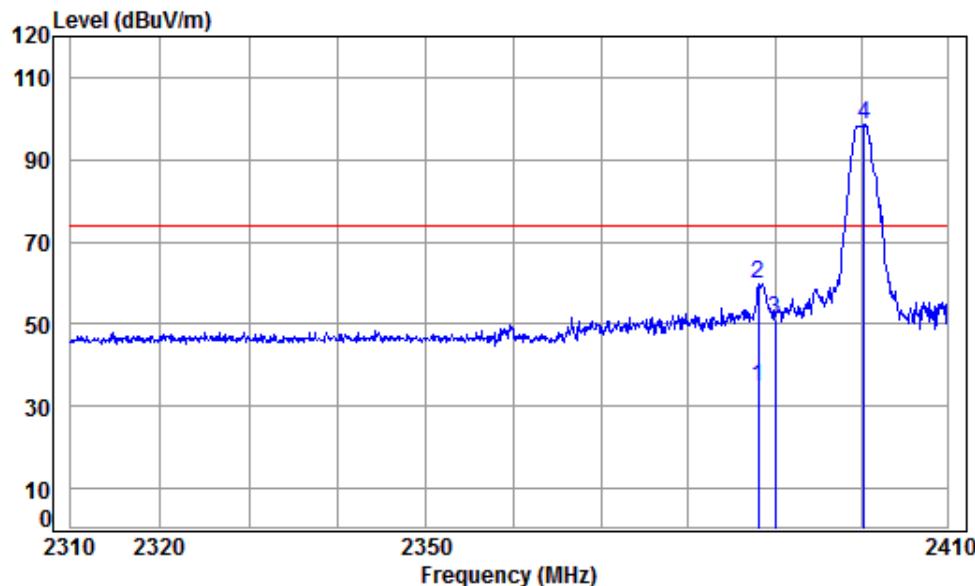
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Mode:b; Polarization:Horizontal; Modulation Type:GFSK; ; Channel:Low



Condition: 3m HORIZONTAL

Job No: : 00967IT

Mode: : 2402 Bandedge
: BLE

Freq	Cable	Ant	Preamp	Read	Limit	Over	Remark
	Loss	Factor	Factor	Level	Level	Line	
MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1 av 2388.141	5.34	29.07	37.96	38.26	34.71	54.00	-19.29 Average
2 2388.141	5.34	29.07	37.96	63.29	59.74	74.00	-14.26 peak
3 2390.000	5.34	29.08	37.96	54.84	51.30	74.00	-22.70 peak
4 pp 2400.317	5.35	29.11	37.96	101.88	98.38	74.00	24.38 peak



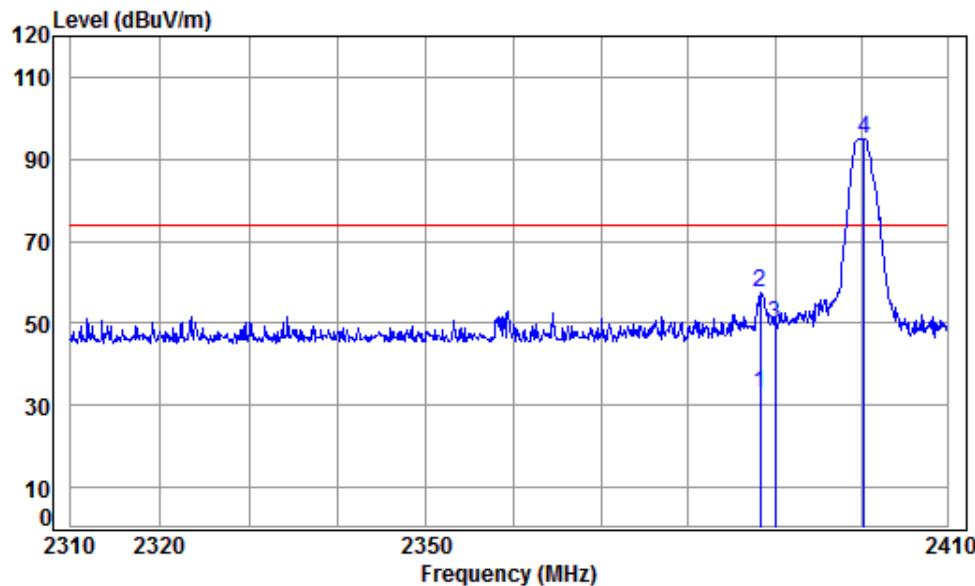
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Mode:b; Polarization:Vertical; Modulation Type:GFSK; ; Channel:Low



Condition: 3m VERTICAL

Job No: : 00967IT

Mode: : 2402 Bandedge
: BLE

Freq	Cable	Ant	Preamp	Read	Limit	Over	Remark
	Loss	Factor	Factor	Level			
MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1 av 2388.343	5.34	29.07	37.96	36.29	32.74	54.00	-21.26 Average
2 2388.343	5.34	29.07	37.96	60.91	57.36	74.00	-16.64 peak
3 2390.000	5.34	29.08	37.96	53.32	49.78	74.00	-24.22 peak
4 pp 2400.317	5.35	29.11	37.96	98.38	94.88	74.00	20.88 peak

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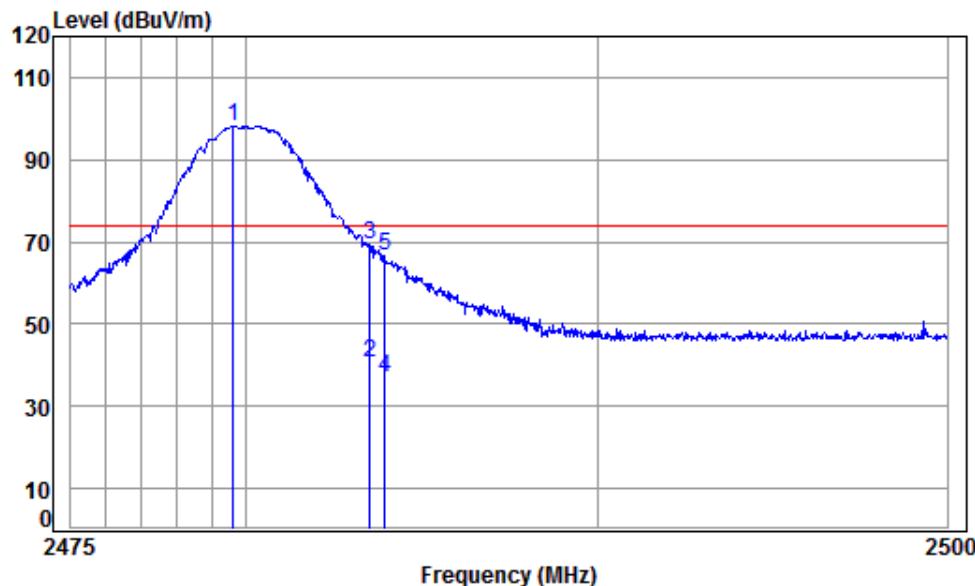
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Mode:b; Polarization:Horizontal; Modulation Type:GFSK; ; Channel:High



Condition: 3m HORIZONTAL

Job No: : 00967IT

Mode: : 2480 Bandedge
: BLE

Freq	Cable	Ant	Preamp	Read	Limit	Over	Remark	
	MHz	Loss	Factor	Factor	Level	Level	Line	
	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1 pp	2479.631	5.40	29.34	37.95	101.21	98.00	74.00	24.00 peak
2 av	2483.500	5.41	29.35	37.95	43.65	40.46	54.00	-13.54 Average
3	2483.500	5.41	29.35	37.95	72.53	69.34	74.00	-4.66 peak
4	2483.921	5.41	29.35	37.95	40.25	37.06	54.00	-16.94 Average
5	2483.921	5.41	29.35	37.95	69.63	66.44	74.00	-7.56 peak

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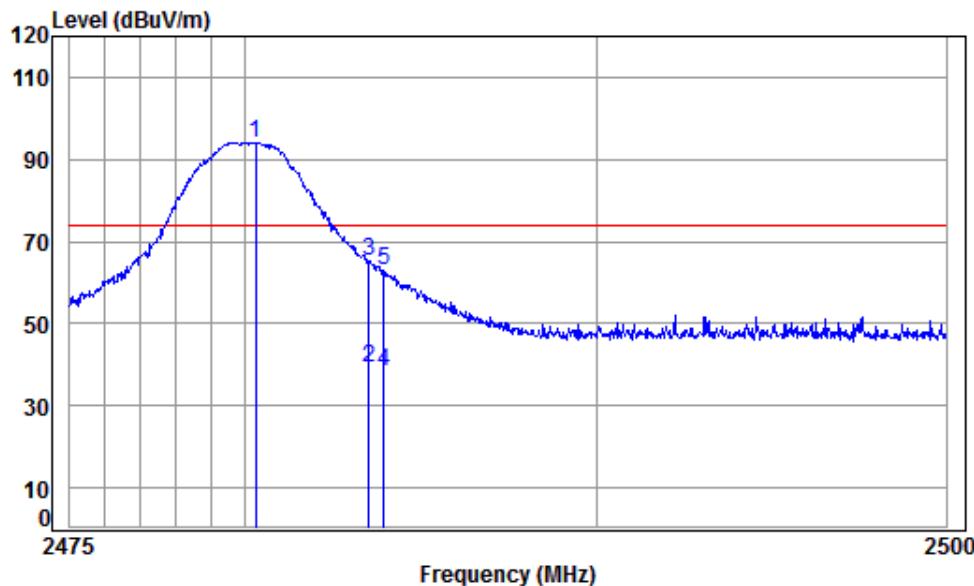
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Mode:b; Polarization:Vertical; Modulation Type:GFSK; ; Channel:High



Condition: 3m VERTICAL

Job No: : 00967IT

Mode: : 2480 Bandedge
: BLE

Freq	Cable	Ant	Preamp	Read	Limit	Over	Remark	
	MHz	Loss	Factor	Factor	Level	Level	Line	
	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1 pp	2480.279	5.41	29.34	37.95	97.17	93.97	74.00	19.97 peak
2 av	2483.500	5.41	29.35	37.95	42.65	39.46	54.00	-14.54 Average
3	2483.500	5.41	29.35	37.95	68.64	65.45	74.00	-8.55 peak
4	2483.946	5.41	29.35	37.95	41.62	38.43	54.00	-15.57 Average
5	2483.946	5.41	29.35	37.95	66.11	62.92	74.00	-11.08 peak

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7.8 Radiated Spurious Emissions

Test Requirement 47 CFR Part 15, Subpart C 15.205 & 15.209

Test Method: ANSI C63.10 (2013) Section 6.4,6.5,6.6

Measurement Distance: 3m

Limit:

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

Remark: The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90kHz, 110-490kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.



