FCC RF Test Report

APPLICANT	:	Ring LLC
EQUIPMENT	:	Test Kit
BRAND NAME	:	ring
MODEL NAME	:	5UM3E5
FCC ID	:	2AEUP-BHAGF001
STANDARD	:	FCC Part 15 Subpart C §15.247
CLASSIFICATION	:	(DSS) Spread Spectrum Transmitter
TEST DATE(S)	:	Nov. 04, 2020 ~ May 27, 2021

We, Sporton International Inc. (Kunshan), would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International Inc. (Kunshan), the test report shall not be reproduced except in full.

Jason Jia

Reviewed by: Jason Jia / Supervisor

Alex Wang

Approved by: Alex Wang / Manager

ACCREDITED Cert #5145.02

Sporton International Inc. (Kunshan)
No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300
People's Republic of China

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REVISION HISTORY

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR151806B	Rev. 01	Initial issue of report	May 16, 2022

SUMMARY OF TEST RESULT

Report Section	FCC Rule	Description	Limit	Result	Remark
3.1	15.247(a)(1)(i)	Number of Channels	15.247(a)(1)(i)	Pass	-
3.2	15.247(a)(1)	Hopping Channel Separation	20dB Bandwidth	Pass	-
3.3	15.247(a)(1)(i)	Dwell Time of Each Channel	15.247(a)(1)(i)	Pass	-
3.4	15.247(a)(1)(i)	20dB Bandwidth	≤ 500 kHz	Pass	-
3.4	-	99% Bandwidth	-	Pass	-
3.5	15.247(b)(2)	Peak Output Power	≤ 1 W	Pass	-
3.6	15.247(d)	Conducted Band Edges	≤ 20dBc	Pass	-
3.7	15.247(d)	Conducted Spurious Emission	≤ 20dBc	Pass	-
3.8	15.247(d)	Radiated Band Edges and Radiated Spurious Emission	15.209(a) & 15.247(d)	Pass	Under limit 3.90 dB at 8353.000 MHz
3.9	15.207	AC Conducted Emission	15.207(a)	Pass	Under limit 15.91 dB at 0.601 MHz
3.10	15.203 & 15.247(b)	Antenna Requirement	N/A	Pass	-

Declaration of Conformity:
The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.
Comments and Explanations:
The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

1 General Description

1.1 Applicant

Ring LLC
1523 26th Street, Santa Monica CA 90404, USA

1.2 Product Feature of Equipment Under Test

Product Feature	
Equipment	Test Kit
Brand Name	ring
Model Name	5UM3E5
FCC ID	2AEUP-BHAGF001
EUT supports Radios application	Bluetooth LE LoRa FSK GPS WIFI sniffing
HW Version	D-SS-A35-01A-A-V2.2
SW Version	nordic-diagnostics-images-1.2.0.5
EUT Stage	Identical Prototype

Remark: The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

1.3 Product Specification of Equipment Under Test

Standards-related Product Specification	
Tx/Rx Frequency Range	902 MHz ~ 928 MHz
Number of Channels / Data Rate	129 chs for 50kbps 64 chs for 150kbps 51 chs for 250kbps
Maximum Output Power to Antenna	Data Rate 50kbps : 26.72 dBm (0.4699 W) Data Rate 150kbps : 27.04 dBm (0.5058 W) Data Rate 250kbps : 26.79 dBm (0.4775 W)
99% Occupied Bandwidth	Data Rate 50kbps : 0.101MHz Data Rate 150kbps : 0.153MHz Data Rate 250kbps : 0.255MHz
Antenna Type / Gain	IFA stamping Antenna with gain -1.20 dBi
Type of Modulation	FSK

1.4 Modification of EUT

No modifications are made to the EUT during all test items.

1.5 Testing Location

Sporton International Inc. (Kunshan) is accredited to ISO/IEC 17025:2017 by American Association for Laboratory Accreditation with Certificate Number 5145.02.

Test Firm	Sporton International Inc. (Kunshan)		
Test Site Location	No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300 People's Republic of China TEL : +86-512-57900158 FAX : +86-512-57900958		
Test Site No.	**Sporton Site No.**	**FCC Designation No.**	**FCC Test Firm Registration No.**
	CO01-KS 03CH04-KS TH01-KS	CN1257	314309

1.6 Test Software

Item	Site	Manufacture	Name	Version
1.	03CH04-KS	AUDIX	E3	6.2009-8-24a
2.	CO01-KS	AUDIX	E3	6.2009-8-24

1.7 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- 47 CFR Part 15 Subpart C §15.247
- FCC KDB 558074 D01 15.247 Meas Guidance v05r02
- ANSI C63.10-2013

Remark:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.

2 Test Configuration of Equipment Under Test

2.1 Carrier Frequency Channel

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
902-928 MHz	1	902.2	44	910.8	87	919.4
	2	902.4	45	911	88	919.6
	3	902.6	46	911.2	89	919.8
	4	902.8	47	911.4	90	920
	5	903	48	911.6	91	920.2
	6	903.2	49	911.8	92	920.4
	7	903.4	50	912	93	920.6
	8	903.6	51	912.2	94	920.8
	9	903.8	52	912.4	95	921
	10	904	53	912.6	96	921.2
	11	904.2	54	912.8	97	921.4
	12	904.4	55	913	98	921.6
	13	904.6	56	913.2	99	921.8
	14	904.8	57	913.4	100	922
	15	905	58	913.6	101	922.2
	16	905.2	59	913.8	102	922.4
	17	905.4	60	914	103	922.6
	18	905.6	61	914.2	104	922.8
	19	905.8	62	914.4	105	923
	20	906	63	914.6	106	923.2
	21	906.2	64	914.8	107	923.4
	22	906.4	65	915	108	923.6
	23	906.6	66	915.2	109	923.8
	24	906.8	67	915.4	110	924
	25	907	68	915.6	111	924.2
	26	907.2	69	915.8	112	924.4
	27	907.4	70	916	113	924.6
	28	907.6	71	916.2	114	924.8
	29	907.8	72	916.4	115	925
	30	908	73	916.6	116	925.2
	31	908.2	74	916.8	117	925.4
	32	908.4	75	917	118	925.6
	33	908.6	76	917.2	119	925.8
	34	908.8	77	917.4	120	926
	35	909	78	917.6	121	926.2
	36	909.2	79	917.8	122	926.4
	37	909.4	80	918	123	926.6
	38	909.6	81	918.2	124	926.8
	39	909.8	82	918.4	125	927
	40	910	83	918.6	126	927.2
	41	910.2	84	918.8	127	927.4
	42	910.4	85	919	128	927.6
	43	910.6	86	919.2	129	927.8

Note: The above EUT's information was declared by manufacturer.

