FCC ID: 2AO93-NM0824-I

FCC Test Report (Part 15 Subpart C)

Client Information:

Applicant: System Level Solutions (India) Pvt. Ltd.

Applicant add.: Plot no. 32, Zone-D4, Phase 1 GIDC Estate, V.U. Nagar, Anand – 388121, Gujarat, India

Manufacturer: System Level Solutions (India) Pvt. Ltd.

Manufacturer add.: Plot no. 32, Zone-D4, Phase 1 GIDC Estate, V.U. Nagar, Anand – 388121, Gujarat, India

Product Information:

Product Name: mPCIe LoRa Concentrator Board

Model No.: NM0824-I

Derivative model No.: N/A

Brand Name: **SLS**

Applied Standard:

FCC Part 15 Subpart C 15.247

Laboratory Details:

AA Electro Magnetic Test Laboratory Private Limited

PlotNo174, Udyog Vihar-Phase4, Sector18, Gurgaon, Haryana, India

Date of Receipt: Aug. 17, 2022

Date of Test: Aug. 17, 2022 ~ Oct. 31, 2022

Date of Issue: Nov. 25, 2022

Test Result: **In Compliance/Pass**

This device has been tested and found to comply with the stated standard(s), which is (are) required by the council directive of 2014/53/EU and indicated in the test report and are applicable only to the tested sample identified in the report.Note: This report shall not be reproduced except in full, without the written approval of AA Electro Magnetic Test Laboratory Private Limited, this document may be altered or revised by AA Electro Magnetic Test Laboratory Private Limited, personal only, and shall be noted in the revision of the document. This test report must not be used by the client to claim product endorsement.

Prepared By (+ signature) Ankur Kumar: _____

Reviewed & Approved by: (+ signature) _____

Dr. Lenin Raja (Authorized Representative)

(/ lenin83/)

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Contact: 0124-4235350, 4145343; e-mail: info @aaemtlabs.com; Website: www.aaemtlabs.com

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2 Test Summary

2.1 Compliance with FCC Part 15 subpart C

Test	Test Requirement	Standard Paragraph	Result
Antenna Requirement	FCC Part 15 C:2013	Section 15.247(c)	**PASS**
Conduction Emissions	FCC Part 15 C:2013	Section 15.207(a)	**PASS**
Radiated Emissions	FCC Part 15 C:2013	Section 15.247(d)	**PASS**
Carrier Frequencies Separated	FCC Part 15 C:2013	Section 15.247(a)(1)	**PASS**
Hopping Channel Number	FCC Part 15 C:2013	Section 15.247(a)(1) (iii)	**PASS**
Dwell Time	FCC Part 15 C:2013	Section 15.247(a)(1) (iii)	**PASS**
Maximum Peak Output Power	FCC Part 15 C:2013	Section 15.247(b)	**PASS**
Occupied bandwidth and 20dB Bandwidth	FCC Part 15 C:2013	15.247 (a) (i)	**PASS**
Band edge	FCC Part 15 C:2013	Section 15.247(d)	**PASS**
Conducted Spurious Emissions	FCC Part 15 C:2013	Section 15.247(d)	**PASS**
Note: N/A is an abbreviation for Not Applicable. **Model description: N/A**			
(1)	Reference to ANSI C63.10:2013.		

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2.2 Test Location

All tests were performed at:

AA Electro Magnetic Test Laboratory Private Limited

Plot No 174, Udyog Vihar - Phase 4, Sector 18, Gurgaon, Haryana, India

Tel.: +91-0124-4235350

2.3 Measurement Uncertainty

All measurements involve certain levels of uncertainties, The following measurements uncertainty Levels have estimated based on ANSI C63.4:2013, the maximum value of the uncertainty as below

No.	Item	Uncertainty
1	Conducted Emission Test	2.82dB
2	Radiated Emission Test	2.77dB

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3 Test Facility

ILAC / NABL Accreditation No.: TC-8597

Three 3m Semi-Anechoic Chamber, 1 full-Anechoic chamber and 2 Shielding Rooms of AA Electro Magnetic Test Laboratory Private Limited have been registered by National Accreditation Board for Testing and Calibration Laboratories (NABL).

ILAC –A2LA Accreditation No.: 5593.01

Three 3m Semi-Anechoic Chamber, 1 full-Anechoic chamber and 2 Shielding Rooms of AA Electro Magnetic Test Laboratory Private Limited have been registered American Association of Laboratory Accreditation (A2LA.)

FCC- Recognition No.: 137777

Three 3m Semi-Anechoic Chamber, 1 full-Anechoic chamber and 2 Shielding Rooms of AA Electro Magnetic Test Laboratory Private Limited have been registered by Federal Communications Commission (FCC).

ISED Recognition No.: 26046

Three 3m Semi-Anechoic Chamber, 1 full-Anechoic chamber and 2 Shielding Rooms of AA Electro Magnetic Test Laboratory Private Limited have been registered by Institute for Social and Economic Development.(ISED)

VCCI- Registration No: 4053

Three 3m Semi-Anechoic Chamber, 1 full-Anechoic chamber and 2 Shielding Rooms of AA Electro Magnetic Test Laboratory Private Limited have been registered by Voluntary Control Council for Interference.(VCCI)

TEC Designation No.: IND063

Three 3m Semi-Anechoic Chamber, 1 full-Anechoic chamber and 2 Shielding Rooms of AA Electro Magnetic Test Laboratory Private Limited have been registered by Telecommunication Engineering (TEC) Center.

BIS Recognition No: 816586

BIS recognized as per CRS scheme for IT electronics, LED control gears, Lamp, Inverter / UPS are recognized as per LRS 2020.

3.1 Deviation from standard

None

3.2 Abnormalities from standard conditions

None

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4 General Information

4.1 General Description of EUT

Manufacturer:	System Level Solutions (India) Pvt. Ltd.
Manufacturer Address:	Plot no. 32, Zone-D4, Phase 1 GIDC Estate, V.U. Nagar, Anand – 388121, Gujarat, India
EUT Name:	mPCIe LoRa Concentrator Board
Model No:	NM0824-I
Brand Name:	SLS
Derivative model No.:	N/A
Serial No:	1531221900004
Operation frequency:	902.3MHz to 914.9MHz 903.0MHz to 927.5MHz
Number Of Channel:	64+8+8
Modulation Technology:	CSS
Channel Spacing **:**	200kHz(DSS) 1.6MHz(DTS)
Antenna Gain:	2.7 dBi
H/W No.:	1A
S/W No.:	V2.1.0
Power Supply Range:	**Input of EUT:** Powered through Adapter **Input for adapter: AC** 100-240VAC,50/60Hz,0.8A Max Output: DC 5V, 6A Total (Each 2.4A Max)
Condition of Sample on receipt:	Good
Note:	1 .For a more detailed features description, please refer to the manufacturer's specifications or the User's Manual. 2. Antenna gain and antenna type provided by manufacturer.

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Description of Channel/frequency:

Frequency Band (GHz)	Channel No.	Frequency (MHz)
Sub-GHz (902 MHz – 915 MHz)	Low	902.3
	:	:
	Mid	908.5
	:	:
	High	914.9

Channel used for SubGHz testing

Channel Low : 902.3MHz

Channel Mid : 908.5MHz

Channel High : 914.9MHz

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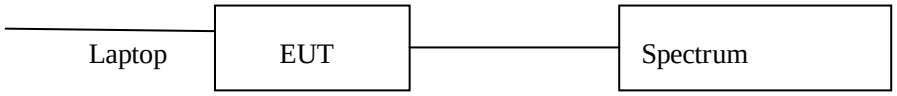
4.2 Description of Test conditions

(1) EUT was tested in normal configuration (Please See following Block diagram)

1. Block diagram of EUT configuration(TX Mode)



Note: 1.The EUT was programmed to be in continuously transmitting mode and the transmit duty cycle is not less than 98%.

(2) E.U.T. test conditions:

15.31(e): For intentional radiators, measurements of the variation of the input power or the adiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

(3) Test frequencies:

According to the 15.31(m) Measurements on intentional radiators or receivers, other than TV broadcast receivers, shall be performed and. If required reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table:

Frequency range over which device operates	Number of frequencies	Location in the range of operation
1 MHz or less	1	Middle
1 to 10 MHz	2	1 near top and 1 near bottom
More than 10 MHz	3	1 near top, 1 near middle and 1 near bottom

(4) Frequency range of radiated measurements:

According to the 15.33, the test range will be up to the tenth harmonic of the highest fundamental frequency.

(5) Pre-test the EUT in all transmitting mode at the lowest (2402 MHz), middle (2441 MHz) and highest (2480 MHz) channel with different data packet and conducted to determine the worst-case mode, only the worst-case results(1Mbps/2Mbps/3Mbps) are recorded in this report.

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4.3 Test Peripheral List

No.	Equipment	Manufacturer	EMC Compliance	Model No.	Serial No.	Power cord	signal cable
1	Laptop	DELL	Latitude 3490	5M2Z1W 2	2m unshielded	N/A	1

4.4 EUT Peripheral List

No.	Equipment	Manufacturer	Model No.	Serial No.	Power cord	signal cable
1.	N/A	N/A	N/A	N/A	N/A	N/A

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5 Equipments List for All Test Items

No	Test Equipment	Manufacturer	Model No	Serial No	Cal. Date	Cal.Due Date
1	Spectrum Analyzer	Rohde and Schwarz	FSP40	101163	2020/12/11	2022/12/10
2	Loop antenna	DAZE Beijing	ZN30900C	18052	2021/01/29	2023/01/28
3	Hi power horn antenna	DAZE Beijing	ZN30700	18012	2021/01/30	2023/01/29
4	Horn antenna	DAZE Beijing	ZN30702	18006	2021/01/30	2023/01/29
5	Horn antenna	DAZE Beijing	ZN30703	18005	2021/01/30	2023/01/29
6	Pre amplifier	KELIANDA	LNA-0009295	-	2021/01/13	2023/01/13
7	Pre amplifier	KELIANDA	CF-00218	-	2021/01/13	2023/01/13
8	Biconical Antenna	DAZE Beijing	ZN30505C	17038	2021/01/13	2023/01/13
9	EMI-RECEIVER	Schwarzbeck	FCKL	1528194	2021/01/13	2023/01/13
10	Spectrum Analyzer	ADVANTEST	R3361	-	2021/01/13	2023/01/13
11	LISN	Kyoritsu	KNW-407	8-1789-5	2021/01/13	2023/01/13
12	Network-LISN	SCHWAR ZBECK	NNBM8125	81251314	2021/01/13	2023/01/13
13	Network-LISN	SCHWAR ZBECK	NNBM8125	81251315	2021/01/13	2023/01/13
14	PULSELIMITER	Rohde and Schwarz	ESH3-Z2	100681	2022/05/13	2023/05/12
15	50ΩCoaxialSwitch	DAIWA	1565157	-	2022/05/13	2023/05/12
16	50ΩCoaxialSwitch	-	-	-	2022/05/13	2023/05/12
17	Wireless signal power meter	DARE!!	RPR3006W	RFSW190220	2021/01/13	2023/01/13
18	Signal Generator	KEYSIGHT	N5181A	512071	2021/01/13	2023/01/13

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19	RF Vector Signal Generator	Keysight	N5182B	512094	2021/01/13	2023/01/13
20	Spectrum analyzer	R&S	FSV-40N	101385	2021/01/13	2023/01/13
21	Radio Communication Tester	R&S	CMW 500	124589	2022/05/15	2023/05/14
22	Signal Generator	R&S	SMP02	837017/004 836593/005	2022/05/15	2023/05/14
23	DC Power Supply	Guanker	JK15040K	TNC/ET/C/001/15	2021/02/02	2023/02/01
24	Pro. Temp & Humi. Chamber	MENTEK	MHP-150-1C	MAA08112501	2021/02/02	2023/02/01
25	Attenuators	AGILENT	8494B	-	-	-
26	Attenuators	AGILENT	8495B	-	-	-

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6 Test Result

6.1 Antenna Requirement

6.1.1 Standard requirement

15.203 requirement: For intentional device, according to 15.203: 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.

15.247(c) (1)(i) requirement: (i) Systems operating in the 2400-2483.5 MHz band that is used exclusively for fixed. Point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi.

6.1.2 EUT Antenna

The ANT-915-IPW1-RPS antenna is a hinged-whip IP67-rated dipole antenna designed for use in 915 MHz frequency bands for low-power, wide-area (LPWA) applications such as LoRaWAN® and WiFi HaLow™ as well as ISM and remote control applications.

The ANT-915-IPW1-RPS provides a ground plane independent dipole antenna solution. The hinged design allows for the antenna to be positioned for optimum performance and reduces the potential for damage from impact compared to a fixed whip design. The antenna attaches with an RP-SMA plug (female socket) connector.

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6.2 Conduction Emissions Measurement

6.2.1 Applied procedures / Limit

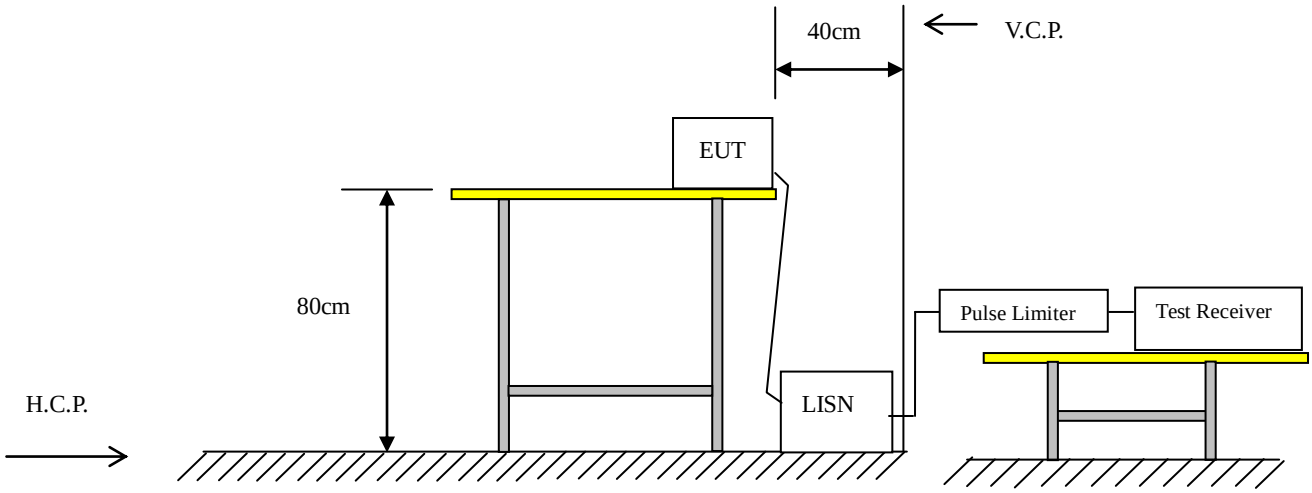
Frequency of Emission (MHz)	Conducted Limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

Note: Decreases with the logarithm of the frequency.

6.2.2 Test procedure

EUT was placed upon a wooden test table 0.8m above the horizontal metal reference plane and 0.4m from the Vertical ground plane, and it was connected to an LISN/AMN. The closest distance between the boundary of the EUT and the surface of the LISN/AMN is 0.8m. All peripherals were connected to another LISN/AMN, and placed at a distance of 10cm from each other. A spectrum and receiver was connected to the RF output port of the LISN/AMN. Both average and quasi-peak value were detected.