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7.8.1 E.U.T. Operation

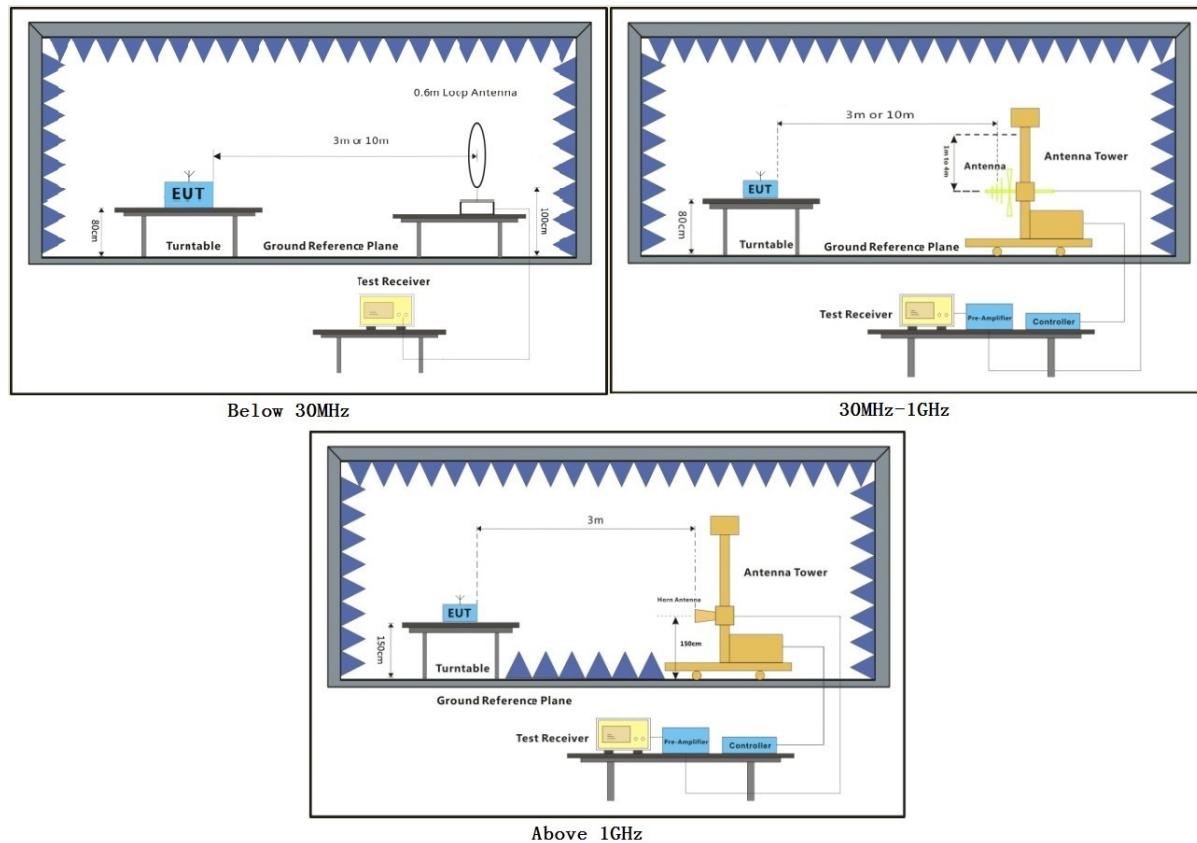
Operating Environment:

Temperature: 25 °C Humidity: 55 % RH Atmospheric Pressure: 1015 mbar

Test mode b:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation

The worst case for final test: b:TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation

7.8.2 Test Setup Diagram



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7.8.3 Measurement Procedure and Data

- a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter fully-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- d. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- e. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- g. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.
- h. Test the EUT in the lowest channel, the middle channel, the Highest channel.
- i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case.
- j. Repeat above procedures until all frequencies measured was complete.

Remark:

- 1) For emission below 1GHz, through pre-scan found the worst case is the lowest channel. Only the worst case is recorded in the report.
- 2) The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:
Final Test Level = Receiver Reading + Antenna Factor + Cable Factor – Preamplifier Factor
- 3) Scan from 9kHz to 25GHz, the disturbance above 18GHz and below 30MHz was very low. The points marked on above plots are the highest emissions could be found when testing, so only above points had been displayed. The amplitude of spurious emissions from the radiator which are attenuated more than 20dB below the limit need not be reported.
- 4) For frequencies above 1GHz, the field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For the emissions whose peak level is lower than the average limit, only the peak measurement is shown in the report.



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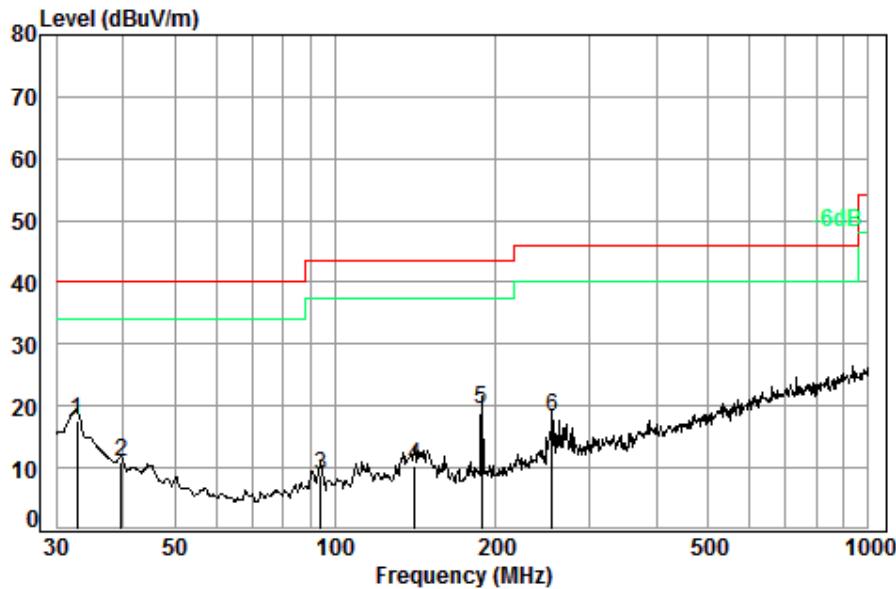
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30MHz~1GHz

QP value:

Mode: b; Polarization: Horizontal



Condition: 3m HORIZONTAL

Job No. : 00968IT

Test mode: b

Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level		Limit Line	Over Line		
				MHz	dB	dB/m	dB	dBuV	dBuV/m
1 pp	32.86	0.60	17.10	27.35	27.31	17.66	40.00	40.00	-22.34
2	39.71	0.60	13.26	27.32	24.38	10.92	40.00	40.00	-29.08
3	94.10	1.14	8.86	27.21	26.04	8.83	43.50	43.50	-34.67
4	141.33	1.30	8.22	26.95	27.68	10.25	43.50	43.50	-33.25
5	188.41	1.38	10.07	26.74	34.75	19.46	43.50	43.50	-24.04
6	255.62	1.70	12.41	26.52	30.52	18.11	46.00	46.00	-27.89

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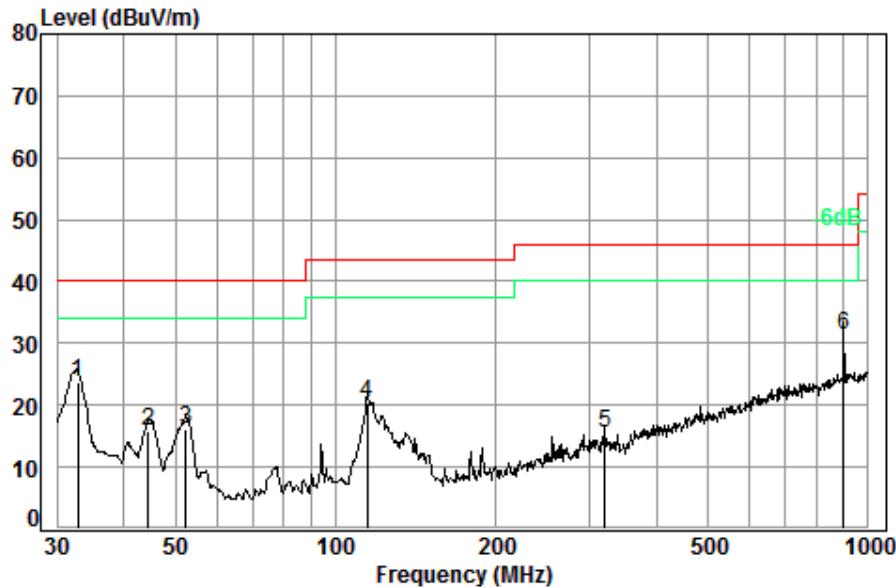
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Mode: b; Polarization: Vertical