2.2 Test Mode

a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: conduction emission (150 kHz to 30 MHz), radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower) For radiated measurement, pre-scanned in three orthogonal panels, X, Y, Z. The worst cases (X plane) were recorded in this report,

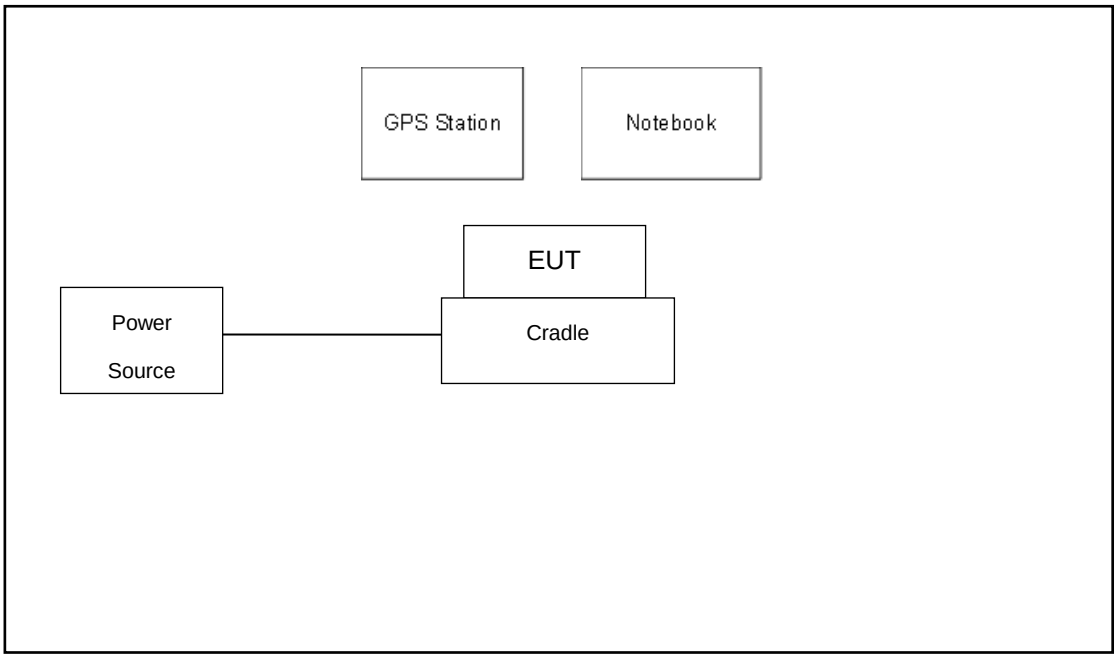
b. AC power line Conducted Emission was tested under maximum output power.

The following summary table is showing all test modes to demonstrate in compliance with the standard.

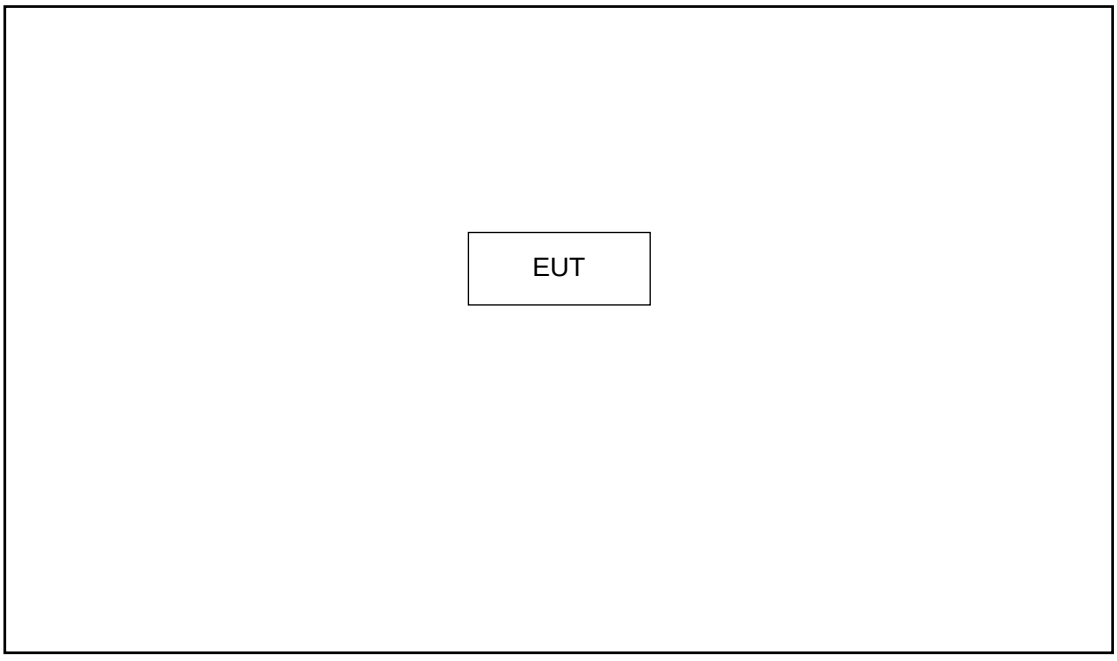
Summary table of Test Cases			
Test Item	**Modulation / Data Rate**		
	FSK FHSS / 50kbps	**FSK FHSS / 150kbps**	**FSK FHSS / 250kbps**
Conducted Test Cases	Low: 902.2 MHz Miid: 915 MHz High: 927.8 MHz	Low: 902.4 MHz Mid: 914.8 MHz High: 927.6 MHz	Low: 902.5 MHz Mid: 915 MHz High: 927.5 MHz
Radiated Test Cases	Low: 902.2 MHz Miid: 915 MHz High: 927.8 MHz	Low: 902.4 MHz Mid: 914.8 MHz High: 927.6 MHz	Low: 902.5 MHz Mid: 915 MHz High: 927.5 MHz
AC Conducted Emission	Mode 1 : Lora Tx + Bluetooth Tx + GPS RX + Cradle + Charging from Adapter		
Co-location	Mode 1: Bluetooth Tx CH39_2480 MHz + FSK 50kbps Tx_915 MHz		

2.3 Connection Diagram of Test System

For Conducted Emission:



For Radiated Emission:



2.4 Support Unit used in test configuration and system

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	GPS Station	RACELOGIC	RLLS03-2RP	N/A	N/A	Unshielded, 1.8m
2.	Notebook	Lenovo	G480	QDS-BRCM1050I	N/A	AC I/P: Unshielded, 1.8 m DC O/P: Shielded, 1.8 m

2.5 EUT Operation Test Setup

For FSK FHSS function, the engineering test program was provided and enabled to make EUT continuous transmit/receive.