6.2.3 Test setup



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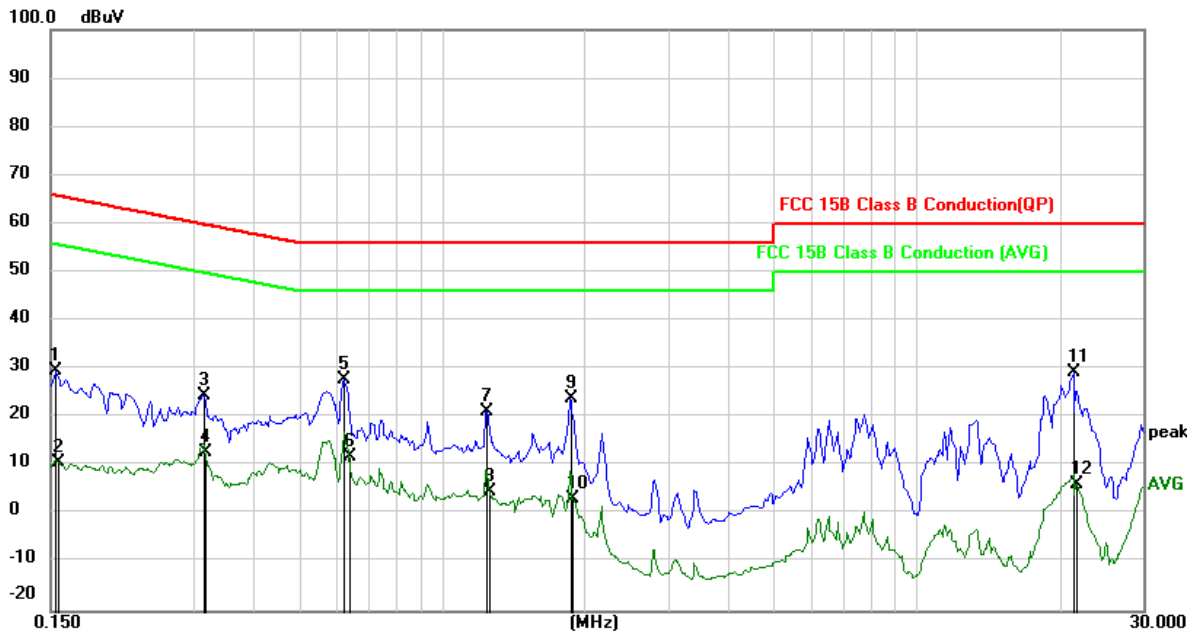
6.2.4 Test results

EUT:	mPCIe LoRa Concentrator Board	Model Name. :	NM0824-I
Temperature:	24°C	Relative Humidity:	52%
Pressure:	1010hPa	Test Date :	2022-09-29
Test Mode:	TX (worst case)	Phase :	Line
Test Voltage :	110Vac,60Hz		

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector
1		0.1539	39.81	-10.03	29.78	65.78	-36.00	QP
2		0.1556	20.87	-10.02	10.85	55.69	-44.84	AVG
3		0.3138	34.50	-9.84	24.66	59.87	-35.21	QP
4		0.3177	22.79	-9.84	12.95	49.76	-36.81	AVG
5	*	0.6219	37.84	-9.86	27.98	56.00	-28.02	QP
6		0.6375	21.84	-9.86	11.98	46.00	-34.02	AVG
7		1.2420	30.98	-9.82	21.16	56.00	-34.84	QP
8		1.2621	14.63	-9.82	4.81	46.00	-41.19	AVG
9		1.8660	33.78	-9.87	23.91	56.00	-32.09	QP
10		1.8879	13.15	-9.87	3.28	46.00	-42.72	AVG
11		21.3894	39.32	-10.05	29.27	60.00	-30.73	QP
12		21.7013	16.21	-10.05	6.16	50.00	-43.84	AVG

Remark: Factor = LISN factor + Cable Loss + Pulse limiter factor.



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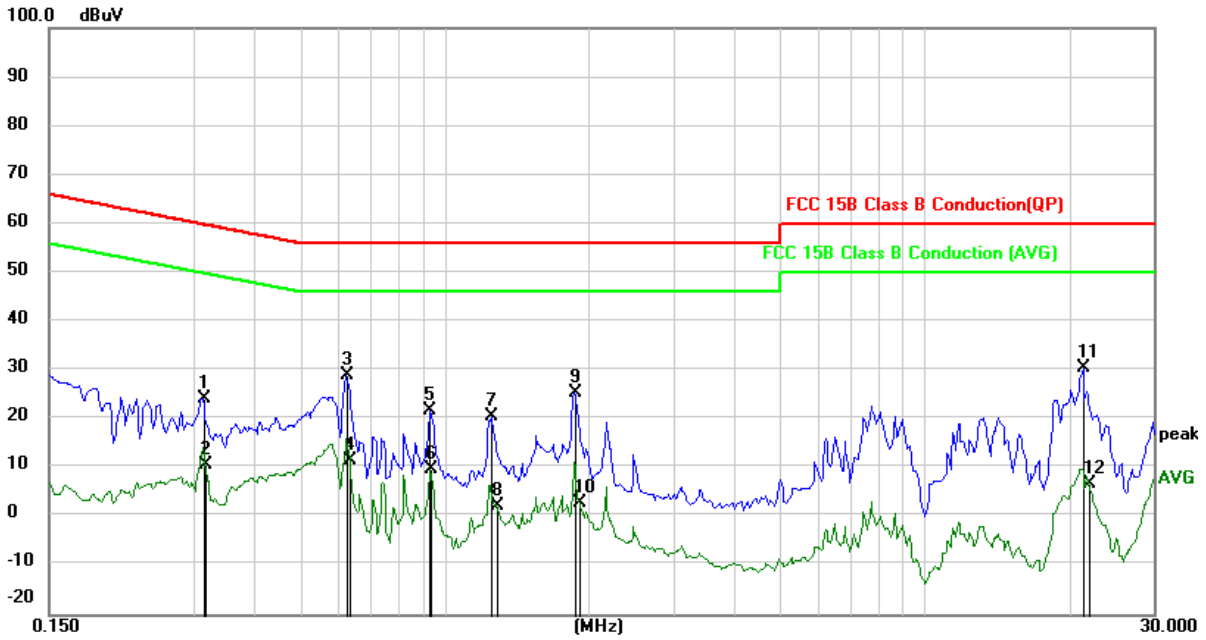
EUT:	mPCIe LoRa Concentrator Board	Model Name. :	NM0824-I
Temperature:	24°C	Relative Humidity:	52%
Pressure:	1010hPa	Test Date :	2022-09-29
Test Mode:	TX (worst case)	Phase :	Neutral
Test Voltage :	110Vac,60Hz		

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure-ment dBuV	Limit dBuV	Over dB	Detector
1		0.3138	34.19	-9.84	24.35	59.87	-35.52	QP
2		0.3177	20.62	-9.84	10.78	49.76	-38.98	AVG
3	*	0.6258	38.90	-9.86	29.04	56.00	-26.96	QP
4		0.6338	21.50	-9.86	11.64	46.00	-34.36	AVG
5		0.9300	31.76	-9.81	21.95	56.00	-34.05	QP
6		0.9339	19.75	-9.81	9.94	46.00	-36.06	AVG
7		1.2536	30.44	-9.82	20.62	56.00	-35.38	QP
8		1.2824	12.09	-9.82	2.27	46.00	-43.73	AVG
9		1.8660	35.29	-9.87	25.42	56.00	-30.58	QP
10		1.9089	12.91	-9.87	3.04	46.00	-42.96	AVG
11		21.3894	40.71	-10.05	30.66	60.00	-29.34	QP
12		21.9463	16.88	-10.06	6.82	50.00	-43.18	AVG

Remark: Factor = LISN factor + Cable Loss + Pulse limiter factor.



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6.3 Radiated Emissions Measurement

6.3.1 Applied procedures / Limit

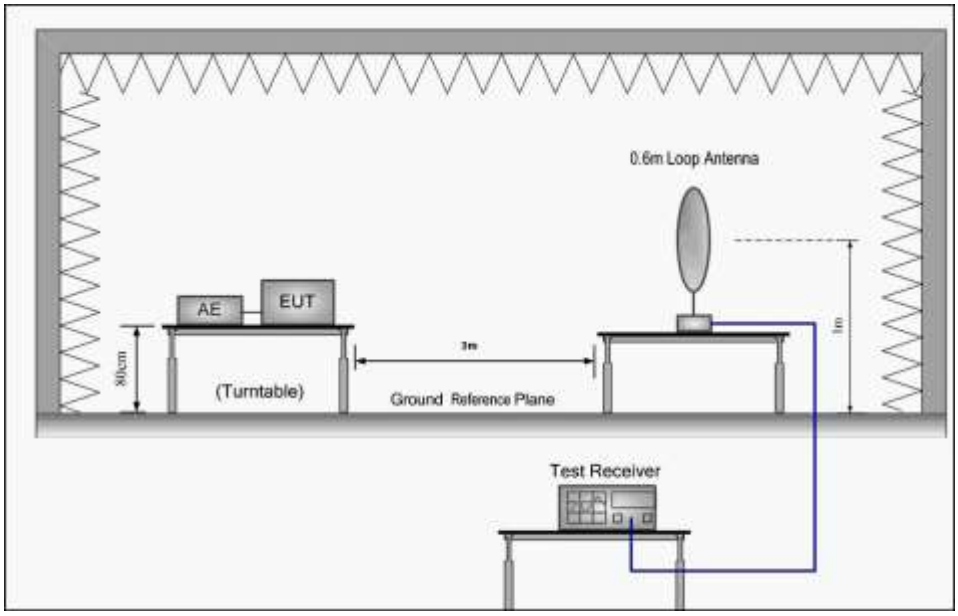
15.247(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that 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 Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

Frequency of Emission (MHz)	Field Strength		Measurement Distance (meters)
	µV/m	dBµV/m	
0.009-0.49	2400/F(kHz)		300
0.49-1.705	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

6.3.2 Test setup

Test Configuration:

1) 9 kHz to 30 MHz emissions:



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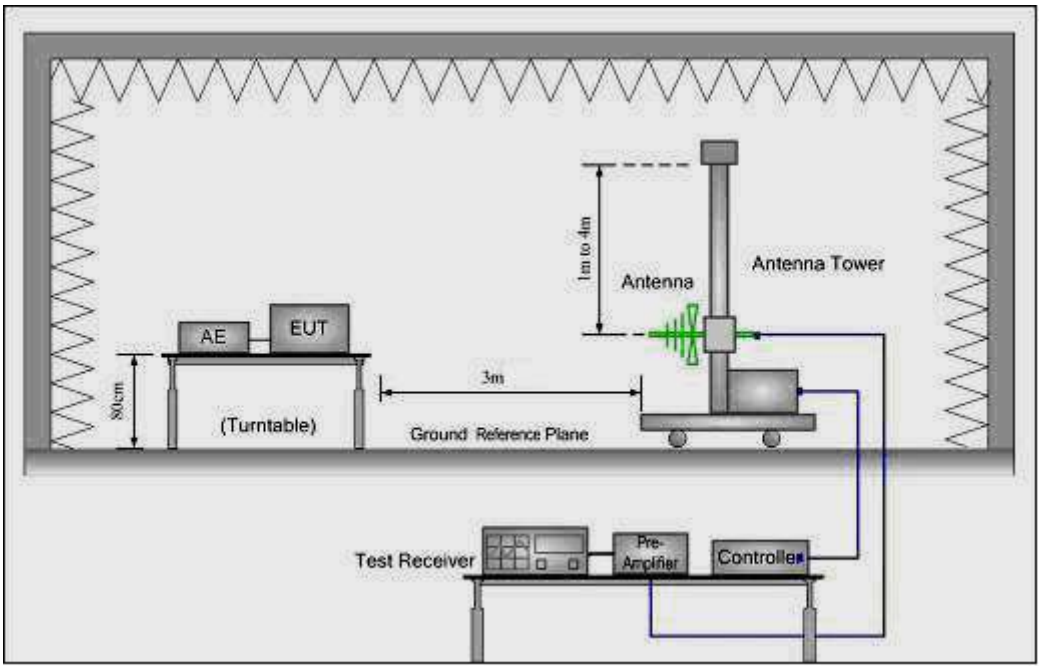
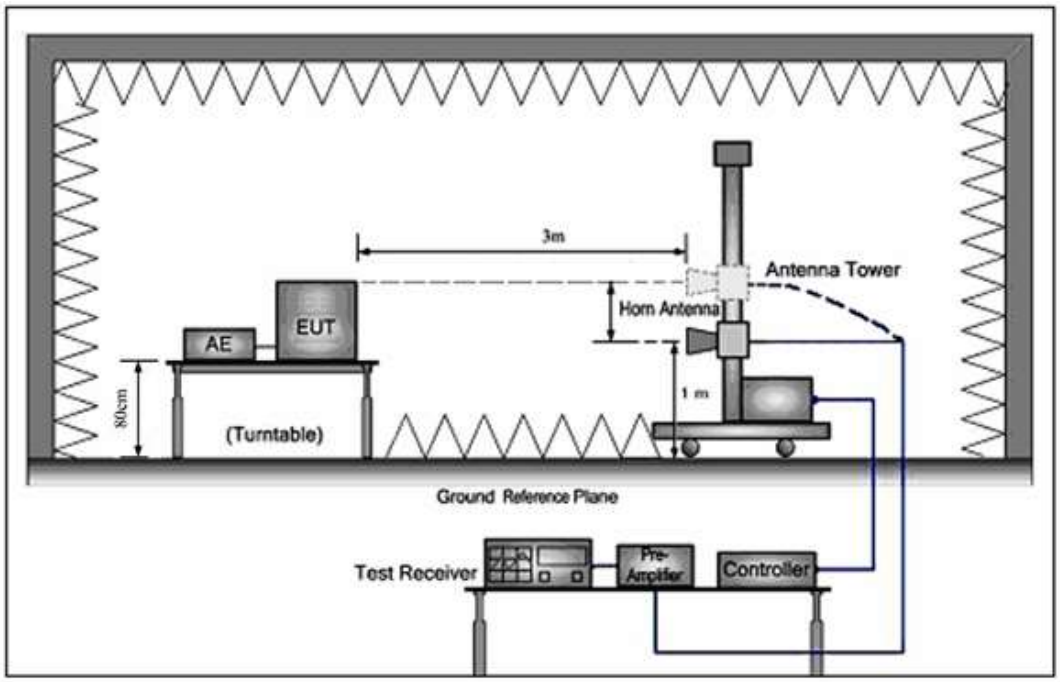
2) 30 MHz to 1 GHz emissions:



3) Above 1 GHz missions:



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6.3.3 Test procedure

EUT was placed upon a wooden test table which was placed on the turn table 0.8m above the horizontal metal ground plane, and operating in the mode as mentioned above. A receiving antenna was placed 3m away from the EUT. During testing, turn around the turn table and move the antenna from 1m to 4m to find the maximum field-strength reading. All peripherals were placed at a distance of 10cm between each other. Both horizontal and Vertical antenna polarities were tested. The worst case emissions were reported.

For measurement at frequency above 1GHz

Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.

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6.3.4 Test Result

Radiated Emissions Test Data Below 30MHz

EUT:	mPCIe LoRa Concentrator Board	Model Name. :	NM0824-I
Temperature:	24.5°C	Test Data	2022-08-17
Pressure:	1010hPa	Relative Humidity:	51%
Test Mode :	TX (worst case)	Test Voltage :	AC 110V, 60Hz
Measurement Distance	3 m	Frequency Range	9KHz to 30MHz
RBW/VBW	9KHz~150KHz/RB 200Hz for QP, 150KHz~30MHz/RB 9KHz for QP		

No emission found between lowest internal used/generated frequencies to 30MHz.

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Radiated Emissions Test Data Below 1GHz

EUT:	mPCIe LoRa Concentrator Board	Model Name. :	NM0824-I
Temperature:	24.5°C	Test Data	2022-08-17
Pressure:	1010hPa	Relative Humidity:	51%
Test Mode :	TX (worst case)	Test Voltage :	AC 110V, 60Hz
Measurement Distance	3 m	Frequency Range	30MHz to 1GHz
RBW/VBW	100KHz / 300KHz for spectrum, RBW=120KHz for receiver.		