Condition: 3m VERTICAL

Job No. : 00968IT

Test mode: b

	Cable Freq	Ant Loss	Preamp Factor	Read Level	Limit Level	Limit Line	Over Limit
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dB
1	32.86	0.60	17.10	27.35	33.47	23.82	40.00 -16.18
2	44.59	0.70	11.08	27.31	31.34	15.81	40.00 -24.19
3	52.39	0.80	8.34	27.28	34.31	16.17	40.00 -23.83
4	114.51	1.24	8.28	27.10	37.87	20.29	43.50 -23.21
5	319.94	1.97	14.62	26.56	25.57	15.60	46.00 -30.40
6 pp	900.15	3.60	23.20	26.78	31.37	31.39	46.00 -14.61

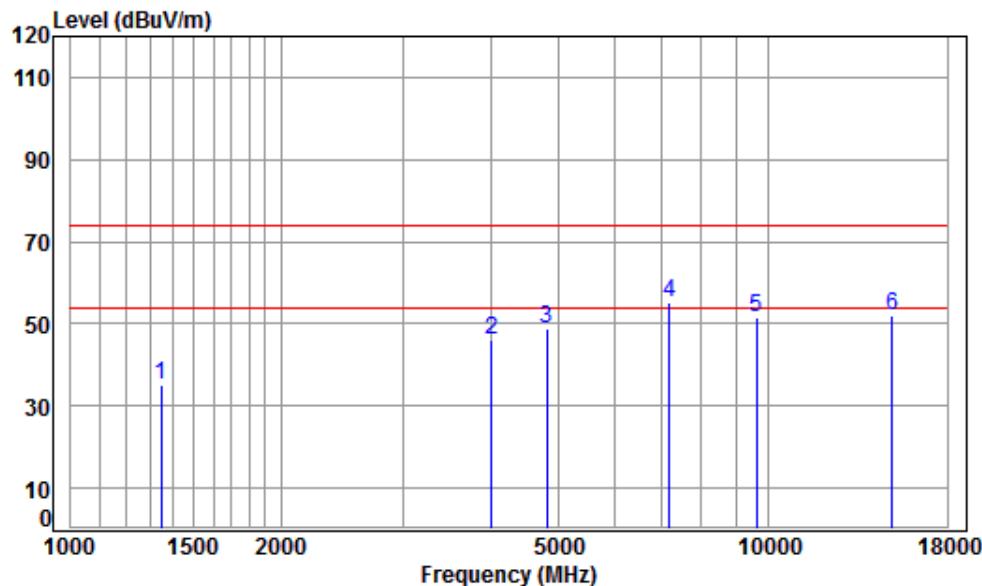


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Above 1GHz

Mode:b; Polarization:Horizontal; Modulation Type:GFSK; ; Channel:Low



Condition: 3m HORIZONTAL

Job No: : 00967IT

Mode: : 2402 TX RSE
: BLE

Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Limit		Over Line	Over Limit	Remark
					MHz	dB	dB/m	dB	dBuV
1	1346.769	4.28	25.16	38.07	43.98	35.35	74.00	-38.65	peak
2	4004.339	6.71	33.60	38.00	43.58	45.89	74.00	-28.11	peak
3	4804.000	7.73	34.16	38.40	45.39	48.88	74.00	-25.12	peak
4 pp	7206.000	9.65	36.42	37.11	46.42	55.38	74.00	-18.62	peak
5	9608.000	11.06	37.52	35.10	37.92	51.40	74.00	-22.60	peak
6	15003.420	14.85	41.30	38.90	34.93	52.18	74.00	-21.82	peak

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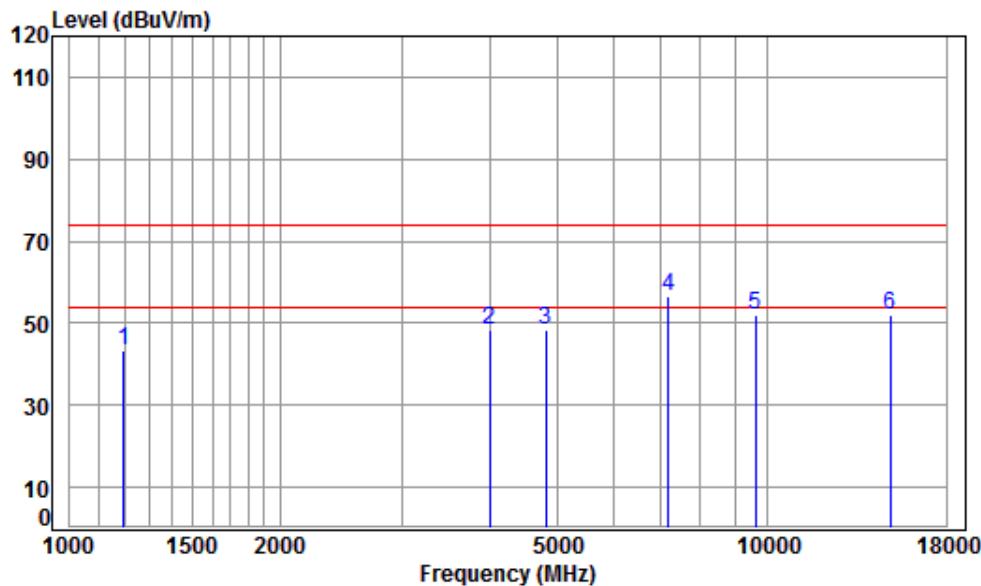
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Mode:b; Polarization:Vertical; Modulation Type:GFSK; ; Channel:Low



Condition: 3m VERTICAL

Job No: : 00967IT

Mode: : 2402 TX RSE
: BLE

	Freq	Cable	Ant	Preamp	Read	Limit	Over	Remark
		Loss	Factor	Factor	Level	Level	Line	
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1	1196.264	4.07	24.46	38.08	53.10	43.55	74.00	-30.45 peak
2	3992.781	6.69	33.58	38.00	45.95	48.22	74.00	-25.78 peak
3	4804.000	7.73	34.16	38.40	44.67	48.16	74.00	-25.84 peak
4	7206.000	9.65	36.42	37.11	47.70	56.66	74.00	-17.34 peak
5	9608.000	11.06	37.52	35.10	38.42	51.90	74.00	-22.10 peak
6	14960.120	14.84	41.23	38.90	35.02	52.19	74.00	-21.81 peak

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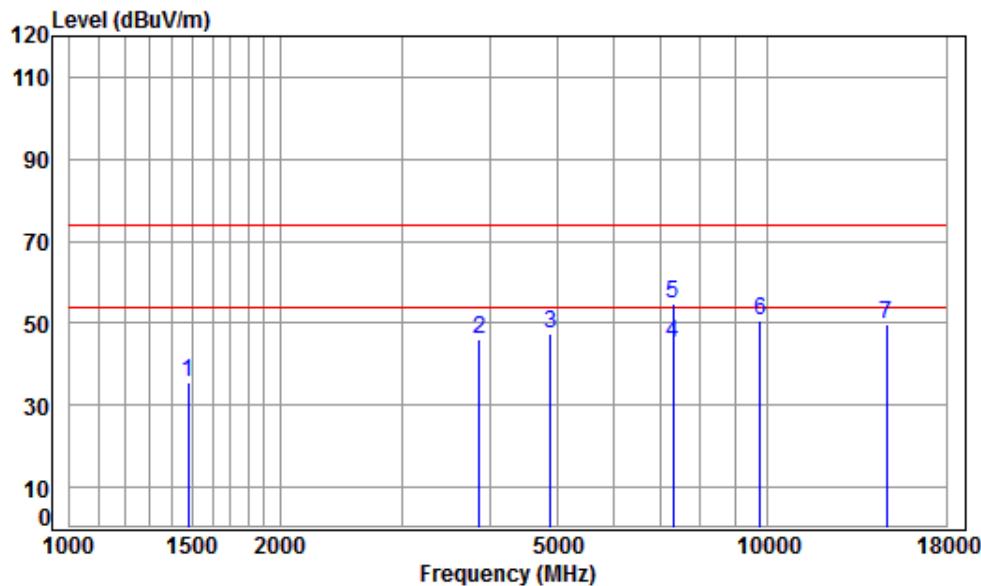
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Mode:b; Polarization:Horizontal; Modulation Type:GFSK; ; Channel:middle



Condition: 3m HORIZONTAL

Job No: : 00967IT

Mode: : 2440 TX RSE
: BLE

Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Limit Level	Line Limit	Over Limit Remark	
							dBuV/m	dB
1 1477.276	4.44	25.71	38.05	43.30	35.40	74.00	-38.60	peak
2 3856.668	6.59	33.22	37.99	44.07	45.89	74.00	-28.11	peak
3 4880.000	7.83	34.29	38.44	43.83	47.51	74.00	-26.49	peak
4 pp 7320.000	9.73	36.37	37.01	35.98	45.07	54.00	-8.93	Average
5 pk 7320.000	9.73	36.37	37.01	45.56	54.65	74.00	-19.35	peak
6 9760.000	11.21	37.55	35.02	36.96	50.70	74.00	-23.30	peak
7 14788.150	14.80	40.92	38.92	33.14	49.94	74.00	-24.06	peak