2.6 Measurement Results Explanation Example

For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Example:

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

Offset = RF cable loss + attenuator factor.

Following shows an offset computation example with cable loss 4.5 dB and 10dB attenuator.

Offset(dB) = RF cable loss(dB) + attenuator factor(dB).

= 4.5 + 10 = 14.5 (dB)

3 Test Result

3.1 Number of Channel Measurement

3.1.1 Limits of Number of Hopping Frequency

For frequency hopping systems operating in the 902-928 MHz band: 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; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.

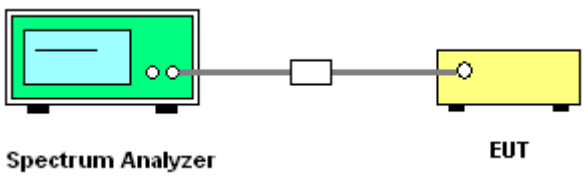
3.1.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.1.3 Test Procedure

1. The testing follows ANSI C63.10-2013 clause 7.8.3.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Enable the EUT hopping function.
5. Use the following spectrum analyzer settings: Span = the frequency band of operation;
   RBW = 50kHz, VBW = 200kHz (for 50kbps);
   RBW = 100kHz, VBW = 300kHz (for 150kbps);
   RBW = 100kHz, VBW = 300kHz (for 250kbps);
   Sweep = auto; Detector function = peak; Trace = max hold.
6. The number of hopping frequency used is defined as the number of total channel.
7. Record the measurement data derived from spectrum analyzer.

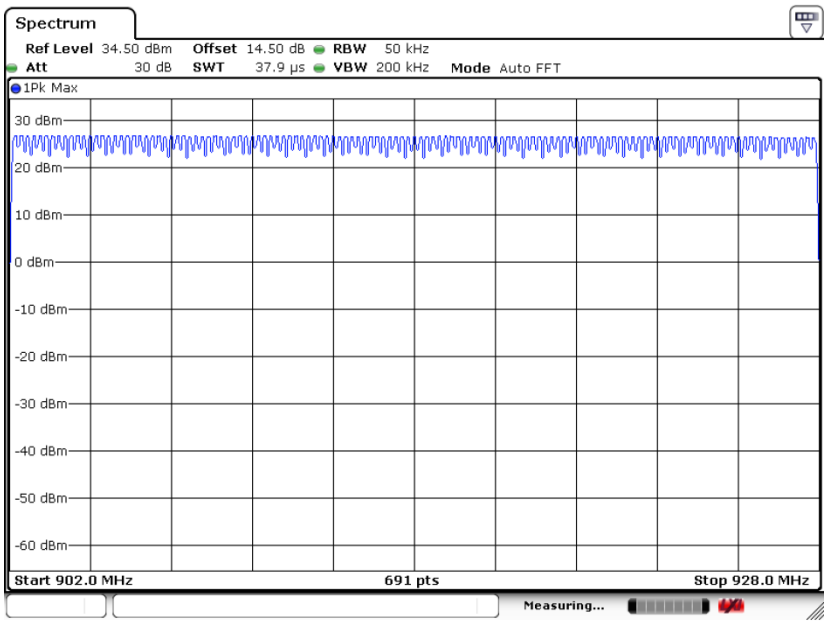
3.1.4 Test Setup



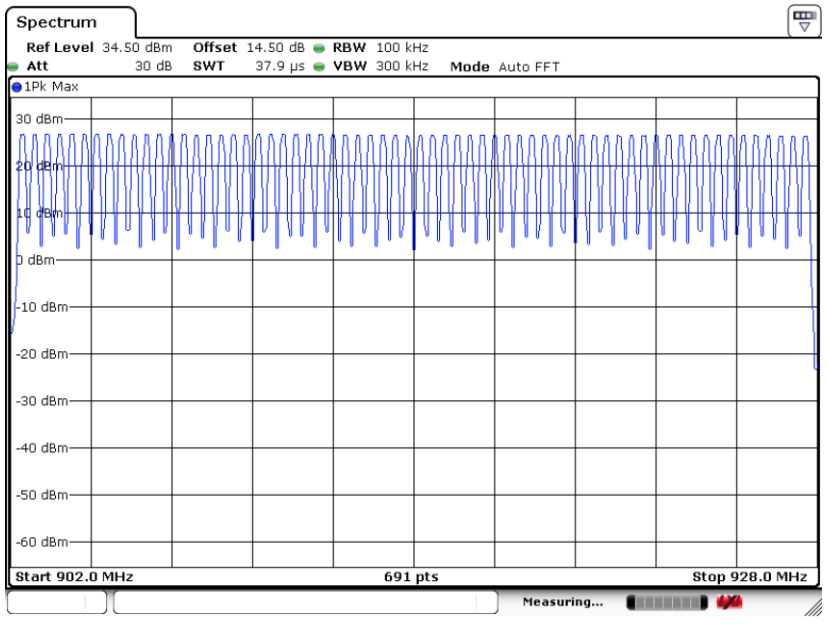
3.1.5 Test Result of Number of Hopping Frequency

Please refer to Appendix A.

Number of Hopping Channel Plot (Data Rate 50kbps)



Number of Hopping Channel Plot (Data Rate 150kbps)



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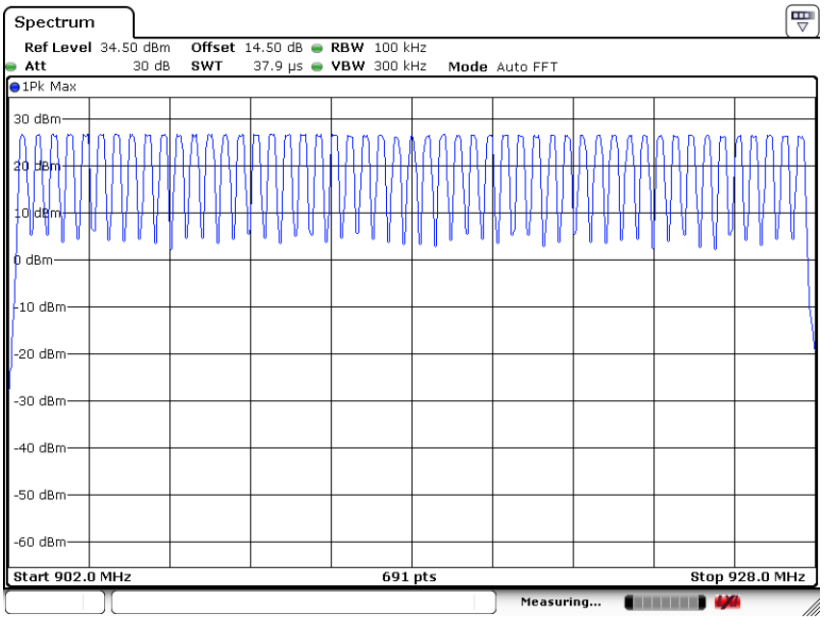
Number of Hopping Channel Plot (Data Rate 250kbps)



3.2 Hopping Channel Separation Measurement

3.2.1 Limit of Hopping Channel Separation

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.