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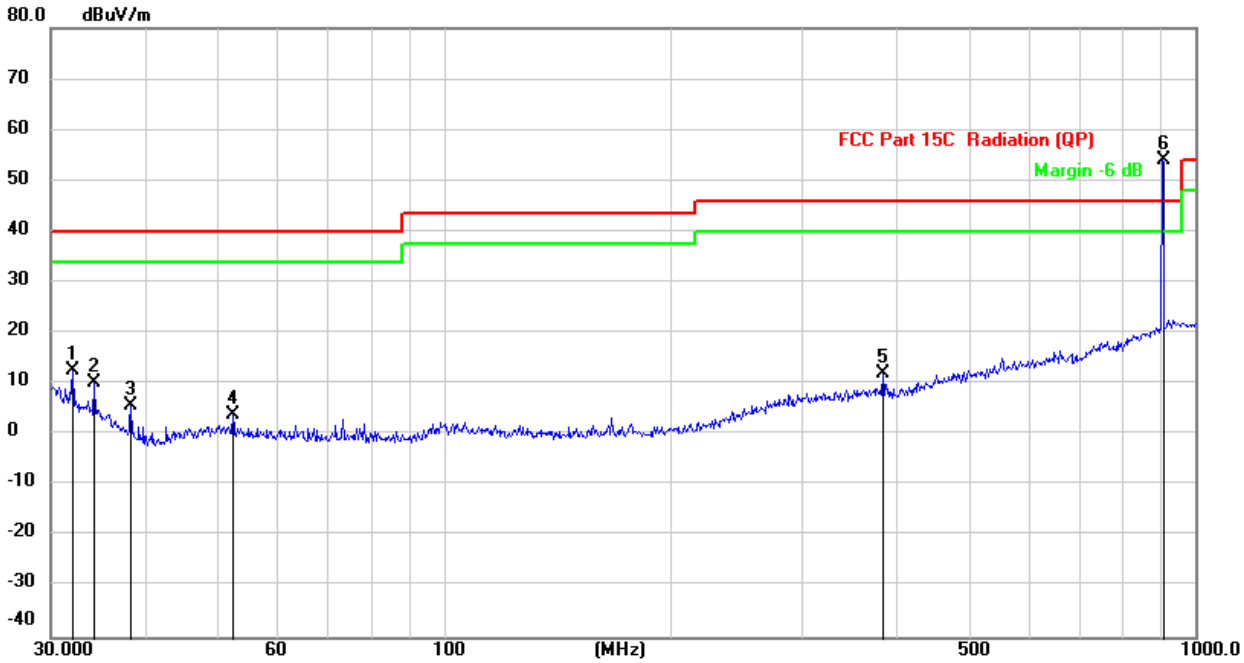
Test at Channel (902.3 GHz) in transmitting status

30 MHz~1 GHz Spurious Emissions .Quasi-Peak Measurement

Vertical:

Peak scan

Level (dBµV/m)



Quasi-peak measurement

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		32.0667	24.66	-11.89	12.77	40.00	-27.23	QP
2		34.2760	23.94	-13.73	10.21	40.00	-29.79	QP
3		38.3462	23.05	-17.28	5.77	40.00	-34.23	QP
4		52.3912	19.61	-15.64	3.97	40.00	-36.03	QP
5		383.9318	18.32	-6.37	11.95	46.00	-34.05	QP
6	*	903.3094	47.68	6.43	54.11	46.00	8.11	QP

Note: '*' means the worst case

Measurement Level = Reading Level + Factor

Factor= Ant Factor + Cable Loss - Pre-amplifier

Note:-Marker 6 is intentional desired frequency of EUT Hence considered as PASS.

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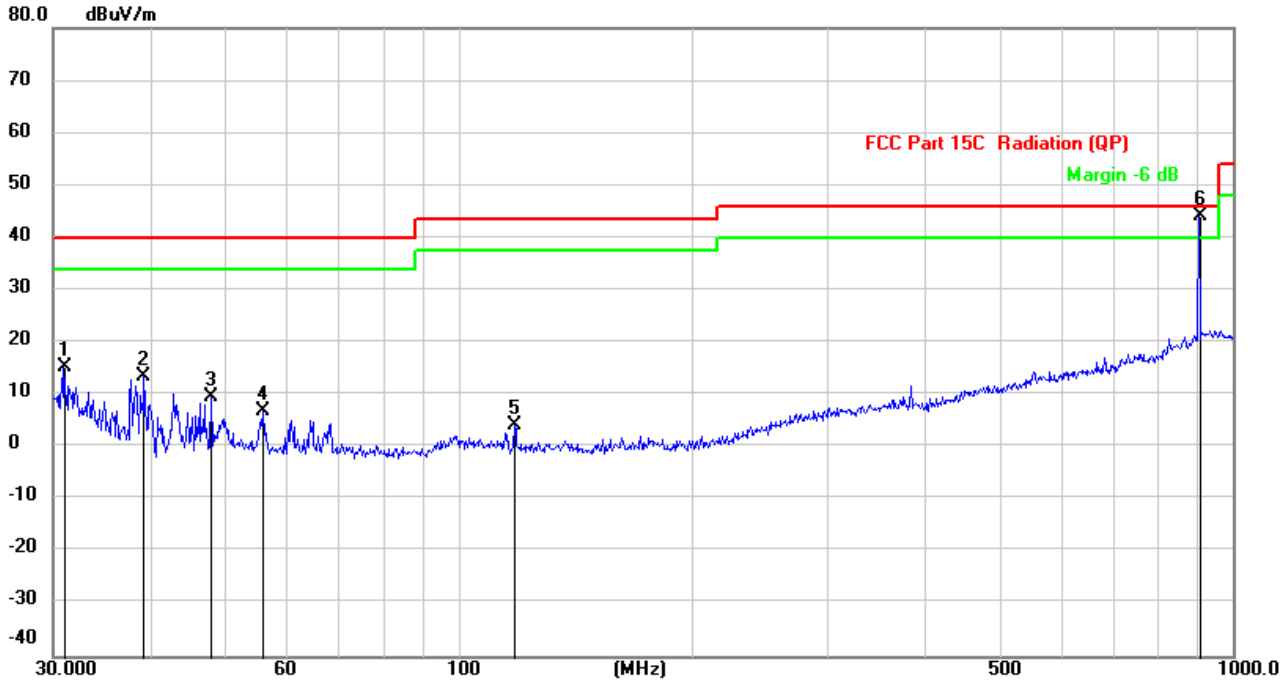
Test at Channel (902.3 GHz) in transmitting status

30 MHz~1 GHz Spurious Emissions .Quasi-Peak Measurement

Horizontal:

Peak scan

Level (dBµV/m)



Quasi-peak measurement

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		30.9619	26.12	-10.70	15.42	40.00	-24.58	QP
2		39.2991	31.61	-18.10	13.51	40.00	-26.49	QP
3		47.9940	25.53	-15.97	9.56	40.00	-30.44	QP
4		56.0007	22.51	-15.67	6.84	40.00	-33.16	QP
5		118.1862	19.05	-14.82	4.23	43.50	-39.27	QP
6	*	903.3094	37.58	6.43	44.01	46.00	-1.99	QP

Note: '*' means the worst case

Measurement Level = Reading Level + Factor

Factor= Ant Factor + Cable Loss - Pre-amplifier

Note:-Marker 6 is intentional desired frequency of EUT Hence considered as PASS.

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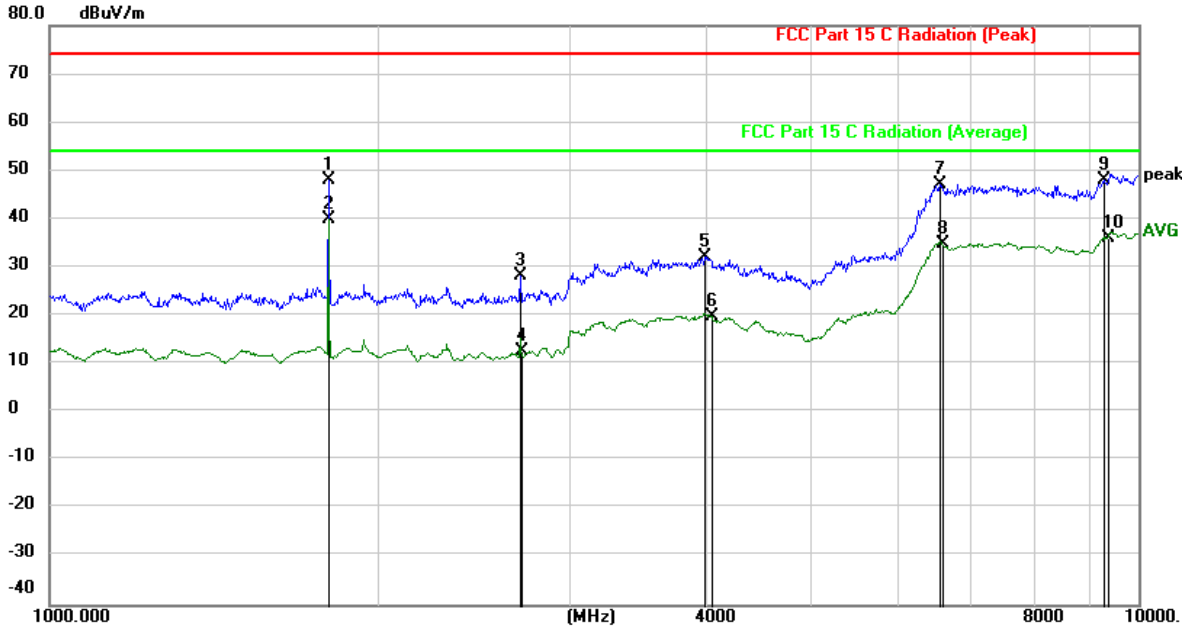
Radiated Emissions Test Data Above 1GHz

EUT:	mPCIe LoRa Concentrator Board	Model Name. :	NM0824-I
Temperature:	24.5°C	Test Data	2022-08-17
Pressure:	1010hPa	Relative Humidity:	51%
Test Mode :	TX (worst case)	Test Voltage :	AC 110V, 60Hz
Measurement Distance	3 m	Frequency Range	1GHz to 25GHz
RBW/VBW	Spurious emission: 1MHz/1MHz for Peak, 1MHz/10Hz for Average. non-restricted band: 100KHz/300KHz for Peak.		

(a) Antenna polarization: Horizontal



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		1803.018	57.05	-8.93	48.12	74.00	-25.88	peak
2	*	1803.018	48.87	-8.93	39.94	54.00	-14.06	AVG
3		2703.958	37.50	-9.40	28.10	74.00	-45.90	peak
4		2710.192	22.12	-9.40	12.72	54.00	-41.28	AVG
5		3999.447	37.44	-5.23	32.21	74.00	-41.79	peak
6		4045.759	25.37	-5.41	19.96	54.00	-34.04	AVG
7		6576.578	36.39	10.64	47.03	74.00	-26.97	peak
8		6622.165	24.04	10.66	34.70	54.00	-19.30	AVG
9		9289.664	35.32	12.69	48.01	74.00	-25.99	peak
10		9354.057	22.80	13.11	35.91	54.00	-18.09	AVG

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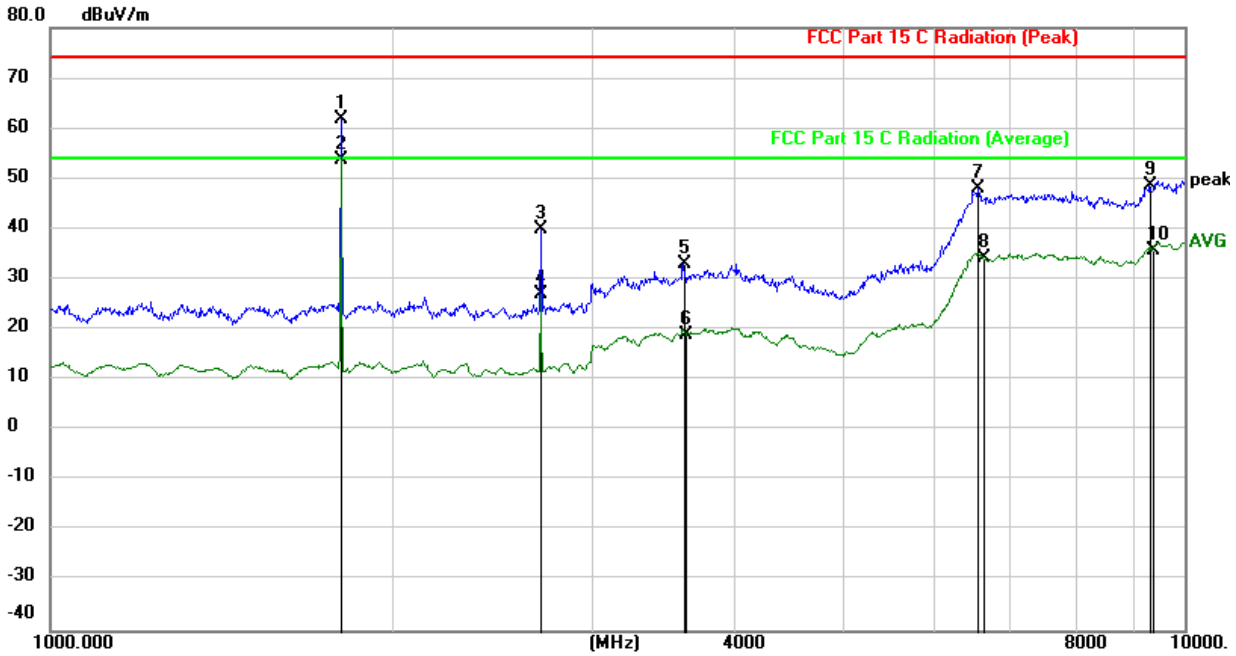
(b) Antenna polarization: Vertical



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		1803.018	70.87	-8.93	61.94	74.00	-12.06	peak
2	*	1803.018	62.79	-8.93	53.86	54.00	-0.14	AVG
3		2703.958	49.28	-9.40	39.88	74.00	-34.12	peak
4		2703.958	36.37	-9.40	26.97	54.00	-27.03	AVG
5		3614.099	39.38	-6.31	33.07	74.00	-40.93	peak
6		3639.150	25.26	-6.24	19.02	54.00	-34.98	AVG
7		6576.578	37.30	10.64	47.94	74.00	-26.06	peak
8		6637.431	23.73	10.67	34.40	54.00	-19.60	AVG
9		9311.079	35.71	12.83	48.54	74.00	-25.46	peak
10		9354.057	22.77	13.11	35.88	54.00	-18.12	AVG

Note:

10~25GHz at least have 20dB margin. No recording in the test report.