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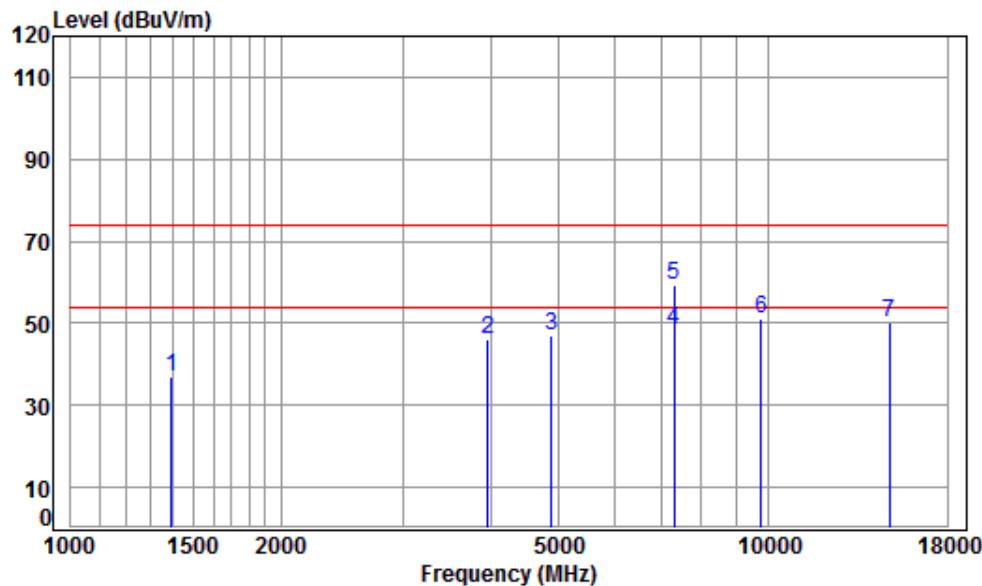
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Mode:b; Polarization:Vertical; Modulation Type:GFSK; ; Channel:middle



Condition: 3m VERTICAL

Job No: : 00967IT

Mode: : 2440 TX RSE
: BLE

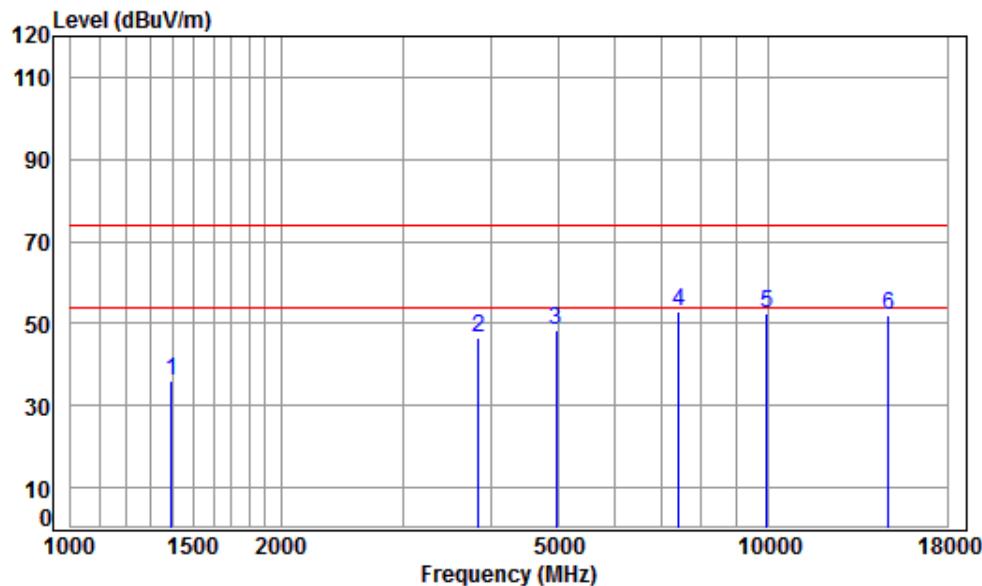
Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Limit Level	Line Limit	Over	
							dB	Remark
MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1 1394.300	4.34	25.37	38.06	45.51	37.16	74.00	-36.84	peak
2 3958.309	6.67	33.49	38.00	44.01	46.17	74.00	-27.83	peak
3 4880.000	7.83	34.29	38.44	43.29	46.97	74.00	-27.03	peak
4 pp 7320.000	9.73	36.37	37.01	39.26	48.35	54.00	-5.65	Average
5 pk 7320.000	9.73	36.37	37.01	50.45	59.54	74.00	-14.46	peak
6 9760.000	11.21	37.55	35.02	37.29	51.03	74.00	-22.97	peak
7 14873.890	14.82	41.08	38.91	33.03	50.02	74.00	-23.98	peak

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Mode:b; Polarization:Horizontal; Modulation Type:GFSK; ; Channel:High



Condition: 3m HORIZONTAL

Job No: : 00967IT

Mode: : 2480 TX RSE
: BLE

Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Limit		Over Line	Over Limit	Remark
					dB	dB/m			
1 1394.300	4.34	25.37	38.06	44.40	36.05	74.00	-37.95	peak	
2 3834.438	6.57	33.16	37.98	44.57	46.32	74.00	-27.68	peak	
3 4960.000	7.95	34.43	38.48	44.44	48.34	74.00	-25.66	peak	
4 pp 7440.000	9.81	36.32	36.90	43.62	52.85	74.00	-21.15	peak	
5 9920.000	11.36	37.58	34.94	38.36	52.36	74.00	-21.64	peak	
6 14830.960	14.81	41.00	38.92	35.15	52.04	74.00	-21.96	peak	

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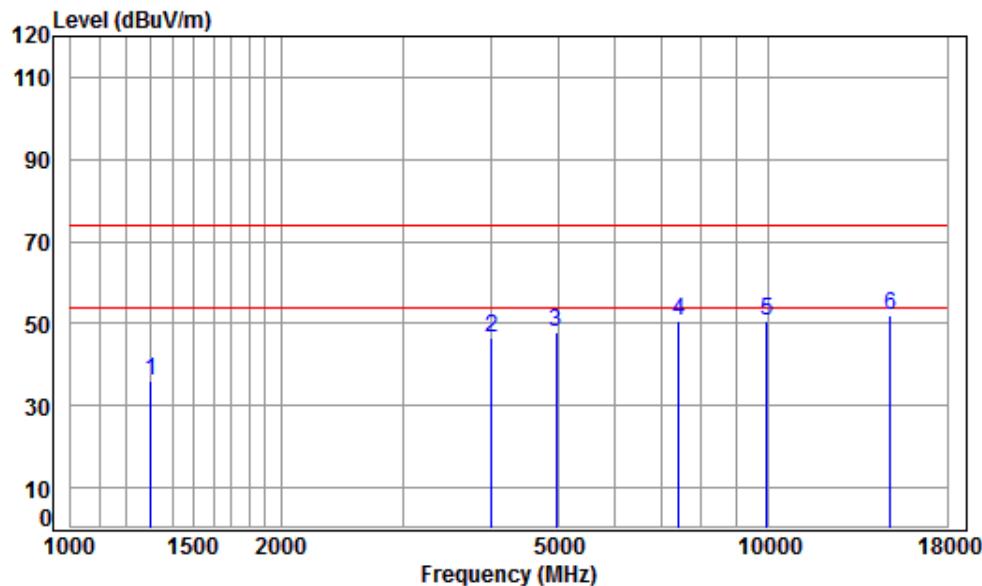
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Mode:b; Polarization:Vertical; Modulation Type:GFSK; ; Channel:High



Condition: 3m VERTICAL

Job No: : 00967IT

Mode: : 2480 TX RSE
: BLE

Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Limit		Over Line	Over Limit	Remark
					dB	dB/m	dB	dBuV	dBuV/m
1 1304.623	4.23	24.97	38.07	44.90	36.03	74.00	74.00	-37.97	peak
2 4004.339	6.71	33.60	38.00	44.13	46.44	74.00	74.00	-27.56	peak
3 4960.000	7.95	34.43	38.48	43.78	47.68	74.00	74.00	-26.32	peak
4 7440.000	9.81	36.32	36.90	41.54	50.77	74.00	74.00	-23.23	peak
5 9920.000	11.36	37.58	34.94	36.45	50.45	74.00	74.00	-23.55	peak
6 pp14916.940	14.83	41.15	38.91	35.11	52.18	74.00	74.00	-21.82	peak

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8 Photographs

8.1 Test Setup

Refer to Setup Photos

8.2 EUT Constructional Details (EUT Photos)

Refer to EUT external and internal photos



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9 Appendix

9.1 Appendix 15.247

1.6dB Bandwidth

Test Mode	Test Channel	EBW[MHz]	Limit	Verdict
BLE	2402	0.762	>=0.5	PASS
BLE	2440	0.795	>=0.5	PASS
BLE	2480	0.768	>=0.5	PASS