3.2.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.2.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.2.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Enable the EUT hopping function.
5. Use the following spectrum analyzer settings:
   Span = wide enough to capture the peaks of two adjacent channels;
   RBW = 50kHz, VBW = 200kHz (for 50kbps);
   RBW = 100kHz, VBW = 300kHz (for 150kbps);
   RBW = 200kHz, VBW = 500kHz (for 250kbps);
   Sweep = auto; Detector function = peak; Trace = max hold.
6. Measure and record the results in the test report.

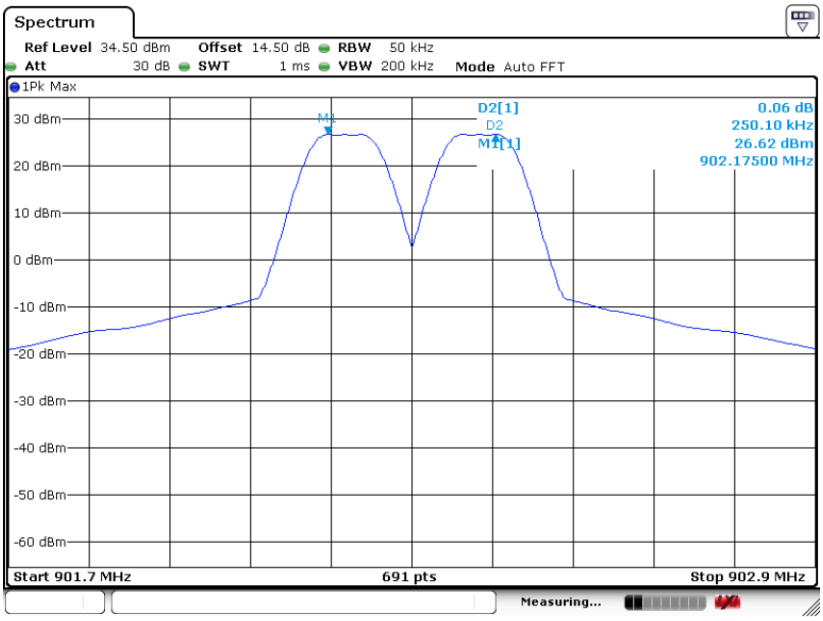
3.2.4 Test Setup

3.2.5 Test Result of Hopping Channel Separation

Please refer to Appendix A.