Measurement Level = Reading Level + Factor

Remark: Factor = Antenna Factor + Cable Loss–Pre-amplifier

Lowest channel: 902.3 MHz

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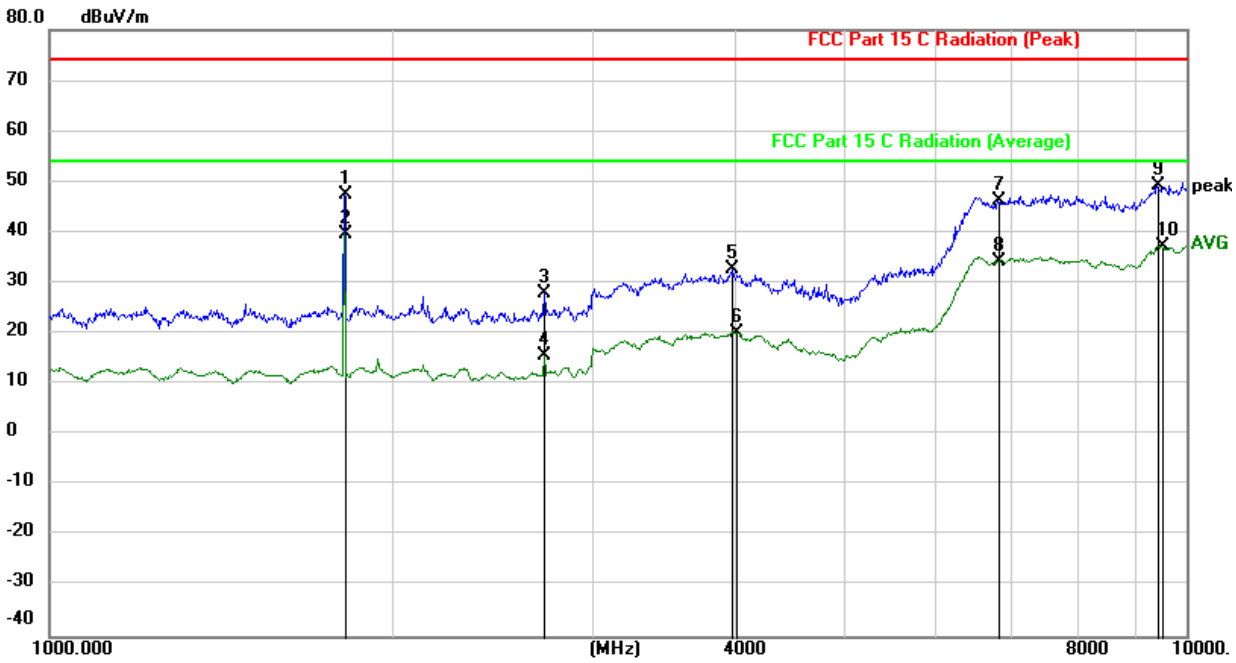
(a) Antenna polarization: Horizontal



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		1815.516	56.43	-8.93	47.50	74.00	-26.50	peak
2	*	1815.516	48.61	-8.93	39.68	54.00	-14.32	AVG
3		2722.701	37.25	-9.39	27.86	74.00	-46.14	peak
4		2722.701	25.10	-9.39	15.71	54.00	-38.29	AVG
5		3990.249	37.88	-5.26	32.62	74.00	-41.38	peak
6		4027.170	25.46	-5.33	20.13	54.00	-33.87	AVG
7		6823.387	35.52	10.75	46.27	74.00	-27.73	peak
8		6839.116	23.52	10.76	34.28	54.00	-19.72	AVG
9		9418.896	35.66	13.55	49.21	74.00	-24.79	peak
10		9506.048	23.09	14.08	37.17	54.00	-16.83	AVG

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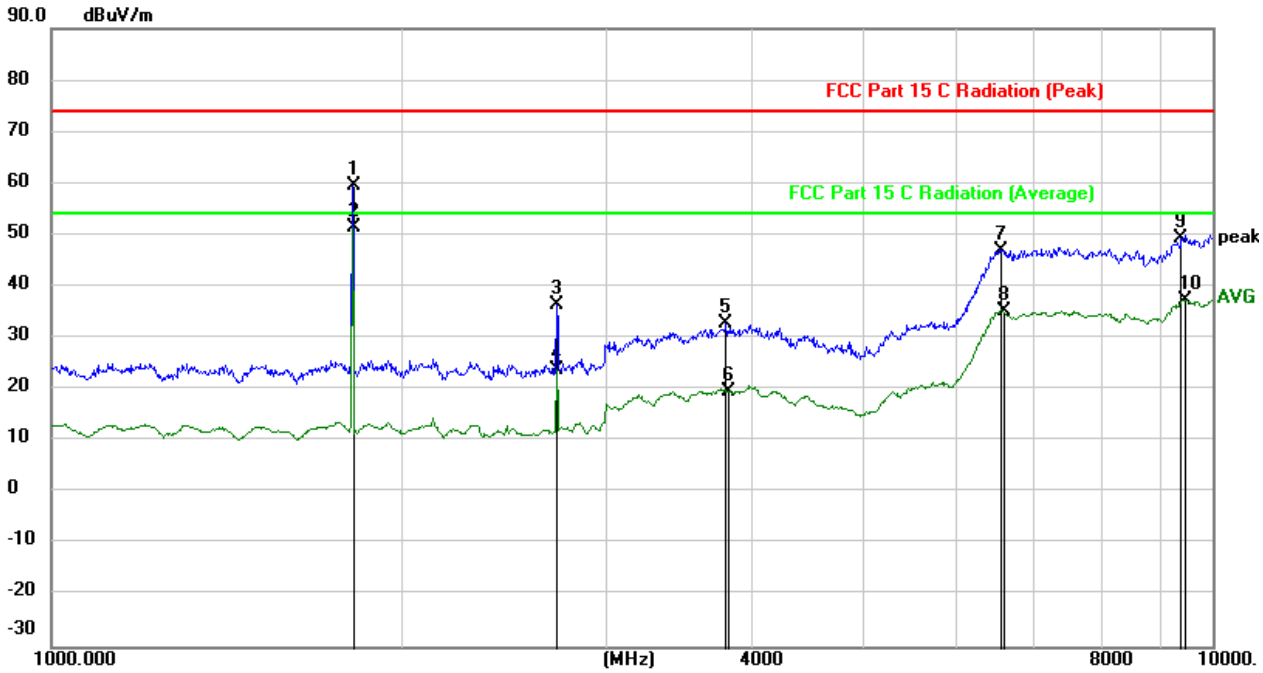
(b) Antenna polarization: Vertical



Note:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		1815.516	68.48	-8.93	59.55	74.00	-14.45	peak
2	*	1815.516	60.36	-8.93	51.43	54.00	-2.57	AVG
3		2722.701	45.90	-9.39	36.51	74.00	-37.49	peak
4		2722.701	33.14	-9.39	23.75	54.00	-30.25	AVG
5		3810.658	38.50	-5.77	32.73	74.00	-41.27	peak
6		3819.443	25.48	-5.74	19.74	54.00	-34.26	AVG
7		6576.578	36.44	10.64	47.08	74.00	-26.92	peak
8		6591.739	24.47	10.65	35.12	54.00	-18.88	AVG
9		9397.233	35.84	13.41	49.25	74.00	-24.75	peak
10		9440.609	23.57	13.70	37.27	54.00	-16.73	AVG

10~25GHz at least have 20dB margin. No recording in the test report.

Measurement Level = Reading Level + Factor

Remark: Factor = Antenna Factor + Cable Loss–Pre-amplifier

Middle Channel: 908.5 MHz

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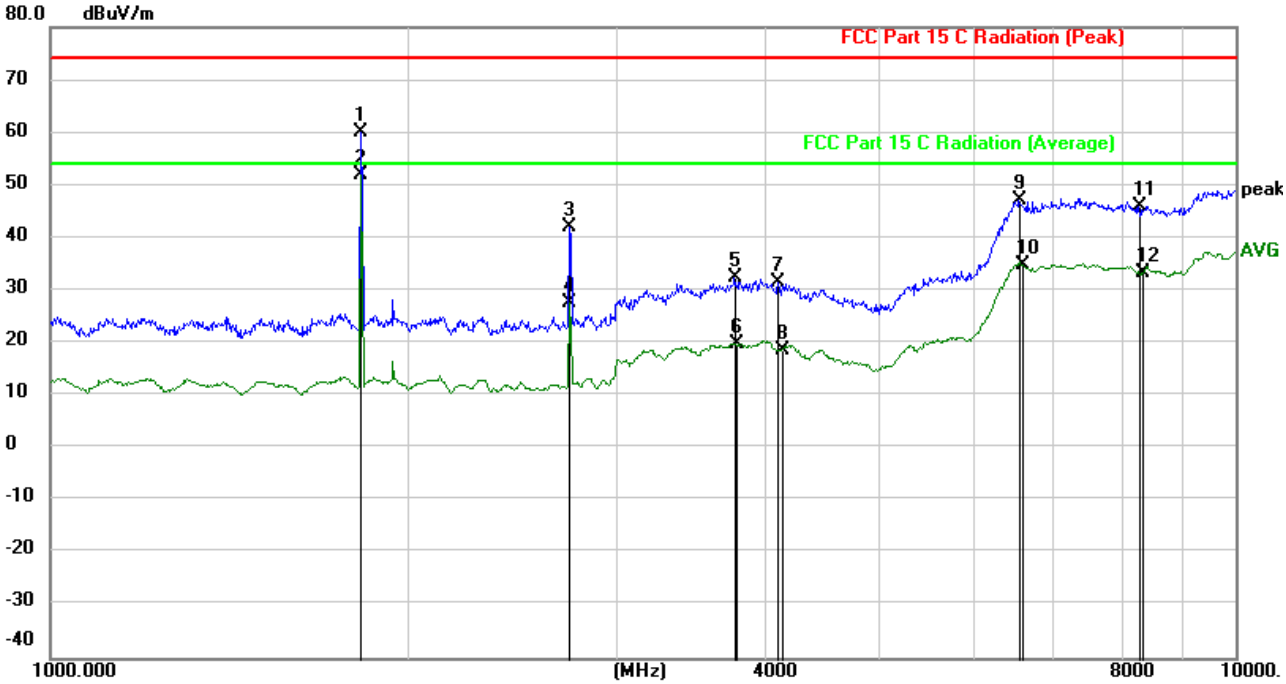
(a) Antenna polarization: Horizontal



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		1828.100	69.08	-8.94	60.14	74.00	-13.86	peak
2	*	1828.100	60.76	-8.94	51.82	54.00	-2.18	AVG
3		2741.574	51.42	-9.37	42.05	74.00	-31.95	peak
4		2741.574	37.14	-9.37	27.77	54.00	-26.23	AVG
5		3775.722	38.29	-5.86	32.43	74.00	-41.57	peak
6		3784.426	25.78	-5.84	19.94	54.00	-34.06	AVG
7		4111.497	37.13	-5.65	31.48	74.00	-42.52	peak
8		4139.997	24.46	-5.77	18.69	54.00	-35.31	AVG
9		6561.453	36.49	10.63	47.12	74.00	-26.88	peak
10		6591.739	24.33	10.65	34.98	54.00	-19.02	AVG
11		8279.422	35.27	10.73	46.00	74.00	-28.00	peak
12		8356.030	22.81	10.68	33.49	54.00	-20.51	AVG

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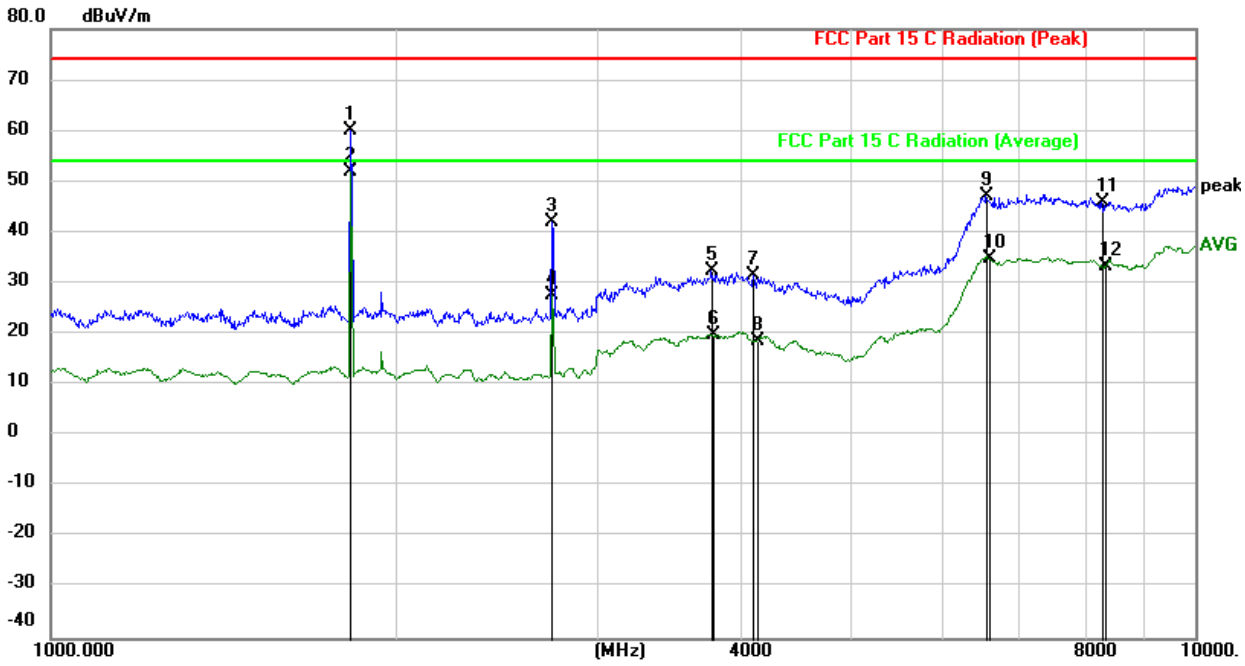
(b) Antenna polarization: Vertical



		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector
1		1828.100	69.08	-8.94	60.14	74.00	-13.86	peak
2	*	1828.100	60.76	-8.94	51.82	54.00	-2.18	AVG
3		2741.574	51.42	-9.37	42.05	74.00	-31.95	peak
4		2741.574	37.14	-9.37	27.77	54.00	-26.23	AVG
5		3775.722	38.29	-5.86	32.43	74.00	-41.57	peak
6		3784.426	25.78	-5.84	19.94	54.00	-34.06	AVG
7		4111.497	37.13	-5.65	31.48	74.00	-42.52	peak
8		4139.997	24.46	-5.77	18.69	54.00	-35.31	AVG
9		6561.453	36.49	10.63	47.12	74.00	-26.88	peak
10		6591.739	24.33	10.65	34.98	54.00	-19.02	AVG
11		8279.422	35.27	10.73	46.00	74.00	-28.00	peak
12		8356.030	22.81	10.68	33.49	54.00	-20.51	AVG

Note:

10~25GHz at least have 20dB margin. No recording in the test report.

Measurement Level = Reading Level + Factor

Remark: Factor = Antenna Factor + Cable Loss–Pre-amplifier

Highest Channel: 914.9 MHz

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6.4 BANDWIDTH TEST

6.4.1 Applied procedures / Limit

The minimum 20 dB bandwidth of the hopping channel is 250 kHz use at least 50 hopping frequencies.

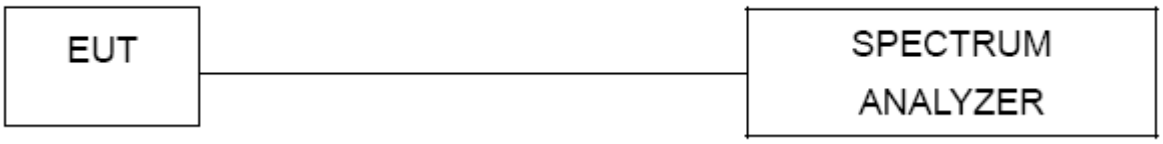
6.4.2 Test procedure

a. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below.
b. Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel
RBW ≥ 1% of the 20 dB bandwidth, VBW ≥ RBW, Sweep = auto, Detector function = peak
Trace = max hold

6.4.3 Deviation from standard

No deviation.