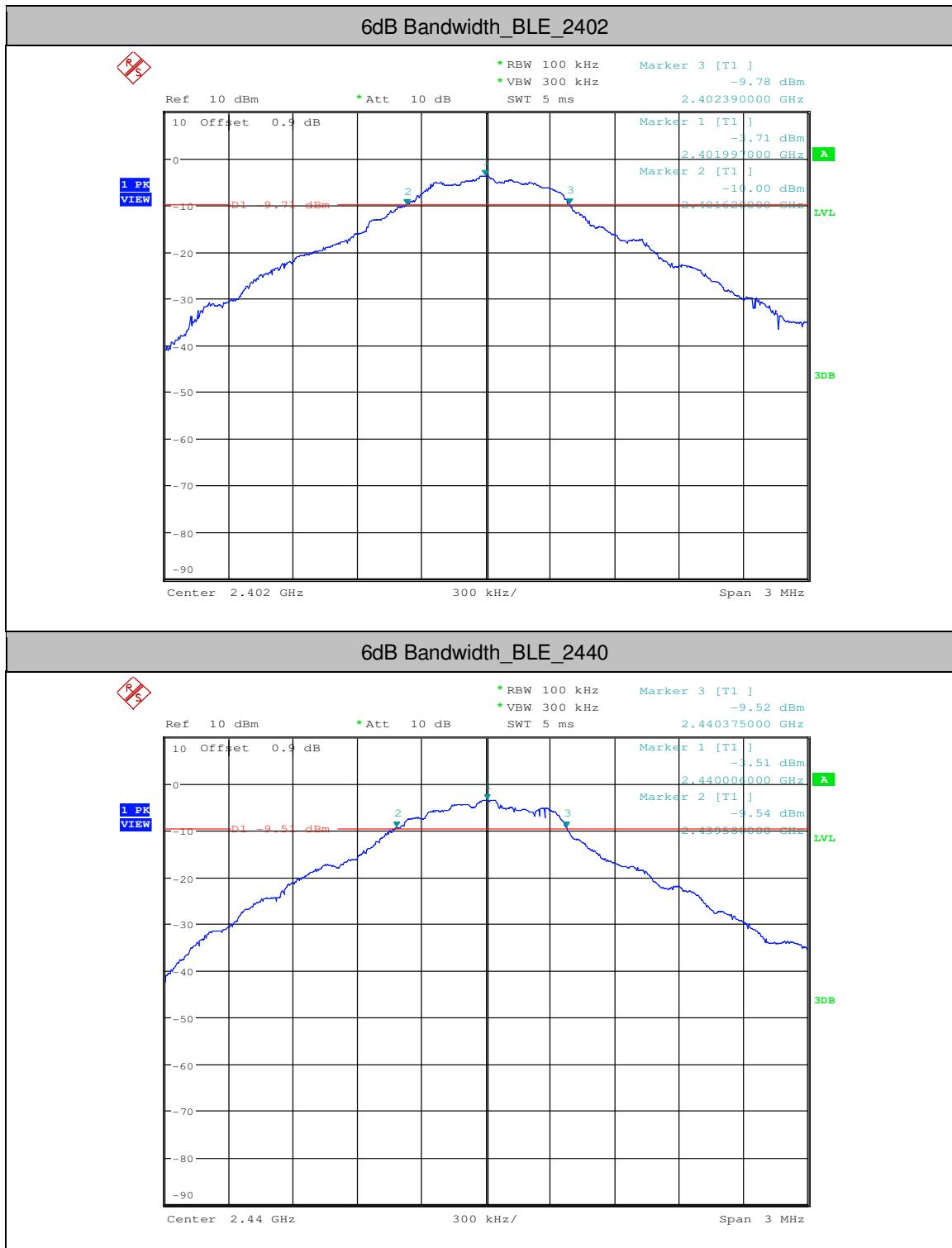


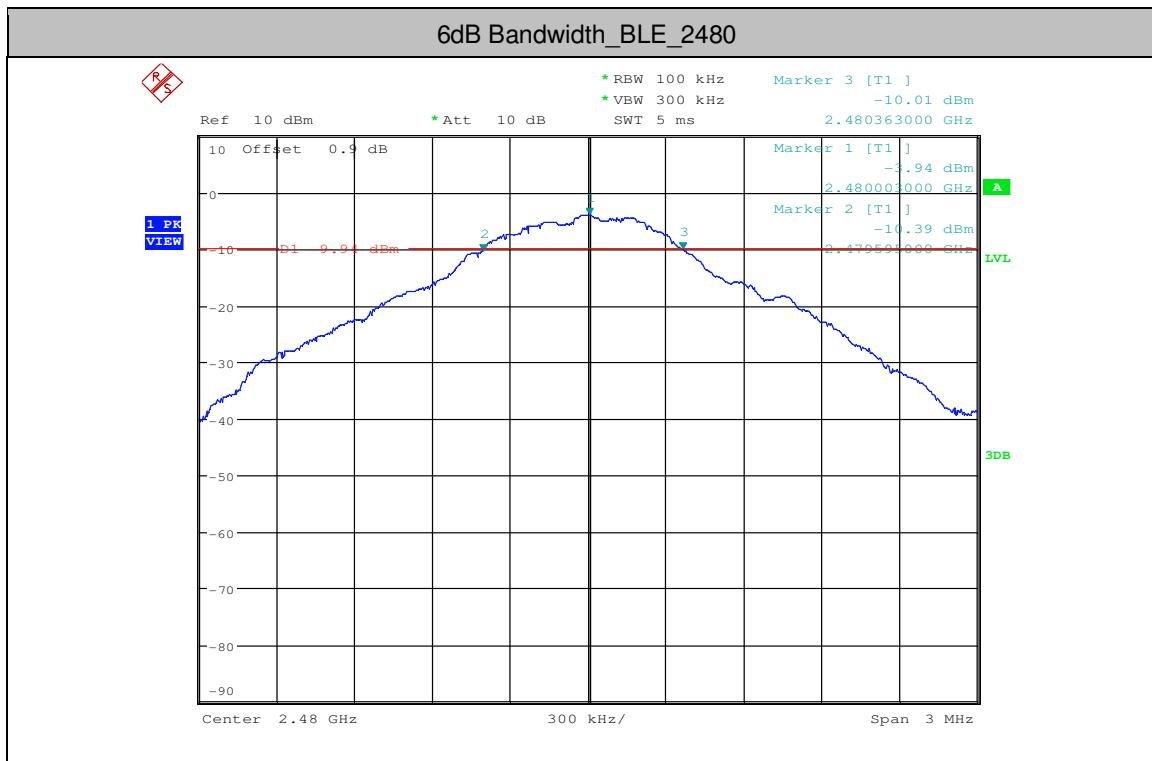
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2. Maximum peak conducted output power

Test Mode	Test Channel	Power[dBm]	Limit[dBm]	Verdict
BLE	2402	-3.73	<30	PASS
BLE	2440	-3.49	<30	PASS
BLE	2480	-3.92	<30	PASS

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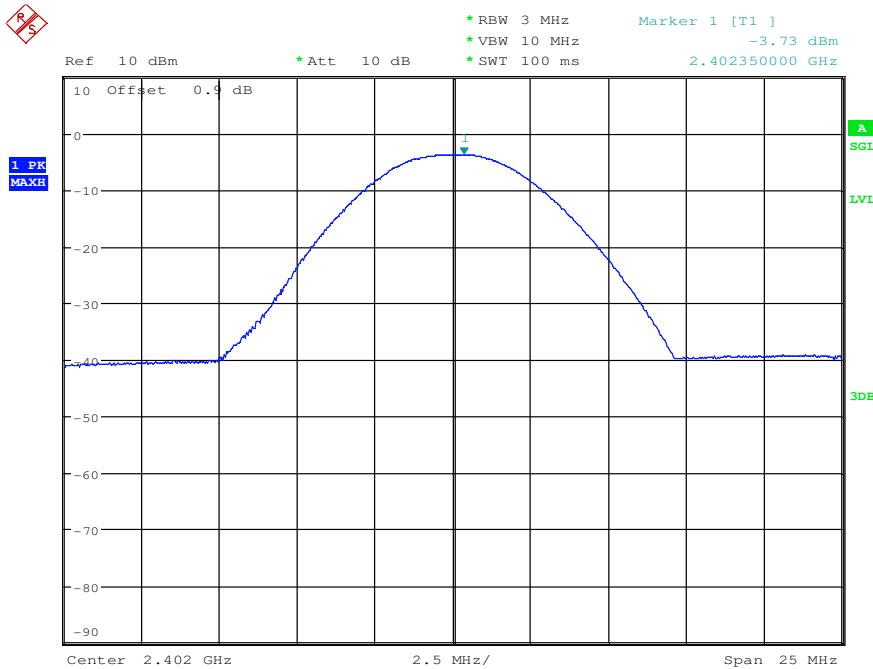
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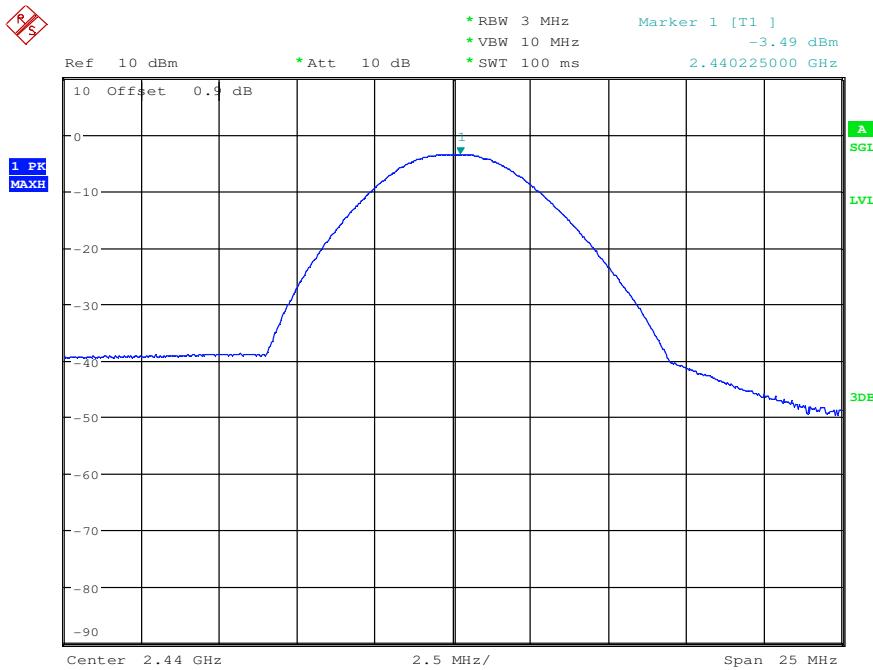
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Maximum peak conducted output power_BLE_2402