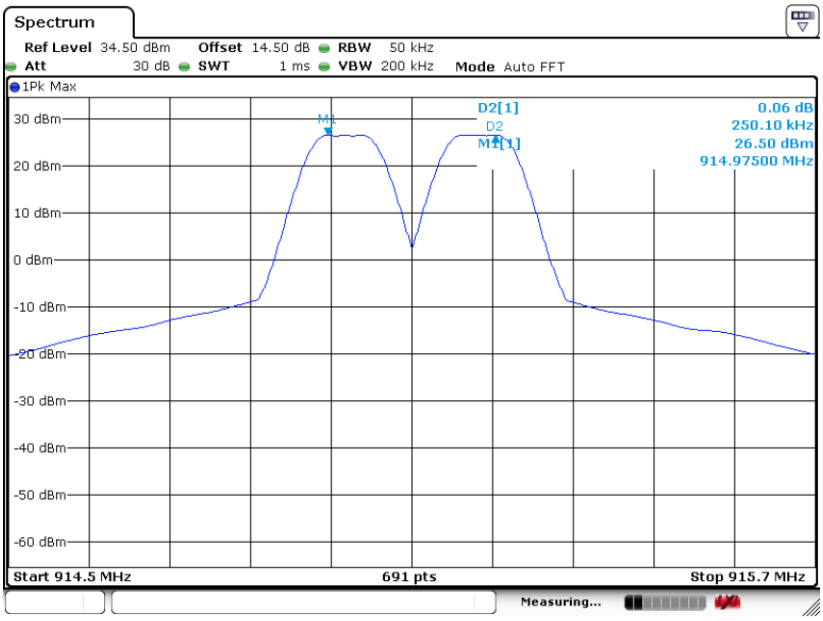
<Data Rate 50kbps>

Channel Separation Plot on Low CH



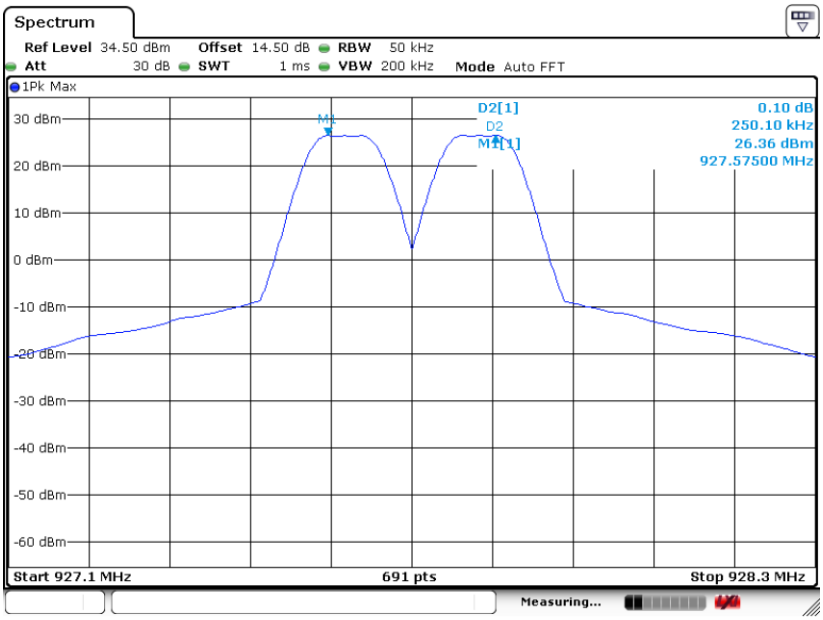
Date: 4.NOV.2020 10:38:35

Channel Separation Plot on Mid CH



Date: 4.NOV.2020 10:36:26

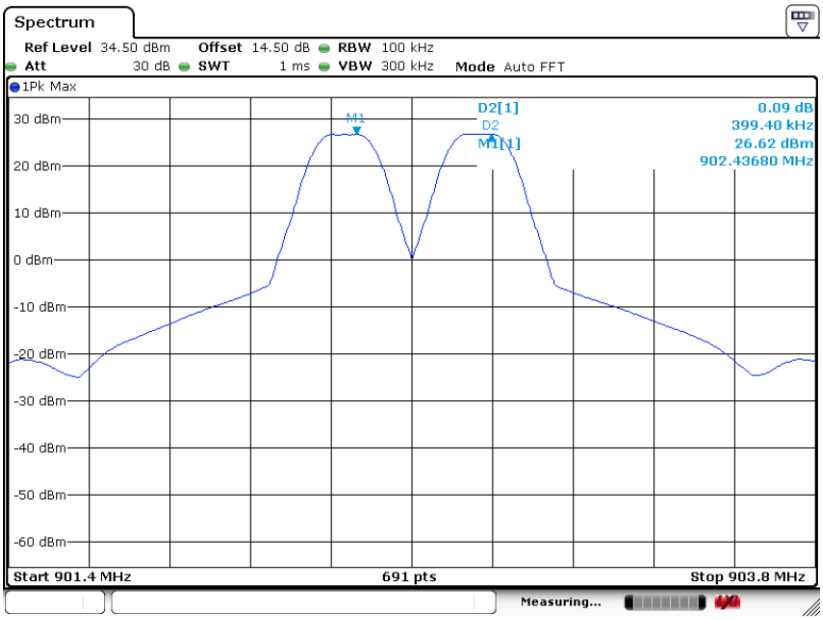
Channel Separation Plot on High CH



Date: 4.NOV.2020 10:33:05

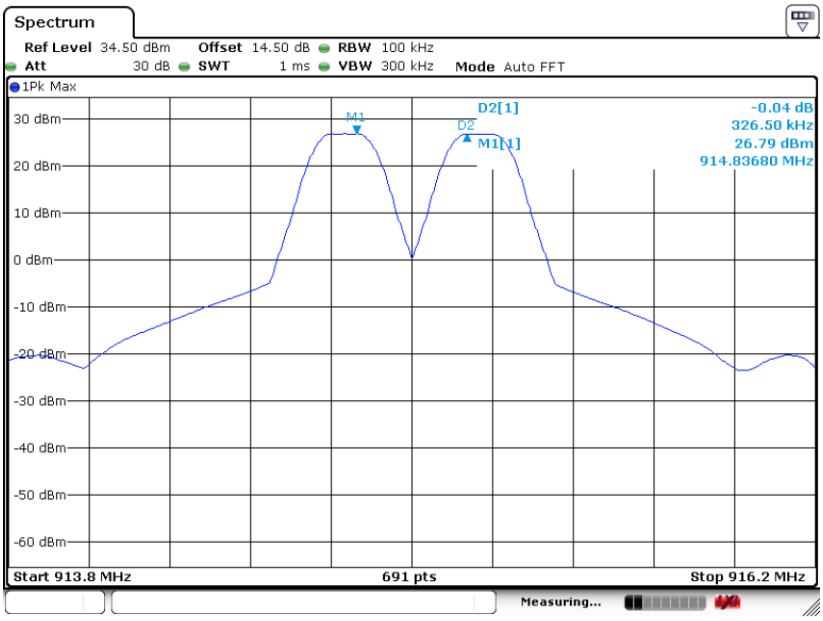
<Data Rate 150kbps>

Channel Separation Plot on Low CH



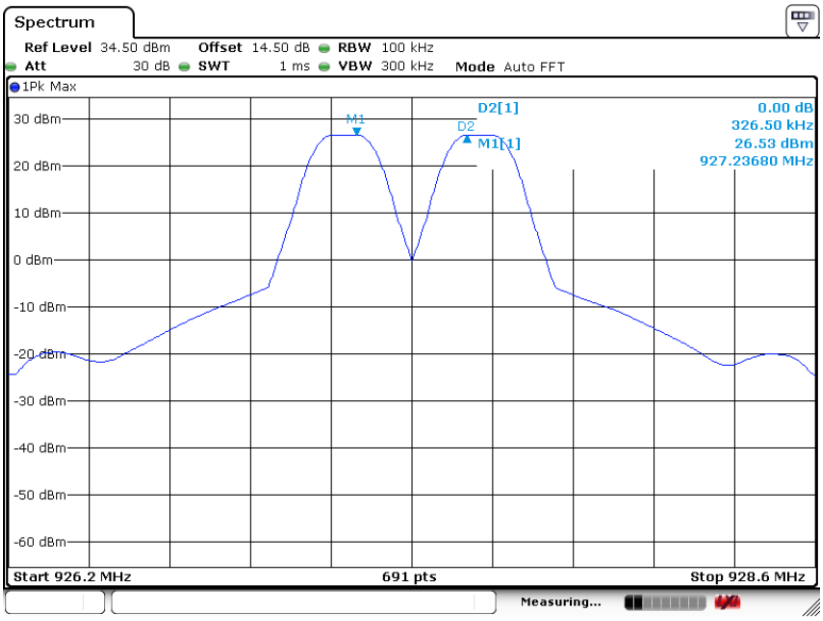
Date: 4.NOV.2020 10:50:47

Channel Separation Plot on Mid CH



Date: 4.NOV.2020 12:16:35

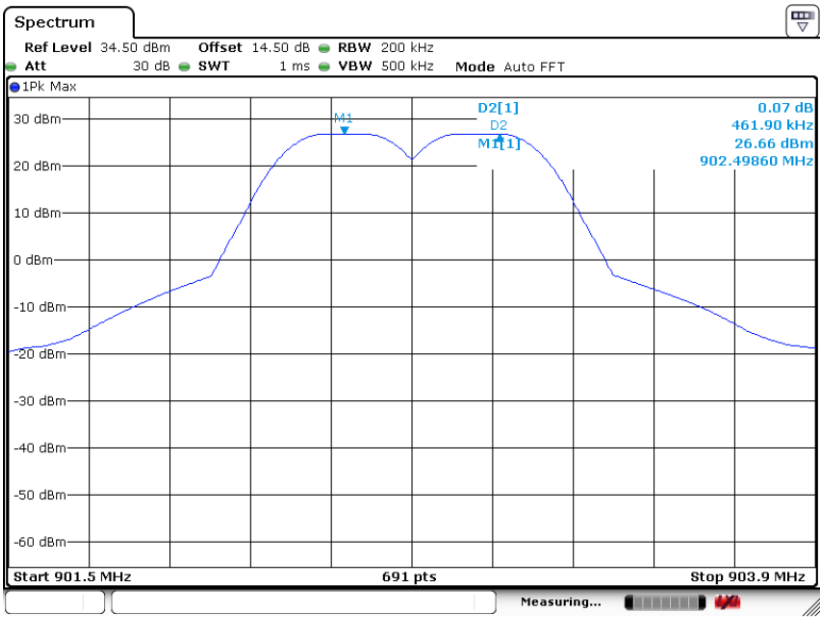
Channel Separation Plot on High CH



Date: 4.NOV.2020 12:19:02

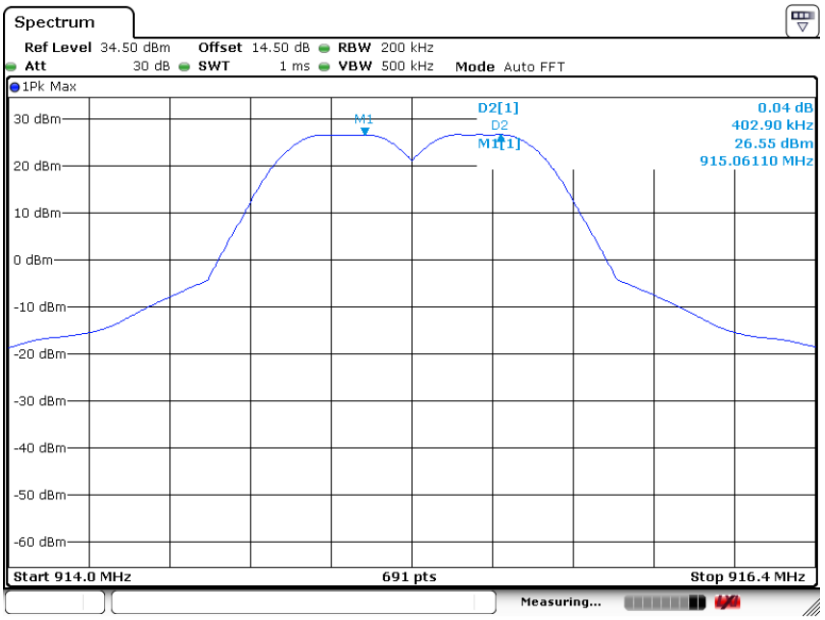
<Data Rate 250kbps>

Channel Separation Plot on Low CH



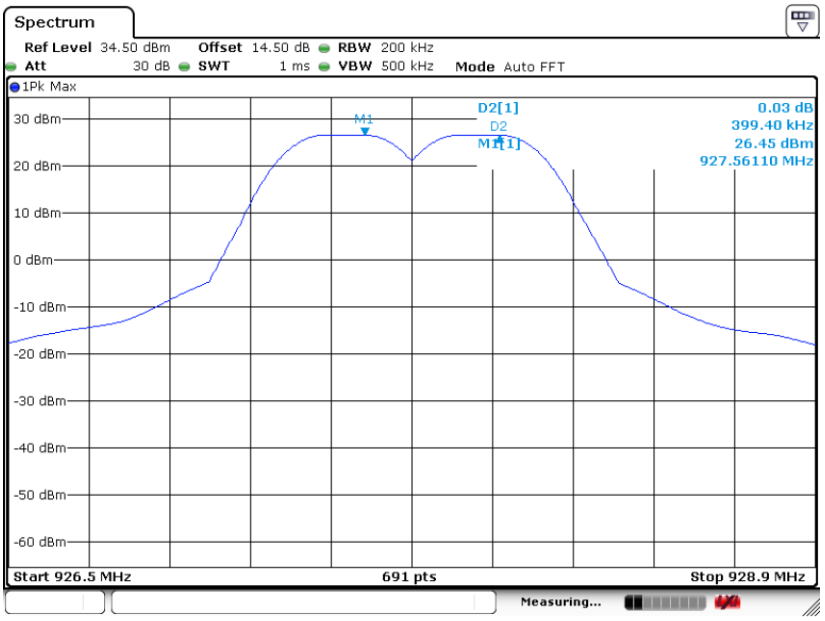
Date: 4.NOV.2020 12:24:15

Channel Separation Plot on Mid CH



Date: 4.NOV.2020 12:26:38