6.4.4 Test setup



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6.4.5 Test results

EUT:	mPCIe LoRa Concentrator Board	Model Name. :	NM0824-I
Temperature:	26 °C	Relative Humidity:	53%
Test Mode :	TX		

Channel	Channel frequency (MHz)	20dB bandwidth (KHz)	99% OBW (KHz)	Limit (KHz)	Conclusion
Low	902.3	135.67	122.64	250	Pass
Middle	908.5	134.59	121.20	250	Pass
High	914.9	136.40	123.010	250	Pass

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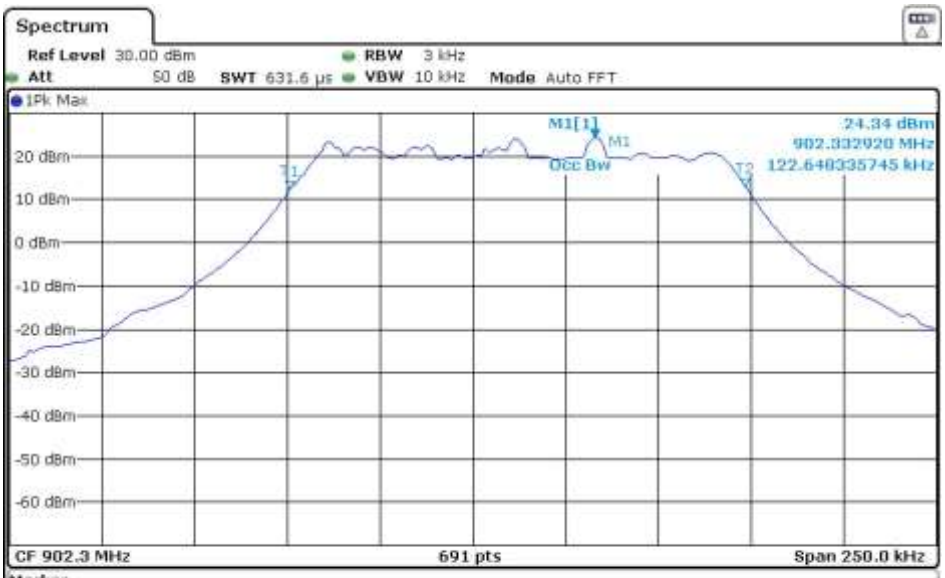
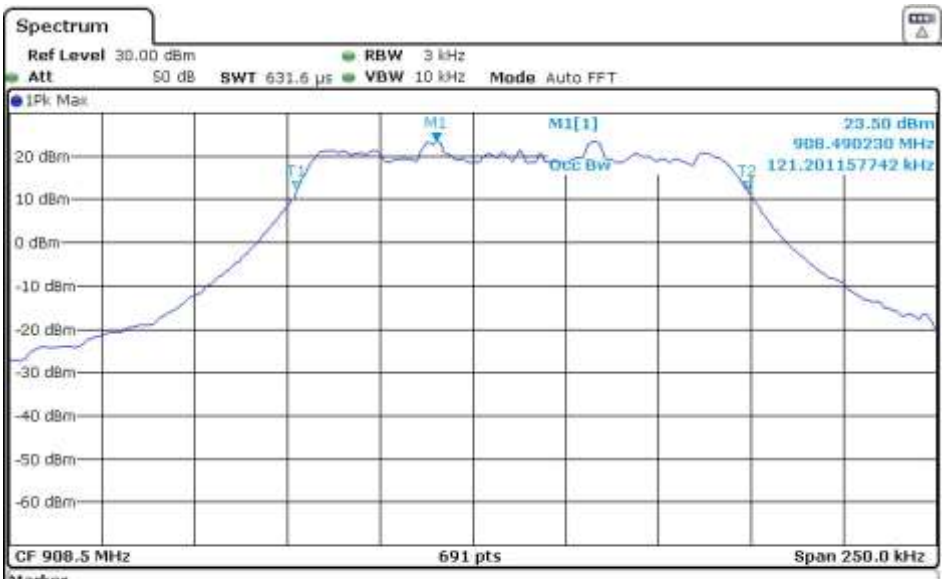
99% OBW @902.3MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	902.33292 MHz	24.34 dBm		
T1		1	902.250796 MHz	12.33 dBm	Occ Bw	122.648335745 kHz
T2		1	902.373444 MHz	12.94 dBm		

99% OBW @908.5MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	908.49023 MHz	23.50 dBm		
T1		1	908.452605 MHz	12.32 dBm	Occ Bw	121.201157742 kHz
T2		1	908.573806 MHz	12.20 dBm		

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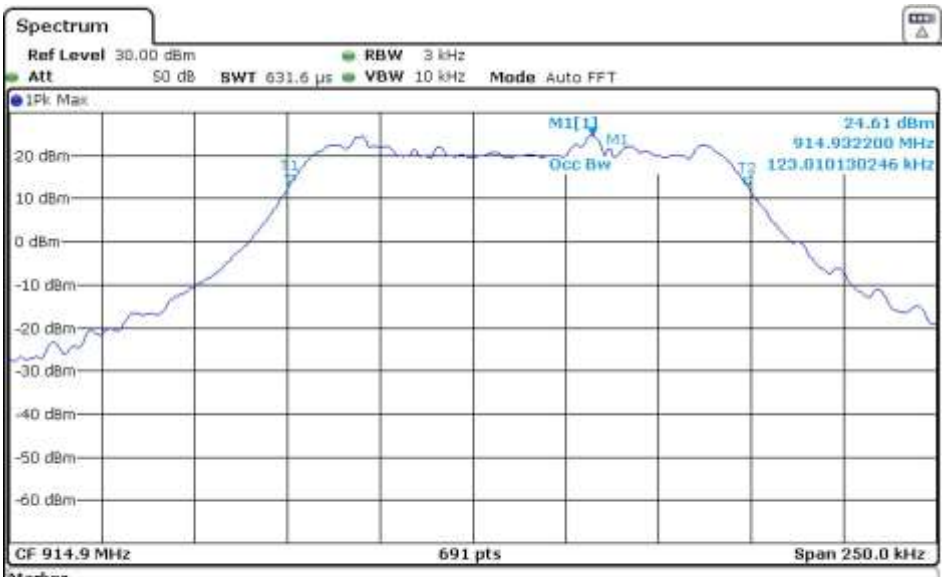
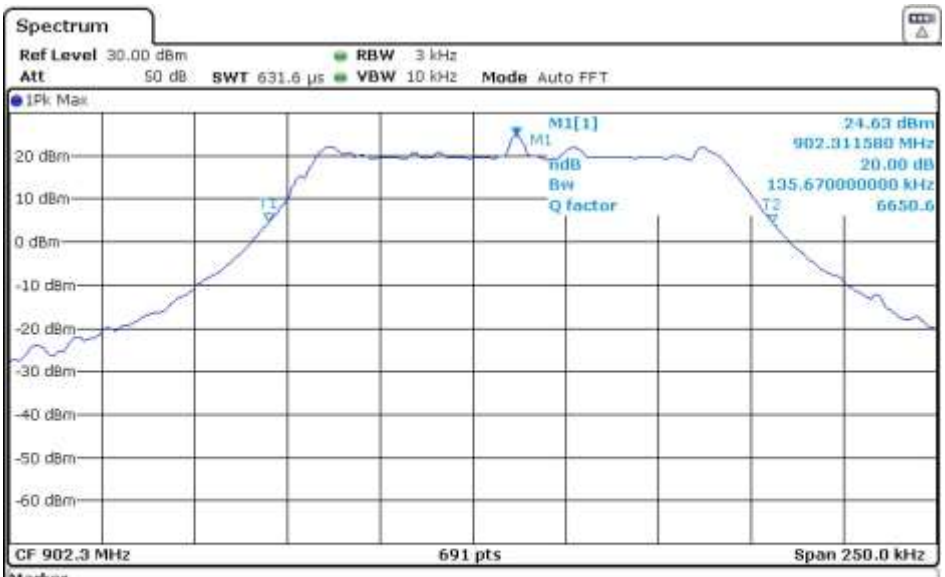
99% OBW @914.9MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	914.9322 MHz	24.61 dBm		
T1		1	914.850796 MHz	13.31 dBm	Occ Bw	123.010130246 kHz
T2		1	914.973806 MHz	12.95 dBm		

20dB bandwidth @902.3MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	902.31158 MHz	24.63 dBm	ndB down	135.67 kHz
T1		1	902.24501 MHz	4.60 dBm	ndB	20.00 dB
T2		1	902.38068 MHz	4.48 dBm	Q factor	6650.6

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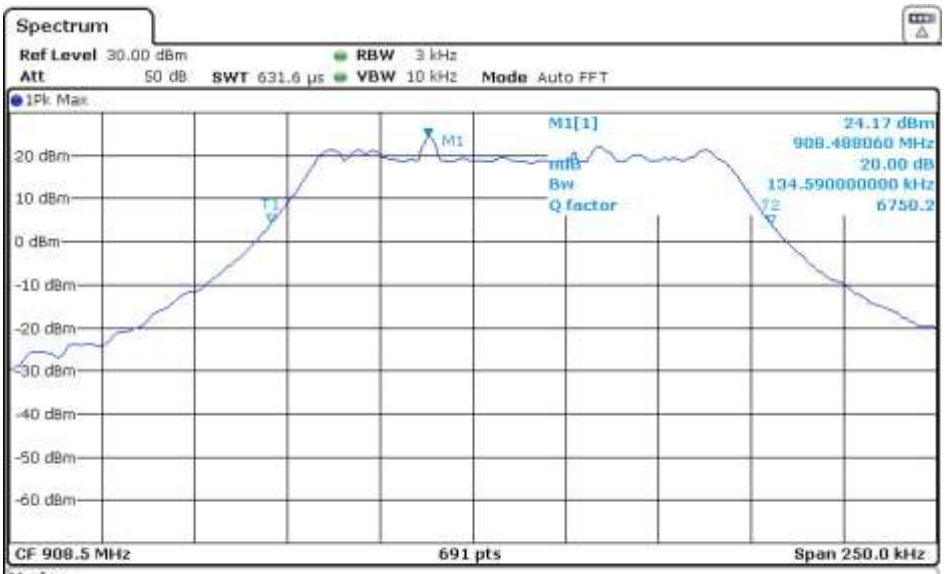
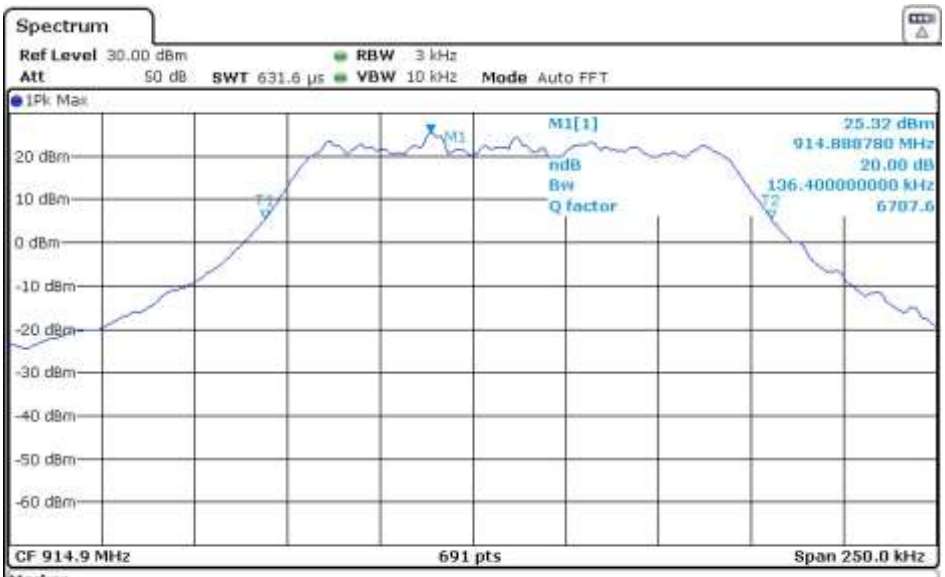
20dB bandwidth @908.5MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	908.48806 MHz	24.17 dBm	ndB down	134.59 kHz
T1		1	908.44573 MHz	4.34 dBm	ndB	20.00 dB
T2		1	908.58032 MHz	4.11 dBm	Q factor	6750.2

20dB bandwidth @914.9MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	914.88878 MHz	25.32 dBm	ndB down	136.4 kHz
T1		1	914.84392 MHz	5.42 dBm	ndB	20.00 dB
T2		1	914.98032 MHz	5.51 dBm	Q factor	6707.6

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6.5 Carrier Frequencies Separated

6.5.1 Applied procedures / Limit

15.247(a) (1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

6.5.2 Test procedure

(1) Connected the antenna port to the Spectrum Analyzer, set the Spectrum Analyzer as Span = wide enough to capture the peaks of two adjacent channels, Resolution (or IF) Bandwidth (RBW) ≥ 1% of the span, Video (or Average) Bandwidth (VBW) ≥ RBW Sweep = auto, Detector function = peak, Trace = max hold

(2) The EUT should be transmitting at its maximum data rate. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

(3) The above procedure shall be repeated at the lowest, the middle, and the highest frequency of the stated frequency range with modulated mode. also shall be performed at different modes of operation.

6.5.3 Deviation from standard

No deviation.

6.5.4 Test setup

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6.5.5 Test results

EUT:	mPCIe LoRa Concentrator Board	Model Name. :	NM0824-I
Temperature:	26 °C	Relative Humidity:	53%
Test Mode :	TX (902.3MHz, 908.5MHz, 914.9MHz)		

Channel frequency (MHz)	Channel Separation (KHz)	Conclusion
908.3	200	Pass
908.5	200	Pass
908.7	200	Pass

Ch. Separation >2/3(20dB bandwidth)

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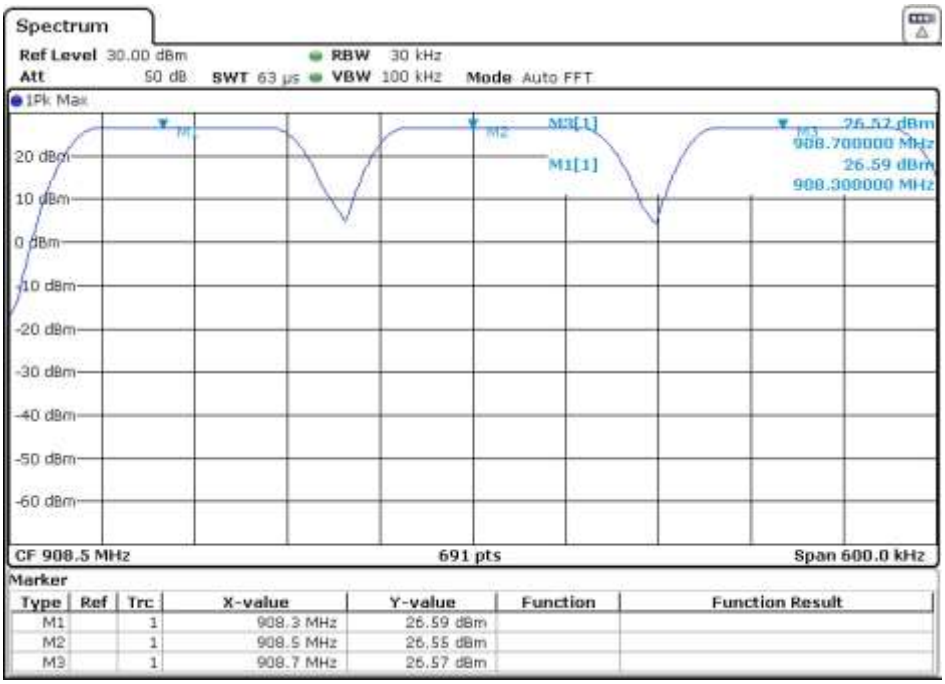

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6.6 Hopping Channel Number

6.6.1 Applied procedures / Limit

FCC Part 15 Subpart C Section 15.247 (a) (i) Frequency hopping systems operating in the band 902.2-928 MHz shall use at least 50 hopping channels if the minimum 20 dB bandwidth is less than 250 kHz. Test procedure

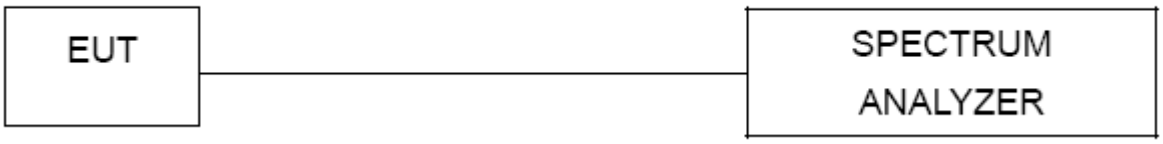
(1) Connected the antenna port to the Spectrum Analyzer , set the Spectrum Analyzer as
Span = the frequency band of operation, RBW ≥ 1% of the span, VBW ≥ RBW Sweep = auto
Detector function = peak, Trace = max hold

(2) The EUT should be have its hopping function enabled. Maxhold and record hopping channels It may prove necessary to break the span up to sections, in order to clearly show all of the hopping frequencies.