Maximum peak conducted output power_BLE_2440



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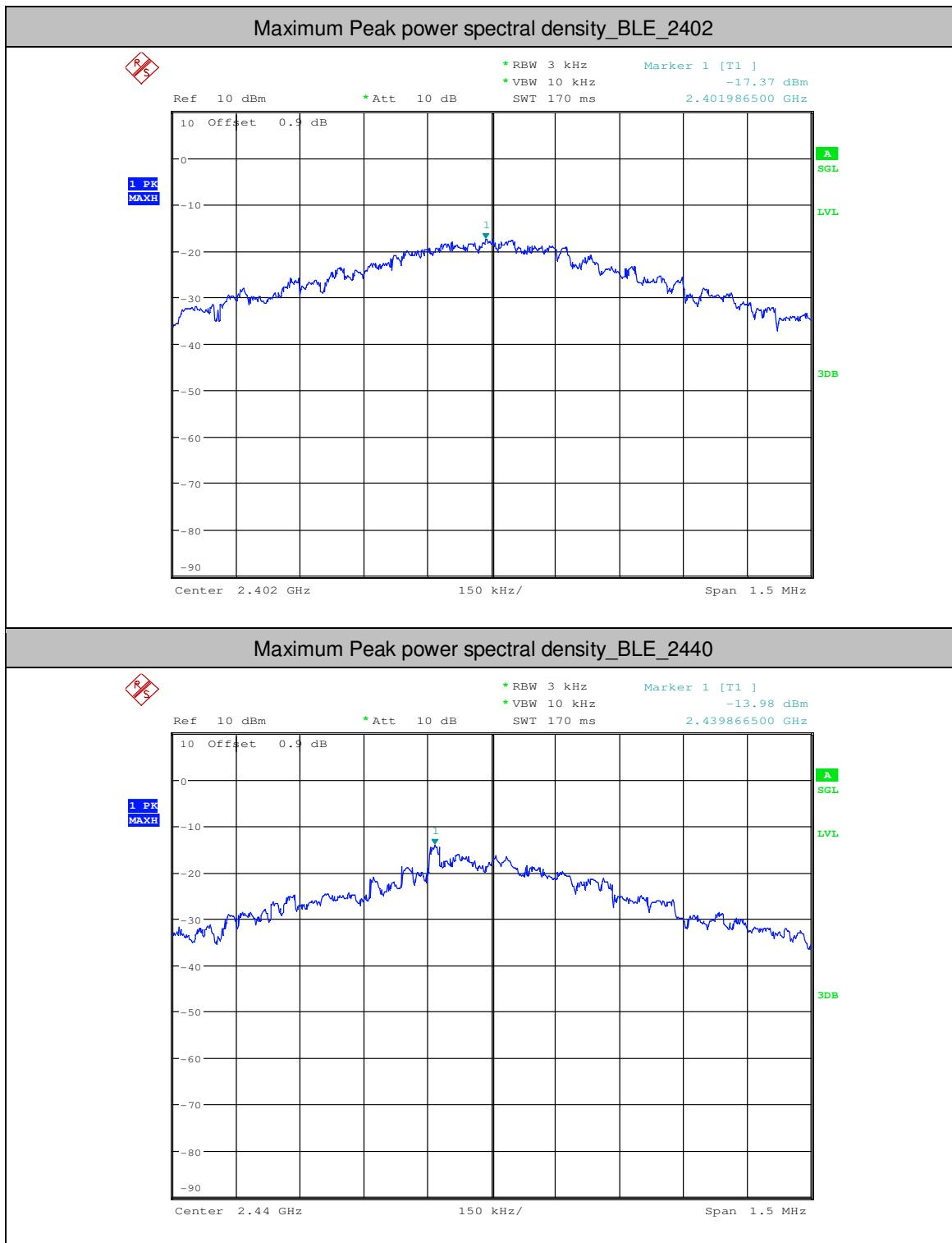
3. Maximum Peak power spectral density

Test Mode	Test Channel	PSD[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
BLE	2402	-17.37	<8.00	PASS
BLE	2440	-13.98	<8.00	PASS
BLE	2480	-16.28	<8.00	PASS

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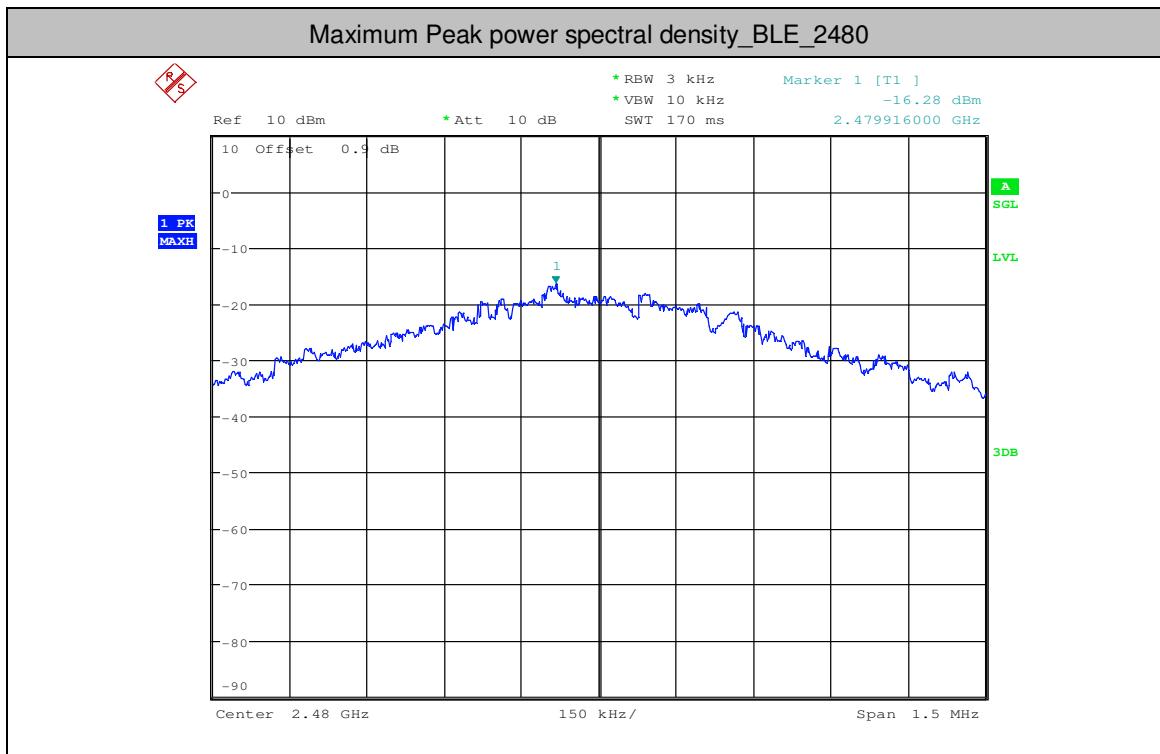
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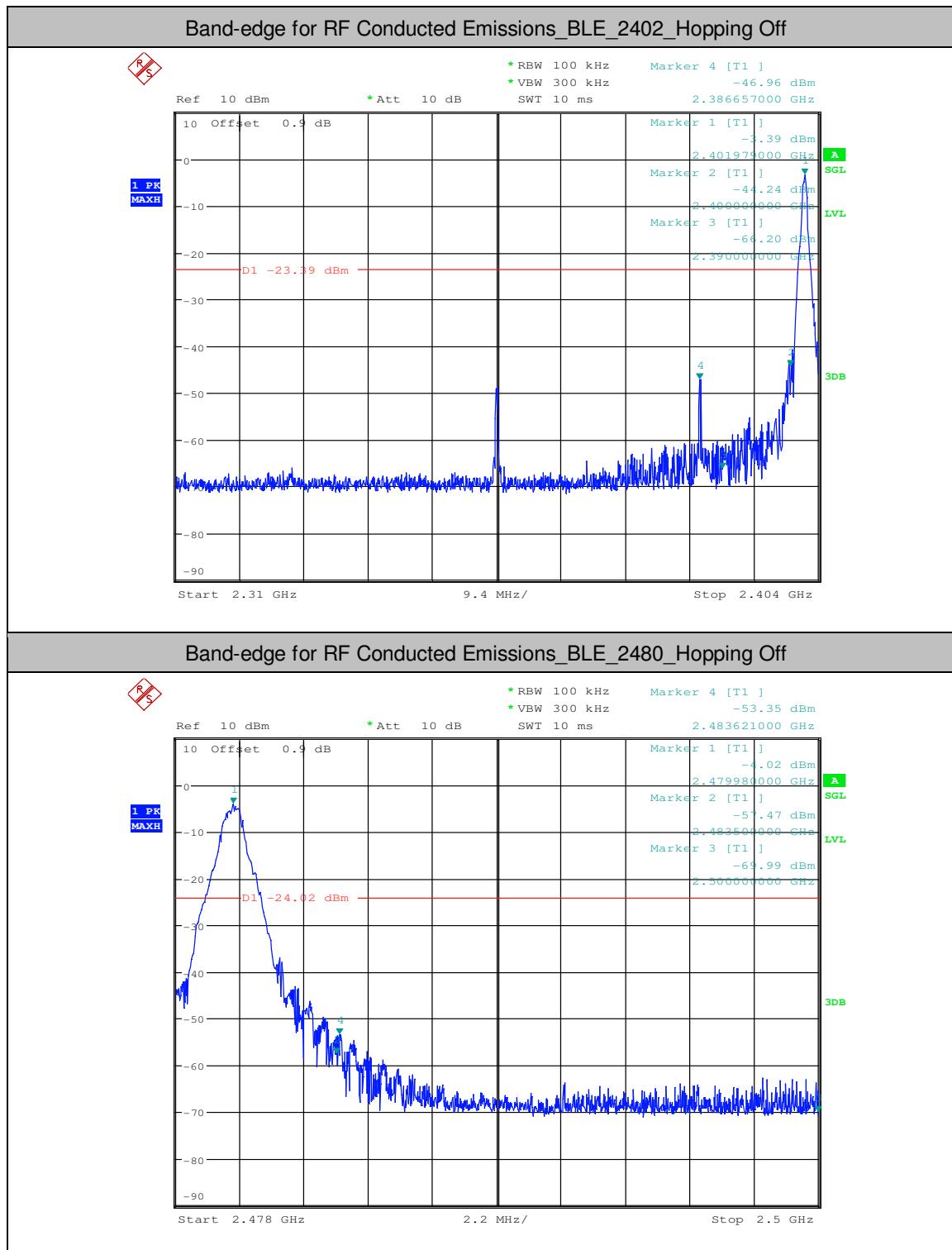
4. Band-edge for RF Conducted Emissions