Channel Separation Plot on High CH



3.3 Dwell Time Measurement

3.3.1 Limit of Dwell Time

For frequency hopping systems operating in the 902-928 MHz band: 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; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.

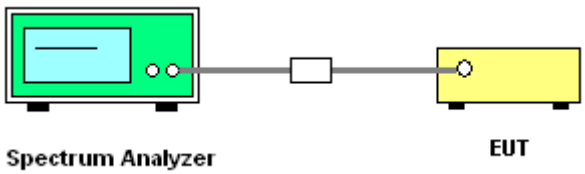
3.3.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.3.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.4.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Enable the EUT hopping function.
5. Use the following spectrum analyzer settings: Span = zero span, centered on a hopping channel; RBW = 20 KHz; VBW = 20 KHz; Sweep = as necessary to capture the entire dwell time per hopping channel; Detector function = peak; Trace = max hold.
6. Measure and record the results in the test report.

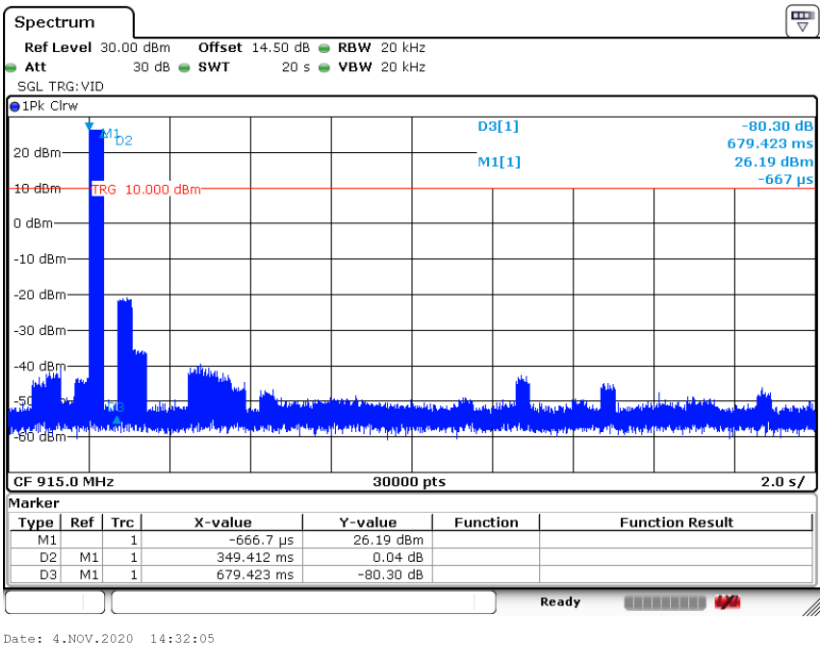
3.3.4 Test Setup



3.3.5 Test Result of Dwell Time

Please refer to Appendix A.