6.6.2 Deviation from standard

No deviation.

6.6.3 Test setup



6.6.4 Test result

Hopping Channel Number result		
Operating Mode: TX Mode		Test date:2022-10-31
Result	Limit	Conclusion
64	>50	Pass

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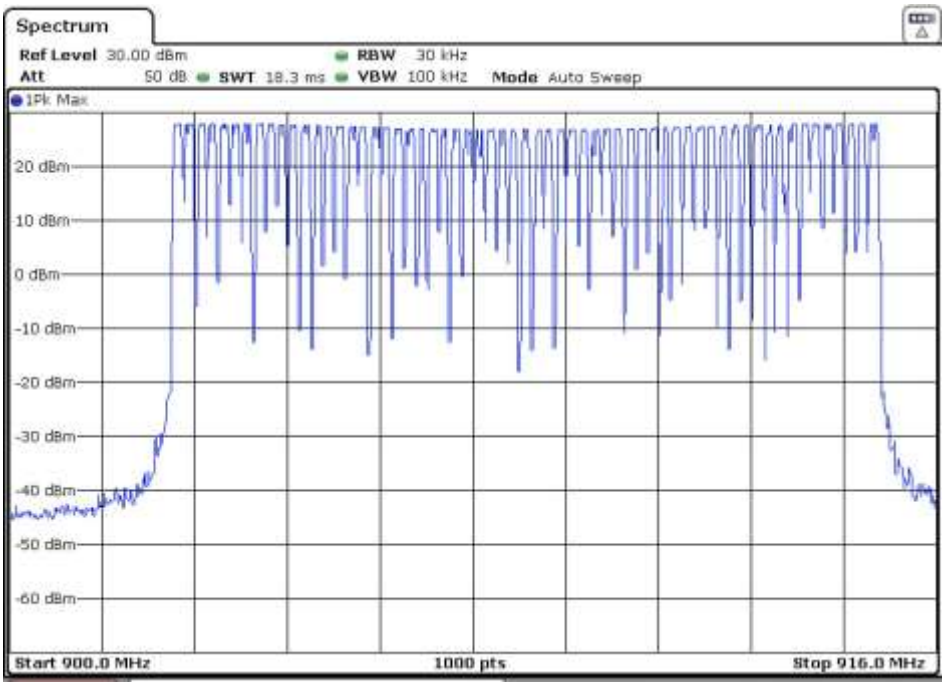
EUT：	mPCIe LoRa Concentrator Board	Model Name. ：	NM0824-I
Temperature：	24.8 °C	Relative Humidity：	53%
Test Mode ：	TX		



Total Number of Hopping Channels Observed = 64

Start hopping Frequency Observed 902.3 MHz
Stop hopping Frequency Observed 914.9 MHz

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6.7 Dwell time

6.7.1 Applied procedures / Limit

15.247(a) (i) If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.

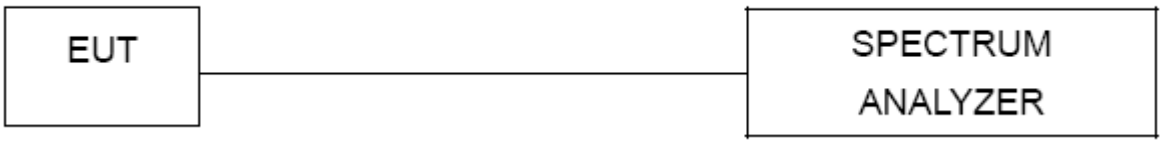
6.7.2 Test procedure

(1) Place the EUT on the table in the chamber or connect the antenna port of the EUT to spectrum analyzer and set it in transmitting mode.
(2) Set RBW of spectrum analyzer to 1MHz, VBW ≥ RBW
(3) Use a video trigger with the trigger level set to enable triggering only on full pulses.
(4) Sweep Time is more than once pulse time.
(5) Set the center frequency on any frequency would be measure and set the frequency span to zero span.
(6) Measure the maximum time duration of one single pulse.
(7) Set the EUT for packet transmitting.
(8) Measure the maximum time duration of one single pulse.

6.7.3 Deviation from standard

No deviation.

6.7.4 Test setup



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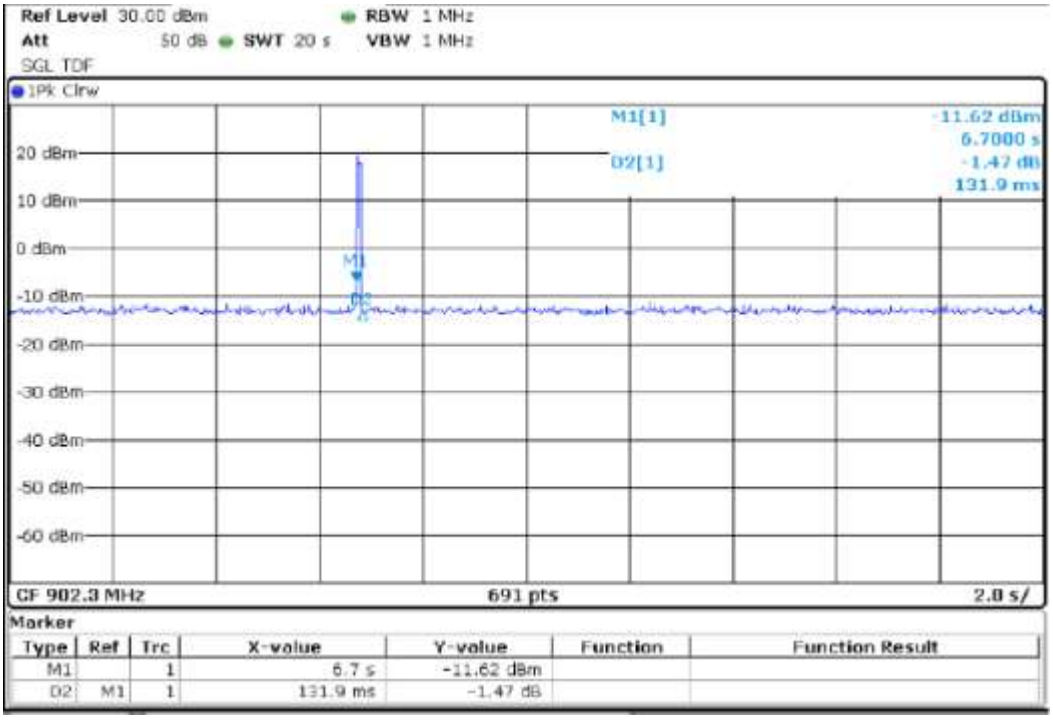
6.7.5 Test result

EUT:	mPCIe LoRa Concentrator Board	Model Name. :	NM0824-I
Temperature:	24.8 °C	Relative Humidity:	53%
Test Mode :	TX		

Dwell Time (ms)	Limits (s)	Verdict
131.9	0.4000	Pass



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6.8 Maximum Peak Output Power

6.8.1 Applied procedures / Limit

15.247(a) (1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Requirement

Power ≤ 1 W (30 dBm)

6.8.2 Test procedure

(1) Connected the antenna port to the Spectrum Analyzer, set the Spectrum Analyzer as
Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel
RBW > the 20 dB bandwidth of the emission being measured, VBW ≥ RBW, Sweep = auto
Detector function = peak, Trace = max hold

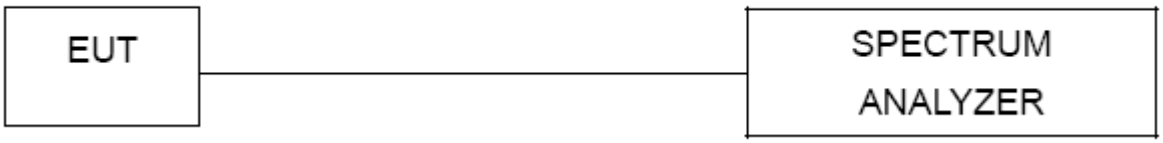
(2) The EUT should be transmitting at its maximum data rate. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power.

(3) The above procedure shall be repeated at the lowest, the middle, and the highest frequency of the stated frequency range with modulated mode. Also shall be performed at different modes of operation.

6.8.3 Deviation from standard

No deviation.

6.8.4 Test setup



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6.8.5 Test results

EUT:	mPCIe LoRa Concentrator Board	Model Name. :	NM0824-I
Temperature:	25 °C	Relative Humidity:	52%
Test Mode :	TX		

Channel	Channel frequency (MHz)	Measured Peak Output Power (dBm)	Measured e.i.r.p (dBm)	Power Limit (dBm)	e.i.r.p Limit (dBm)	Result
Low	902.3	27.11	30.71	30	36	Pass
Middle	908.5	25.84	29.44	30	36	Pass
High	914.9	26.81	30.41	30	36	Pass
Cable loss = 0.9dBm						

Measured e.i.r.p (dBm)= Measured Peak power (dBm) + Cable loss (0.9dB)+Antenna gain

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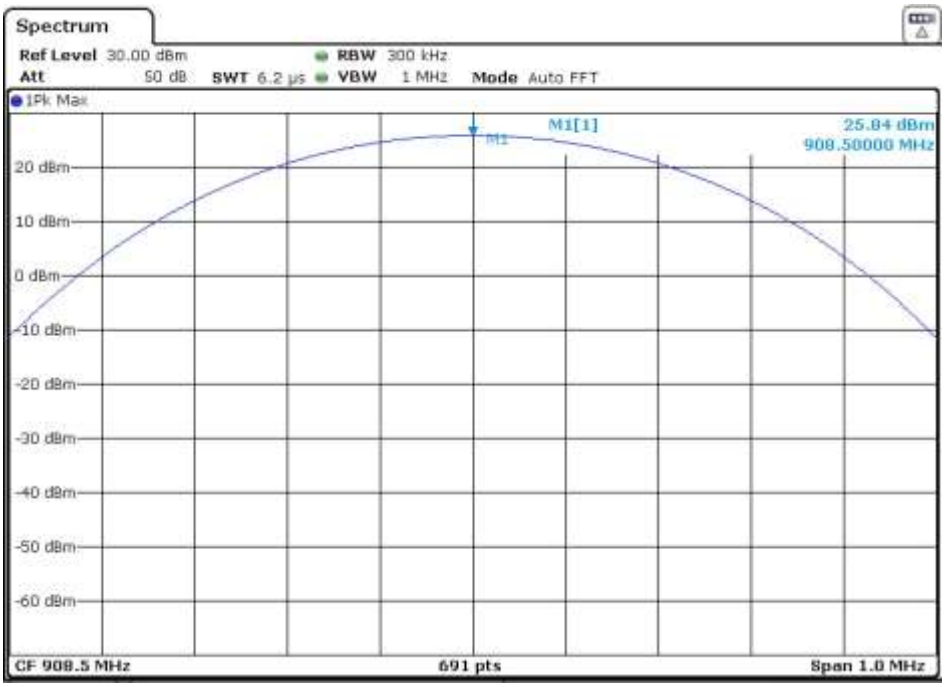
@902.3MHz

@908.5MHz



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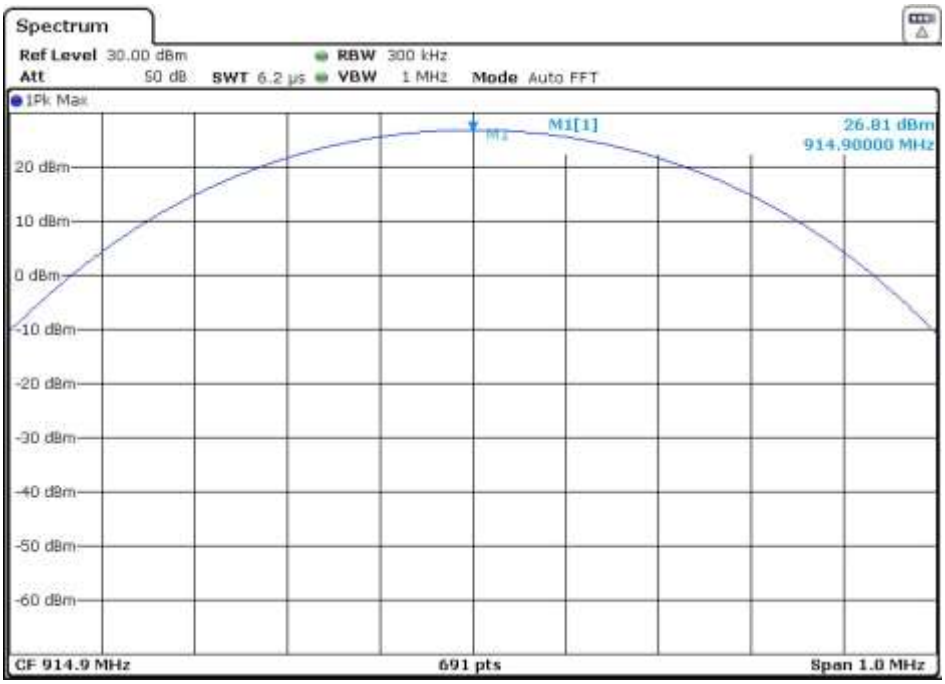
@914.9MHz



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6.9 Band edge

6.9.1 Applied procedures / Limit

15.247(d) 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 Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

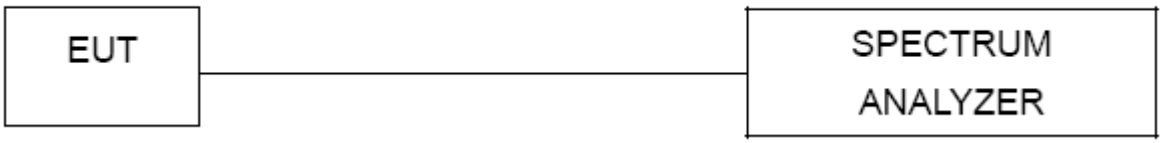
6.9.2 Test procedure

a. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below.
b. Span = wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation, RBW ≥ 1% of the span, VBW ≥ RBW, Sweep = auto,
Detector function = peak, Trace = max hold

6.9.3 Deviation from standard

No deviation.