Test Mode	Test Channel	Carrier Power[dBm]	Max. Spurious Level [dBm]	Limit [dBm]	Verdict
BLE	2402	-3.390	-46.956	<-23.39	PASS
BLE	2480	-4.020	-53.346	<-24.02	PASS



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5.RF Conducted Spurious Emissions

Test Mode	Test Channel	StartFre [MHz]	StopFre [MHz]	RBW [kHz]	VBW [kHz]	Pref[dBm]	Max. Level [dBm]	Limit [dBm]	Verdict
BLE	2402	30	10000	1000	3000	-3.51	-40.820	<-23.51	PASS
BLE	2402	10000	25000	1000	3000	-3.51	-65.140	<-23.51	PASS
BLE	2440	30	10000	1000	3000	-3.83	-38.390	<-23.83	PASS
BLE	2440	10000	25000	1000	3000	-3.83	-63.950	<-23.83	PASS
BLE	2480	30	10000	1000	3000	-3.85	-36.110	<-23.85	PASS
BLE	2480	10000	25000	1000	3000	-3.85	-64.690	<-23.85	PASS

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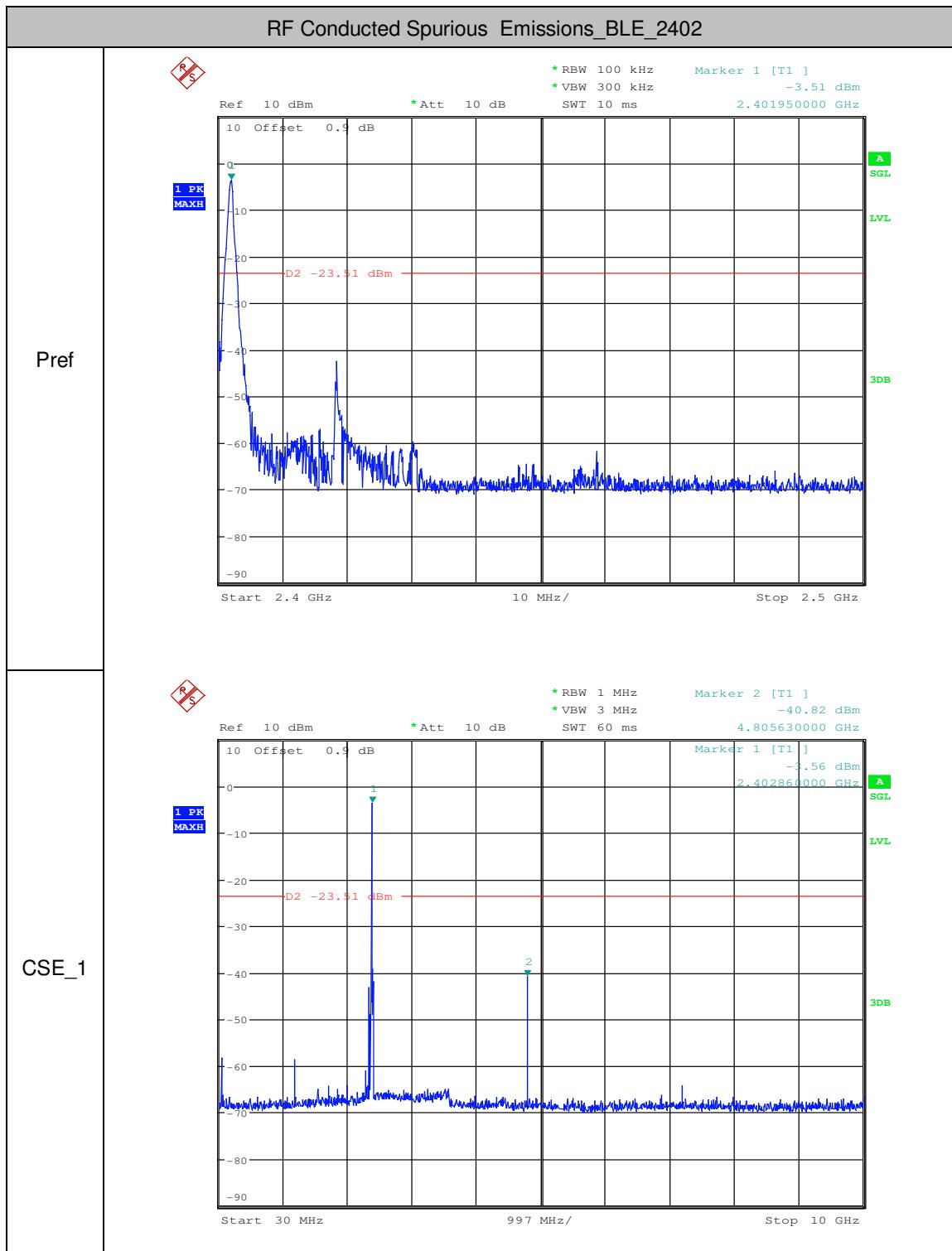
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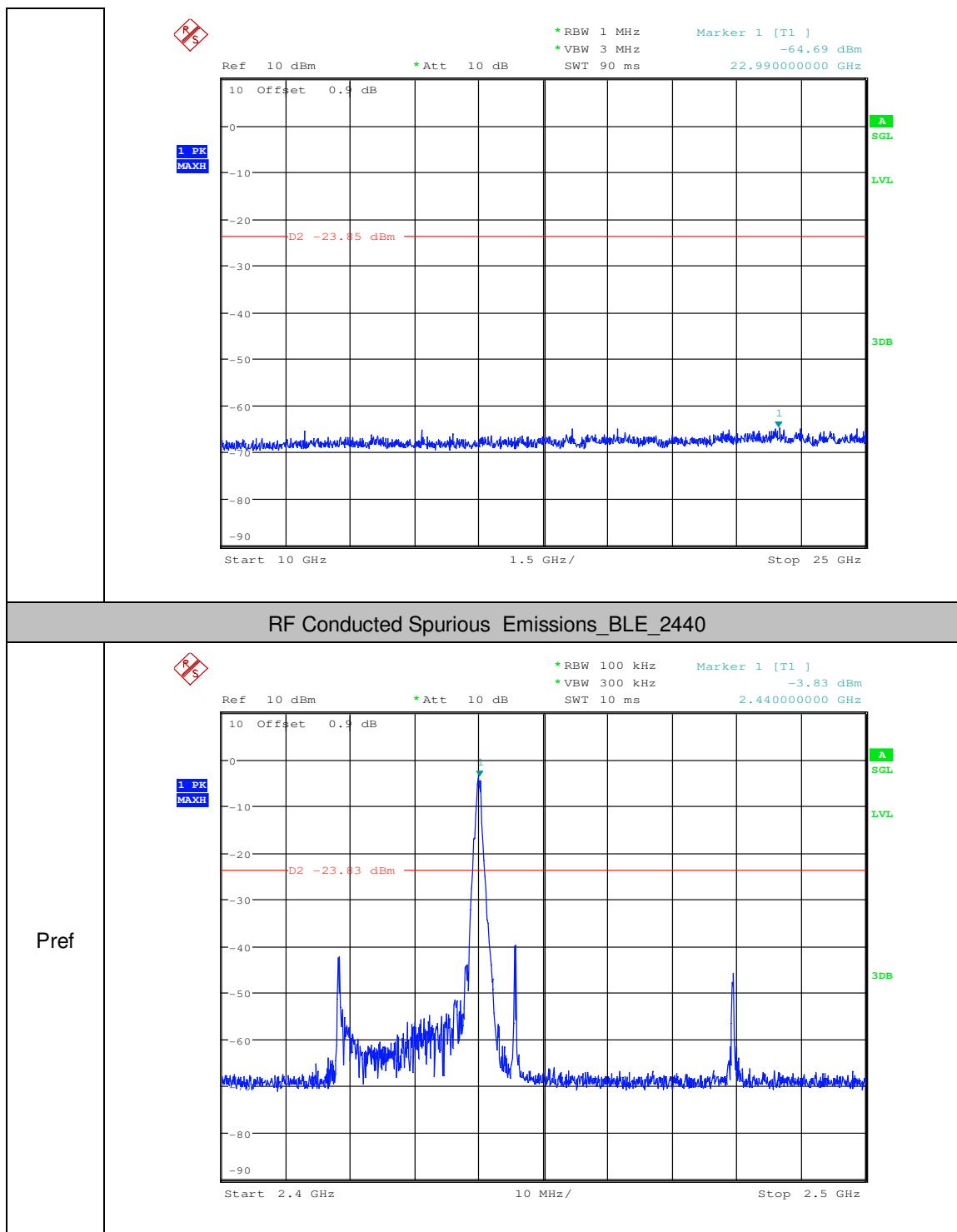
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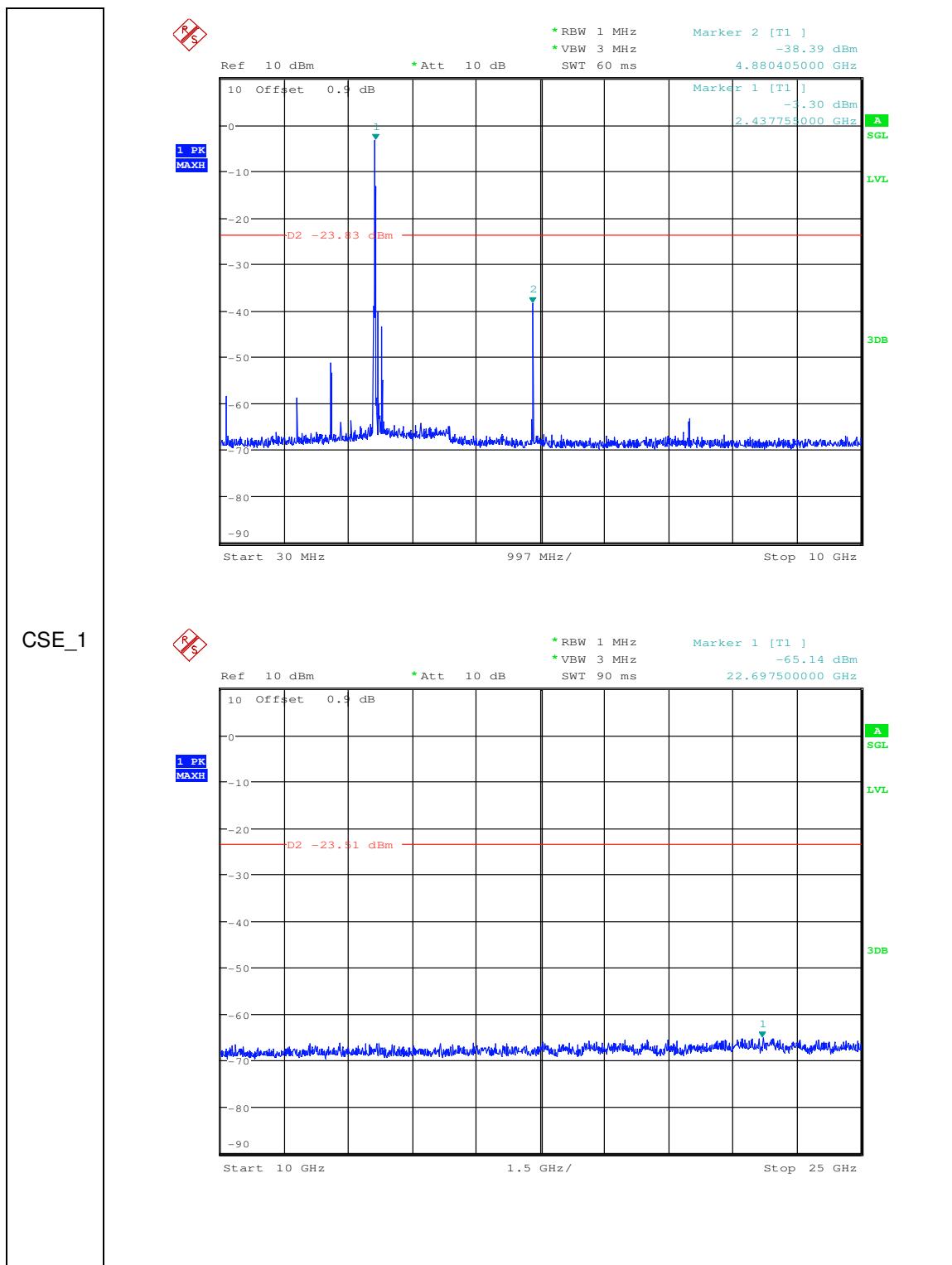