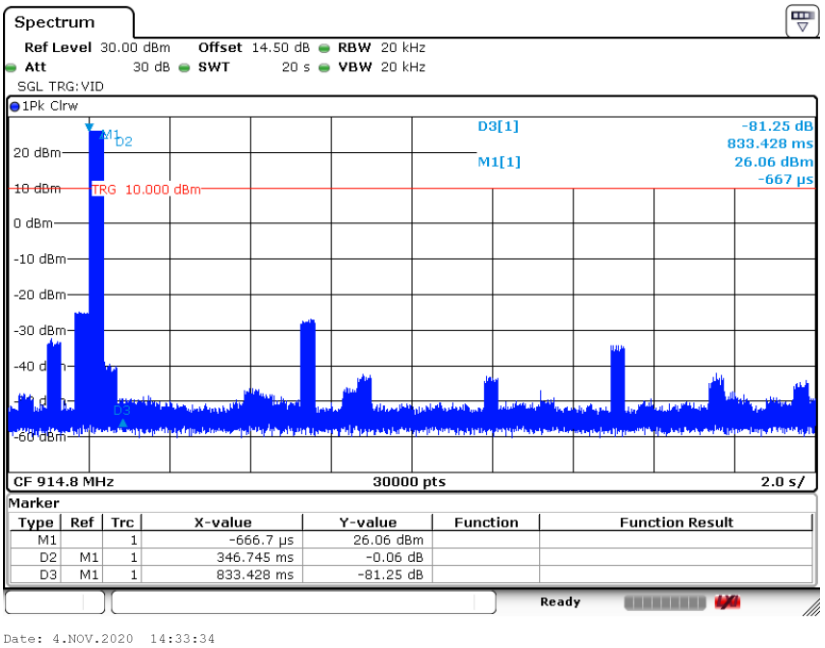
DT on-time and Hops over 20 sec period for Data Rate 50kbps



Remark:

Dwell Time(s) = Hops Over Occupancy Time (hops) x Package Transfer Time
= 1 (hop) x 349.412 (ms)
= 0.349 (sec)

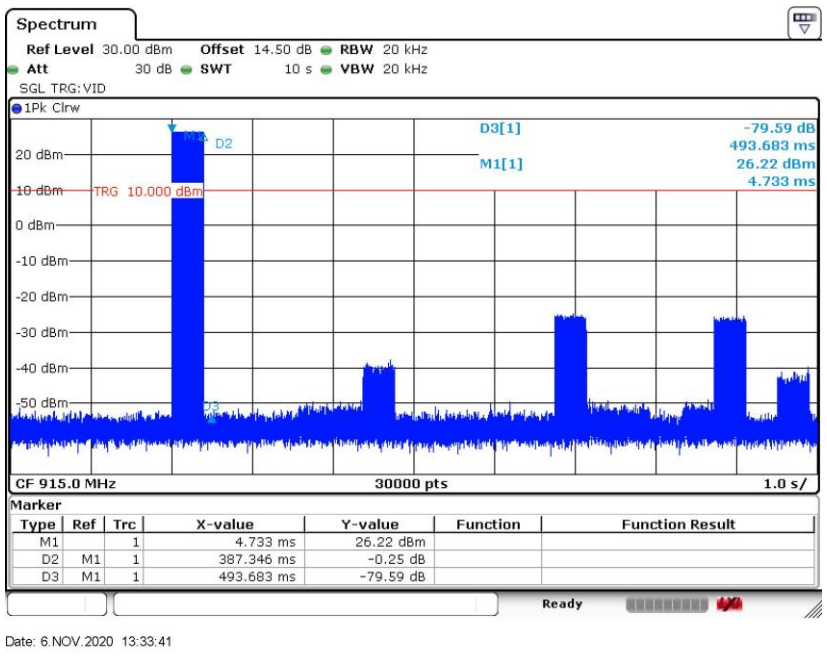
DT on-time and Hops over 20 sec period for Data Rate 150kbps



Remark:

Dwell Time(s) = Hops Over Occupancy Time (hops) x Package Transfer Time
= 1 (hop) x 346.745 (ms)
= 0.347 (sec)

DT on-time and Hops over 10 sec period for Data Rate 250kbps



Remark:

Dwell Time(s) = Hops Over Occupancy Time (hops) x Package Transfer Time
= 1 (hop) x 387.346 (ms)
= 0.387 (sec)

3.4 20dB and 99% Bandwidth Measurement

3.4.1 Limit of 20dB and 99% Bandwidth

The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

3.4.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.4.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 6.9.2 and 6.9.3.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Use the following spectrum analyzer settings for 20dB Bandwidth measurement.
   Span = approximately 2 to 5 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.
5. Use the following spectrum analyzer settings for 99 % Bandwidth measurement.
   Span = approximately 1.5 to 5 times the 99% bandwidth, centered on a hopping channel;
   RBW ≥ 1% of the 99% bandwidth; VBW ≥ RBW; Sweep = auto; Detector function = sample;
   Trace = max hold.
6. Measure and record the results in the test report.