6.9.4 Test setup



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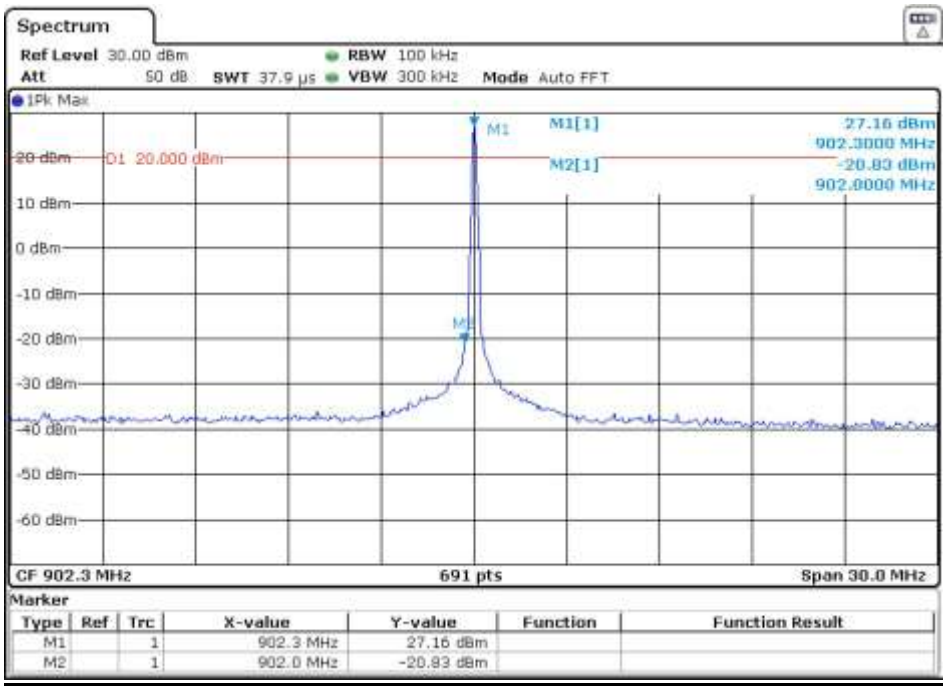
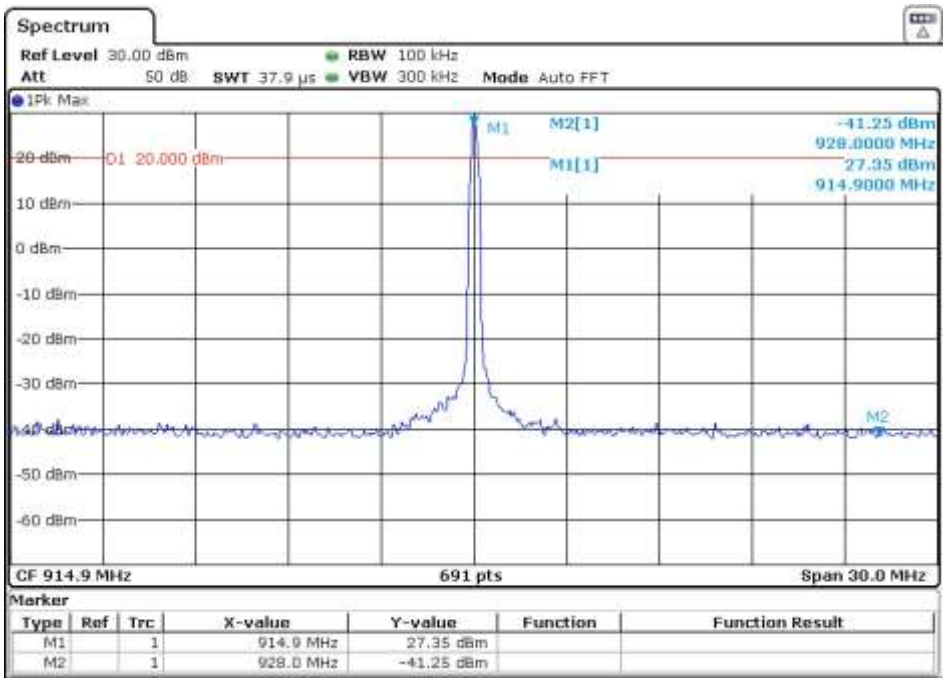
6.9.5 Test results

@902.3MHz



@914.9MHz



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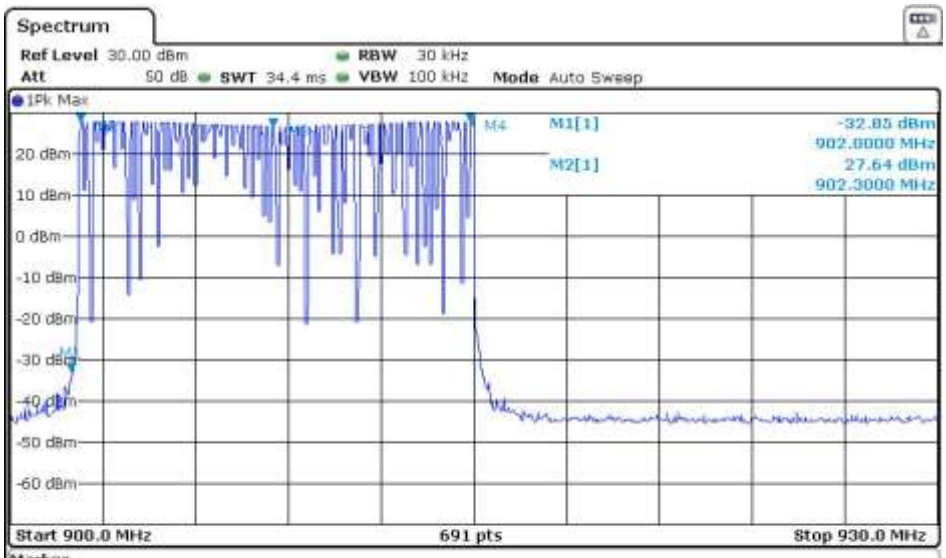
Device in Hopping Mode:

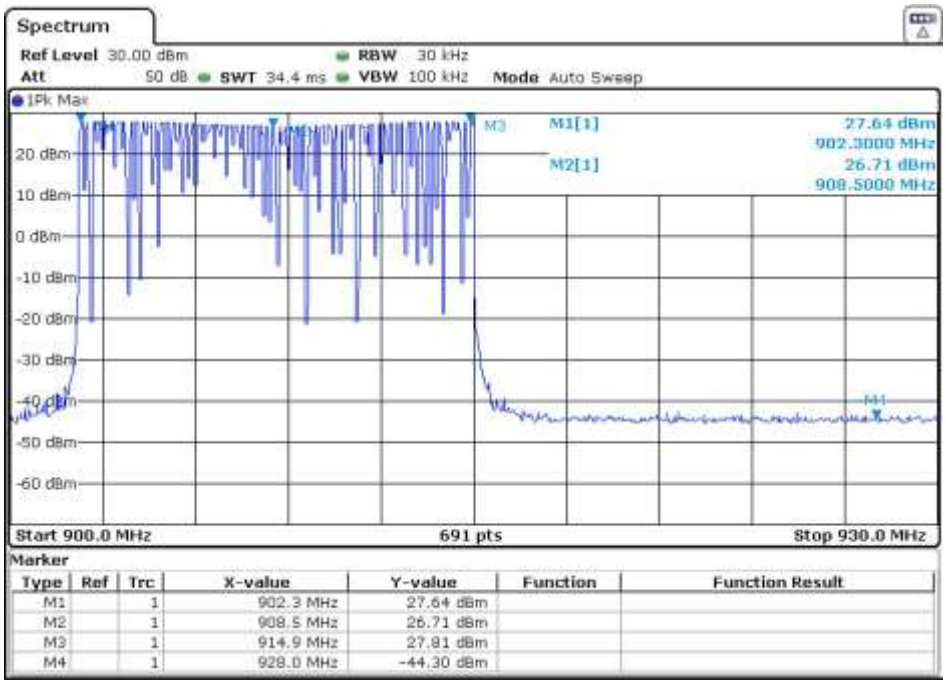
@902.3MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	902.0 MHz	-32.85 dBm		
M2		1	902.3 MHz	27.64 dBm		
M3		1	908.5 MHz	26.71 dBm		
M4		1	914.9 MHz	27.81 dBm		

@914.9MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	902.3 MHz	27.64 dBm		
M2		1	908.5 MHz	26.71 dBm		
M3		1	914.9 MHz	27.81 dBm		
M4		1	928.0 MHz	-44.30 dBm		

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6.10 Conducted Spurious Emissions

6.10.1 Applied procedures / Limit

15.247(d) 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 Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

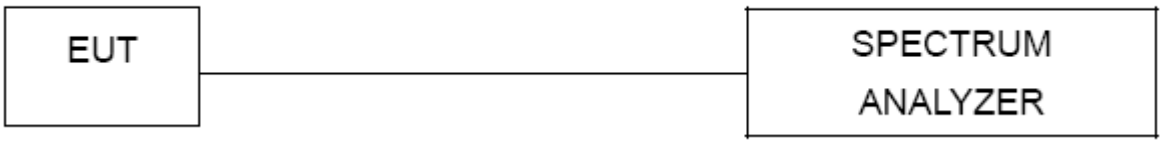
6.10.2 Test procedure

a. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below.
b. Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span. RBW = 100 kHz
VBW ≥ RBW, Sweep = auto, Detector function = peak, Trace = max hold
sweep points ≥ investigated frequency range/RBW.

6.10.3 Deviation from standard

No deviation.

6.10.4 Test setup



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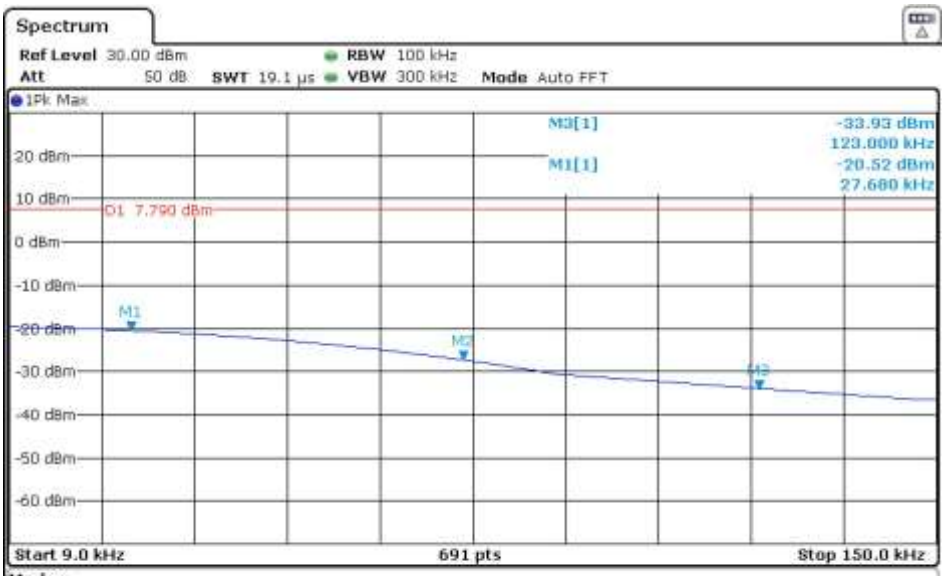
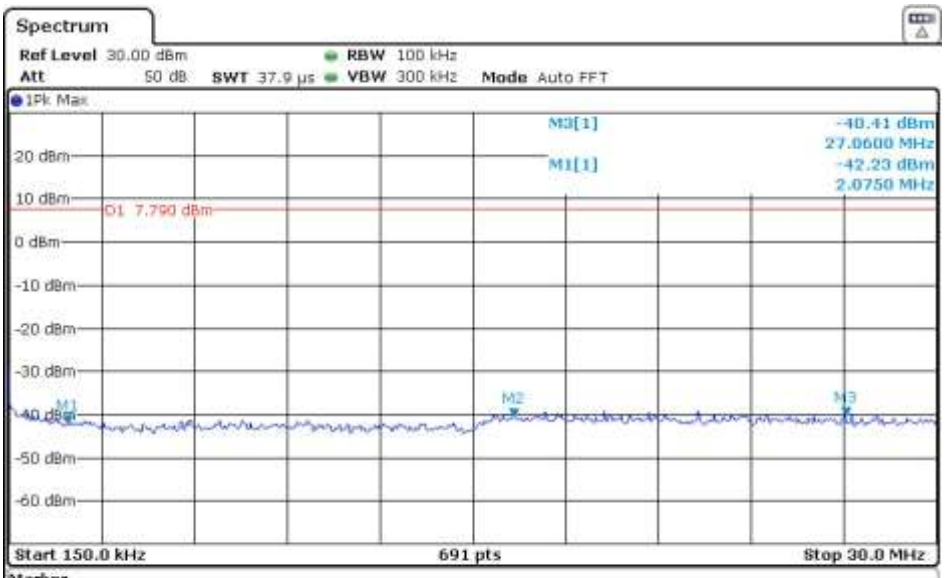
6.10.5 Test results

@902.3MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	27.68 kHz	-20.52 dBm		
M2		1	78.02 kHz	-27.33 dBm		
M3		1	123.0 kHz	-33.93 dBm		



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.075 MHz	-42.23 dBm		
M2		1	16.403 MHz	-40.55 dBm		
M3		1	27.06 MHz	-40.41 dBm		

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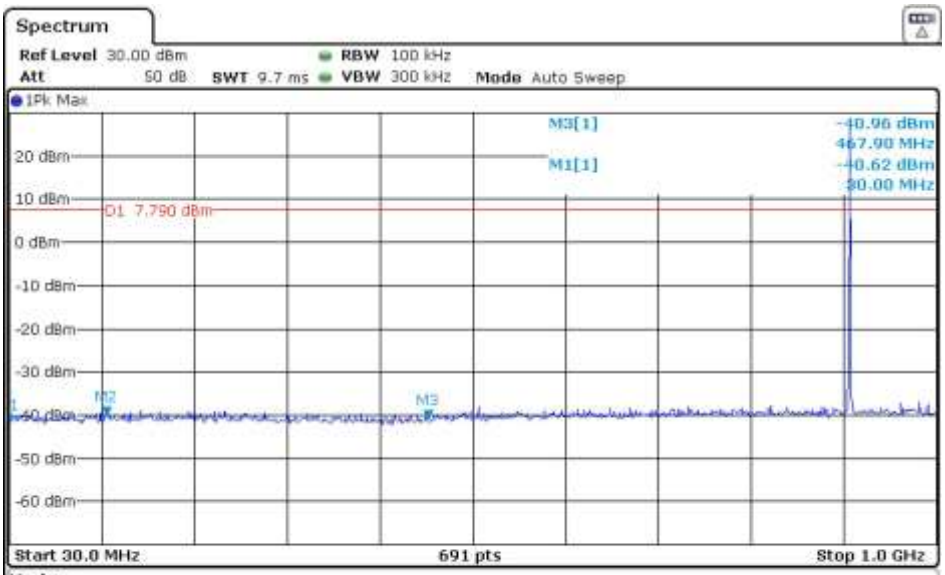
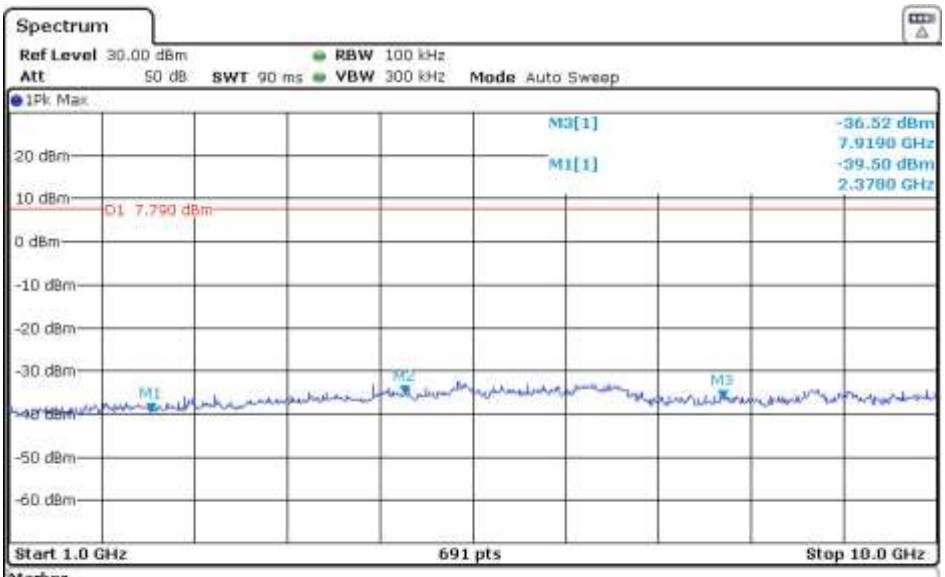