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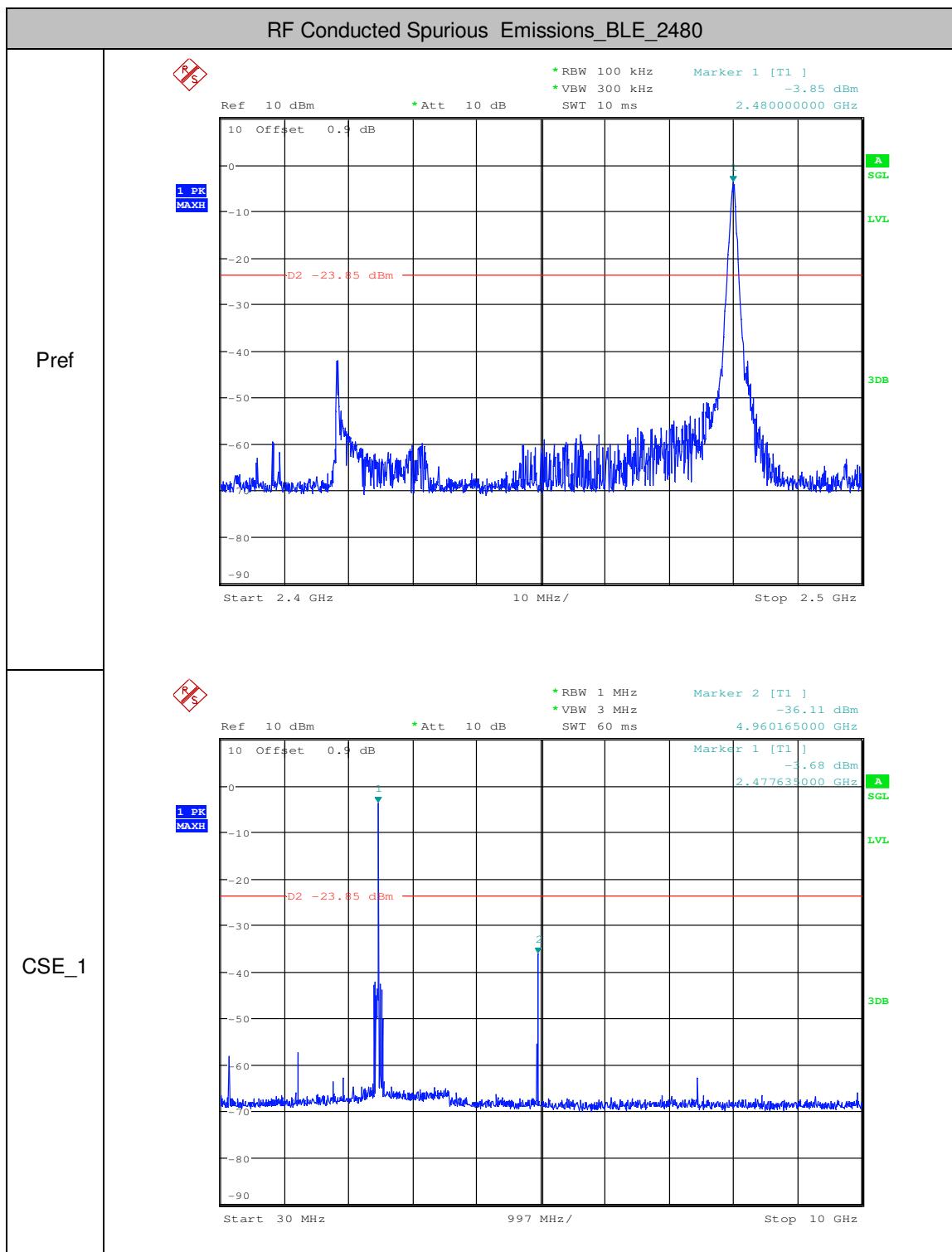
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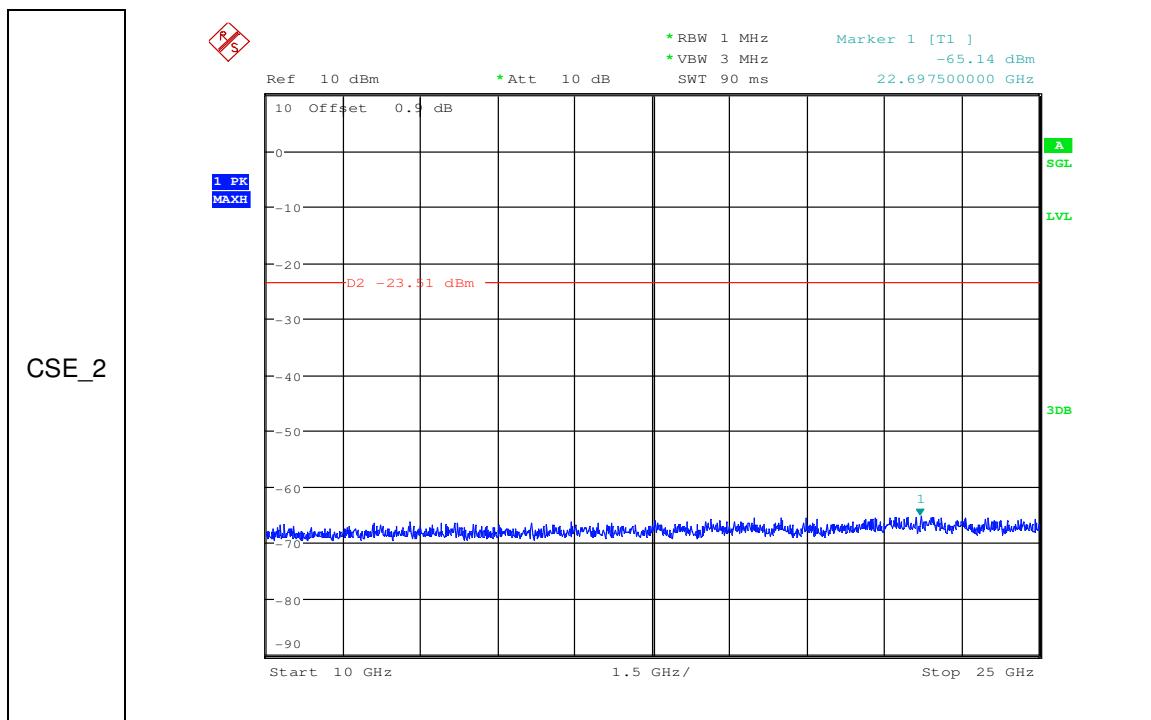
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