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	30.0 MHz	-40.62 dBm		
M2		1	132.0 MHz	-39.98 dBm		
M3		1	467.9 MHz	-40.96 dBm		



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.378 GHz	-39.50 dBm		
M2		1	4.838 GHz	-35.41 dBm		
M3		1	7.919 GHz	-36.52 dBm		

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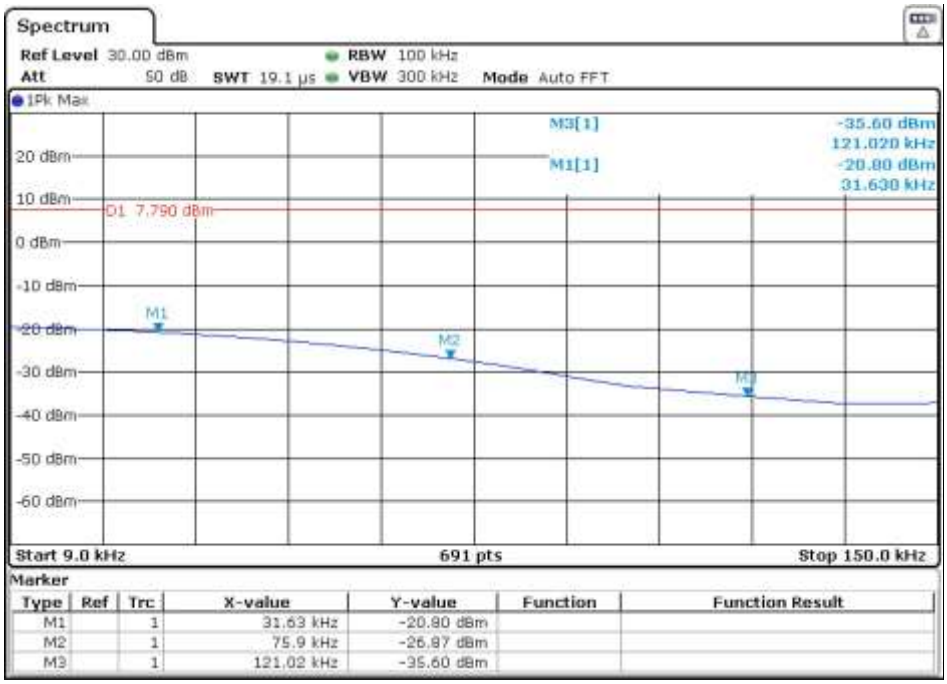
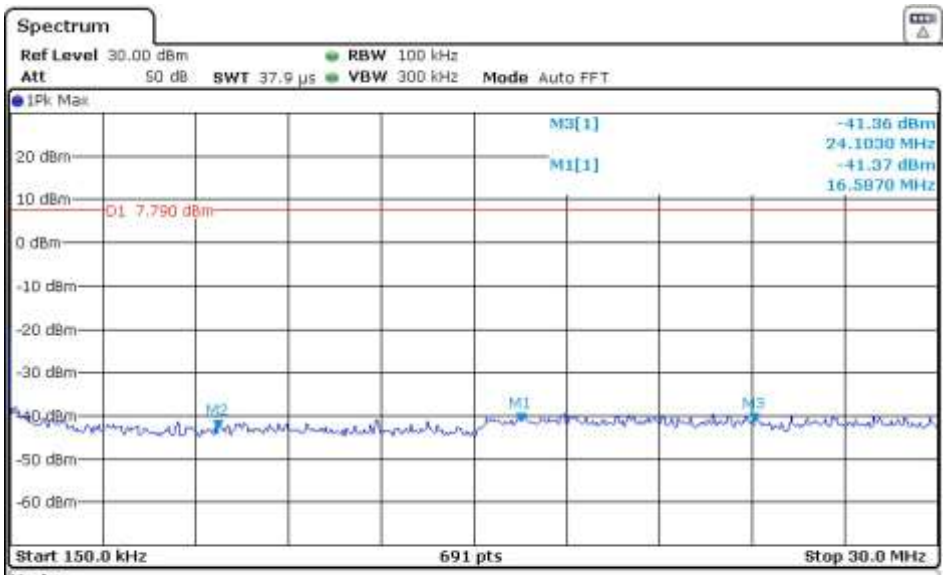
@908.5MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	31.63 kHz	-20.80 dBm		
M2		1	75.9 kHz	-26.87 dBm		
M3		1	121.02 kHz	-35.60 dBm		



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	16.587 MHz	-41.37 dBm		
M2		1	6.867 MHz	-43.13 dBm		
M3		1	24.103 MHz	-41.36 dBm		

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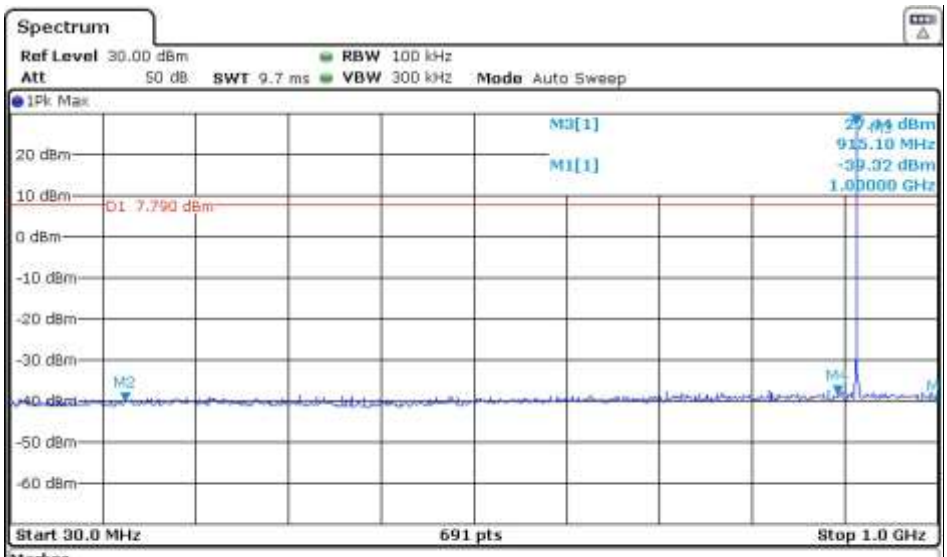
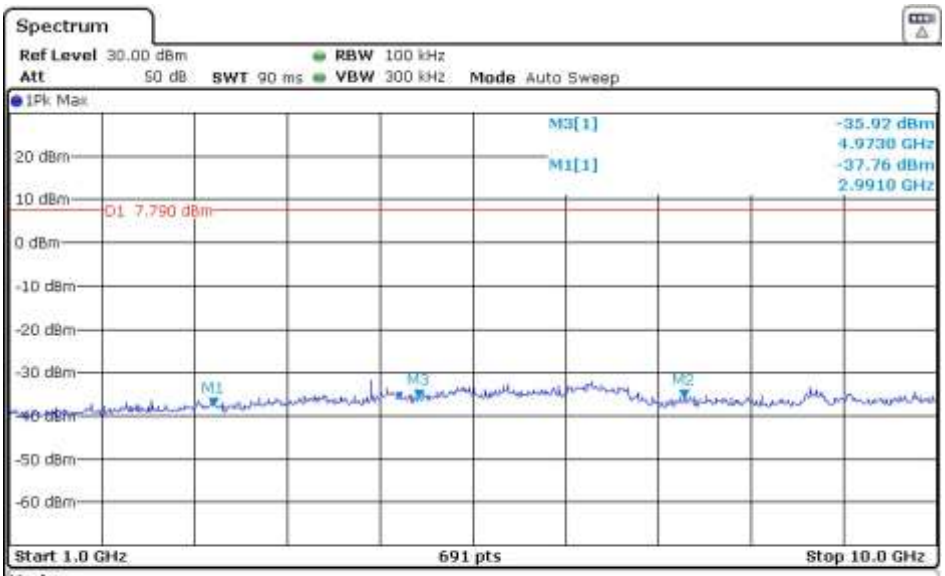


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	1.0 GHz	-39.32 dBm		
M2		1	151.14 MHz	-40.05 dBm		
M3		1	915.1 MHz	27.44 dBm		
M4		1	895.1 MHz	-38.32 dBm		



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.991 GHz	-37.76 dBm		
M2		1	7.55 GHz	-36.18 dBm		
M3		1	4.973 GHz	-35.92 dBm		

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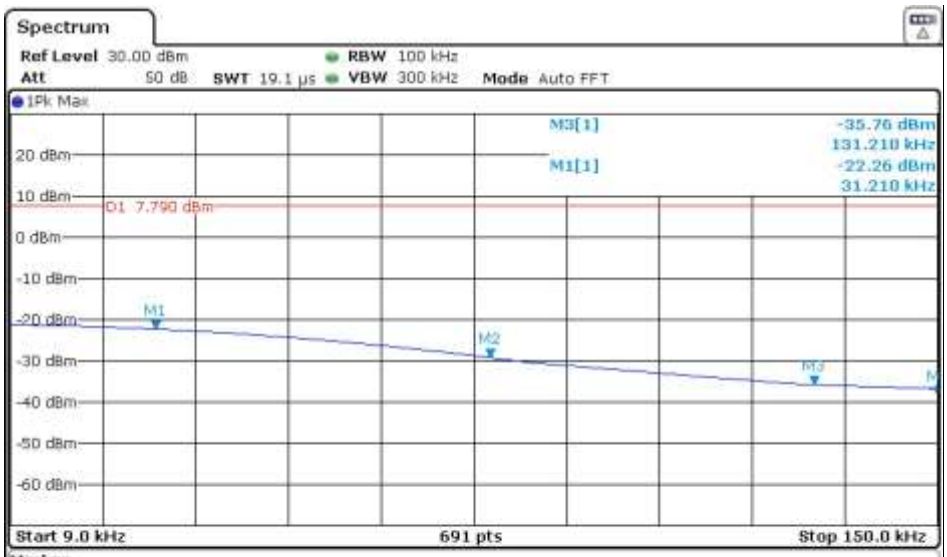
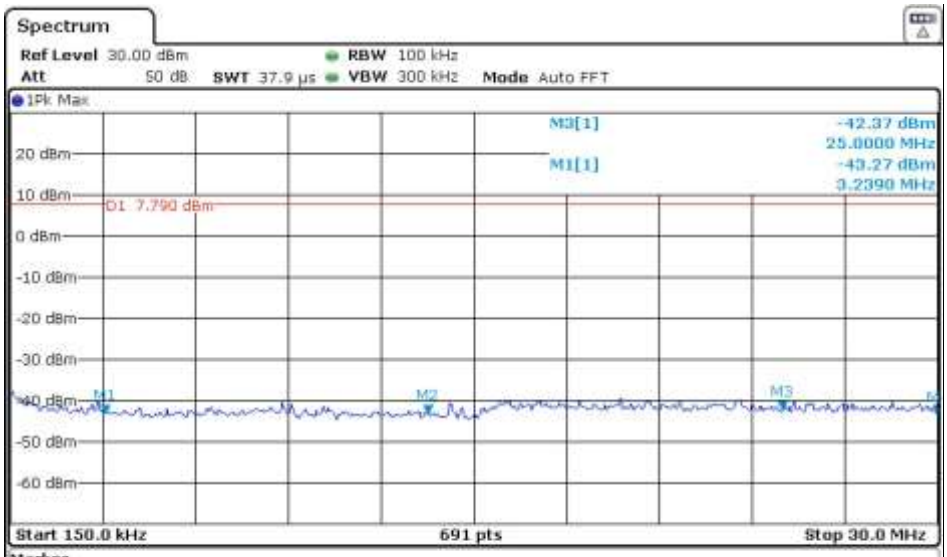
@914.9MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	31.21 kHz	-22.26 dBm		
M2		1	81.97 kHz	-29.20 dBm		
M3		1	131.21 kHz	-35.76 dBm		
M4		1	150.0 kHz	-36.72 dBm		



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	3.239 MHz	-43.27 dBm		
M2		1	13.62 MHz	-43.03 dBm		
M3		1	25.0 MHz	-42.37 dBm		
M4		1	30.0 MHz	-42.36 dBm		

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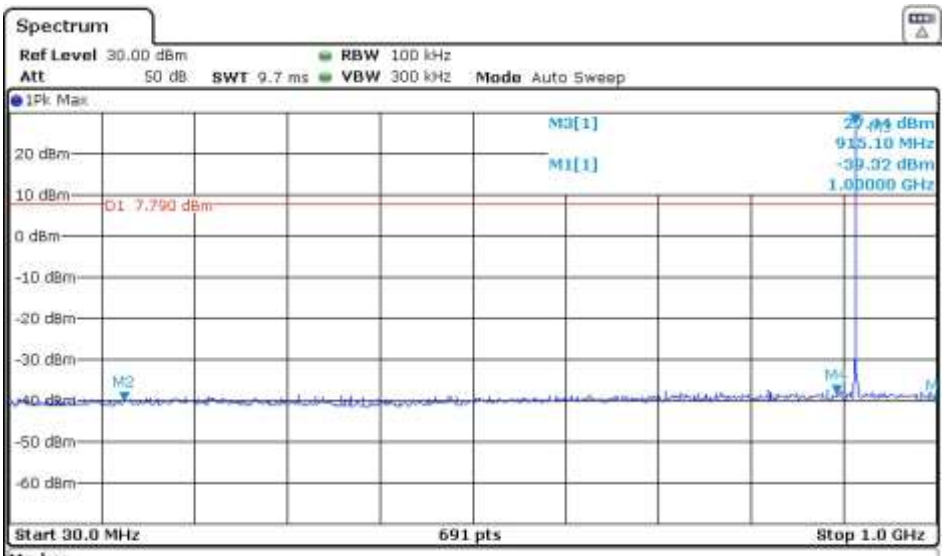
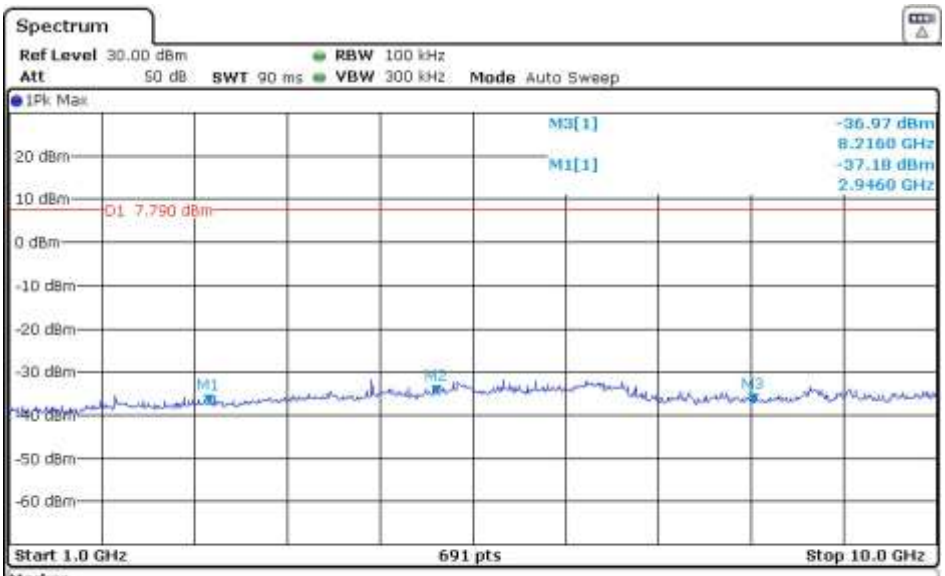


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	1.0 GHz	-39.32 dBm		
M2		1	151.14 MHz	-40.05 dBm		
M3		1	915.1 MHz	27.44 dBm		
M4		1	895.1 MHz	-38.32 dBm		



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.946 GHz	-37.18 dBm		
M2		1	5.144 GHz	-35.23 dBm		
M3		1	8.216 GHz	-36.97 dBm		

****End of Report****

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