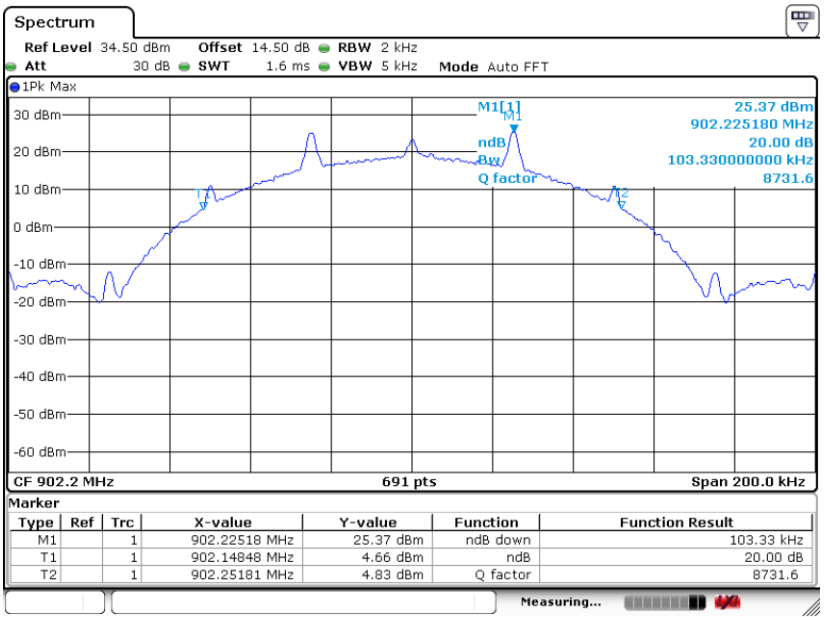
3.4.4 Test Setup

3.4.5 Test Result of 20dB Bandwidth

Please refer to Appendix A.

<Data Rate 50kbps>

20 dB Bandwidth Plot on Low Channel



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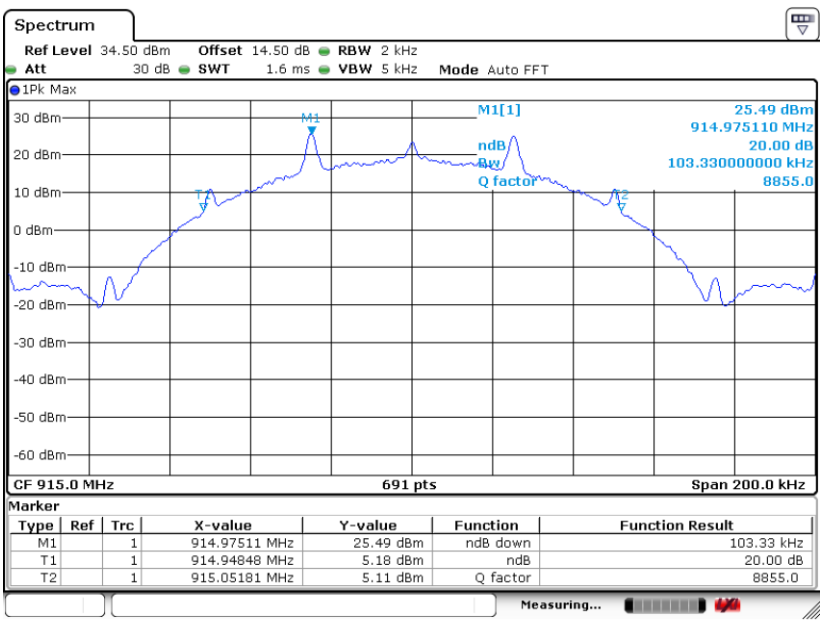
20 dB Bandwidth Plot on Mid Channel



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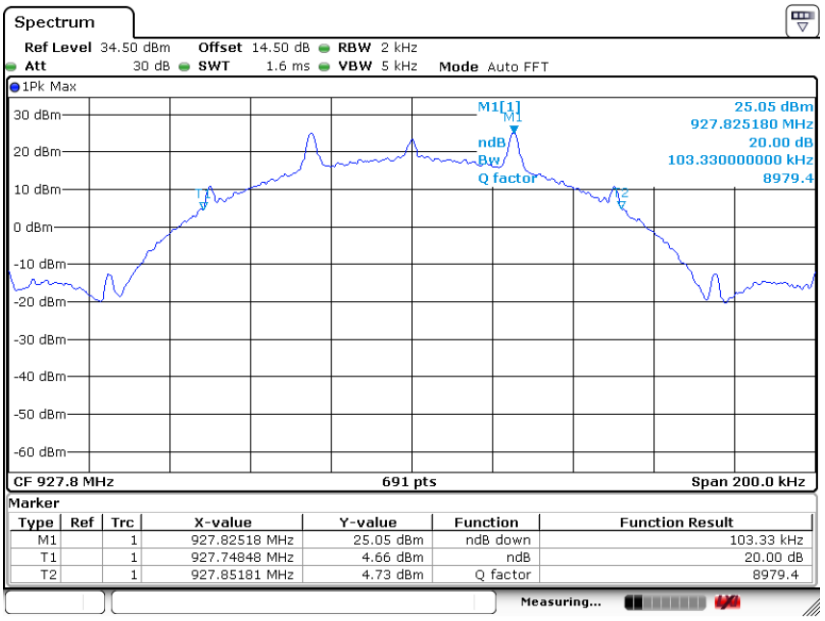
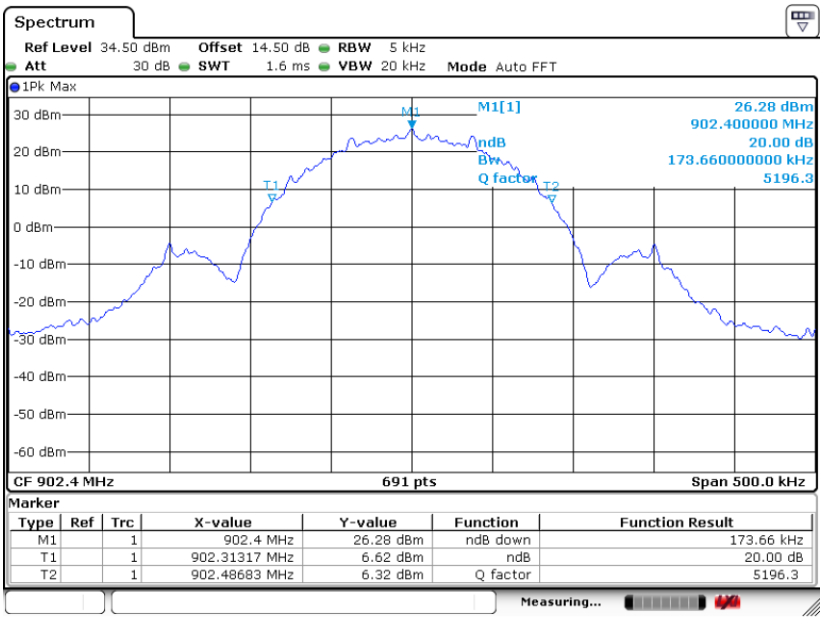
20 dB Bandwidth Plot on High Channel



Date: 4.NOV.2020 09:12:50

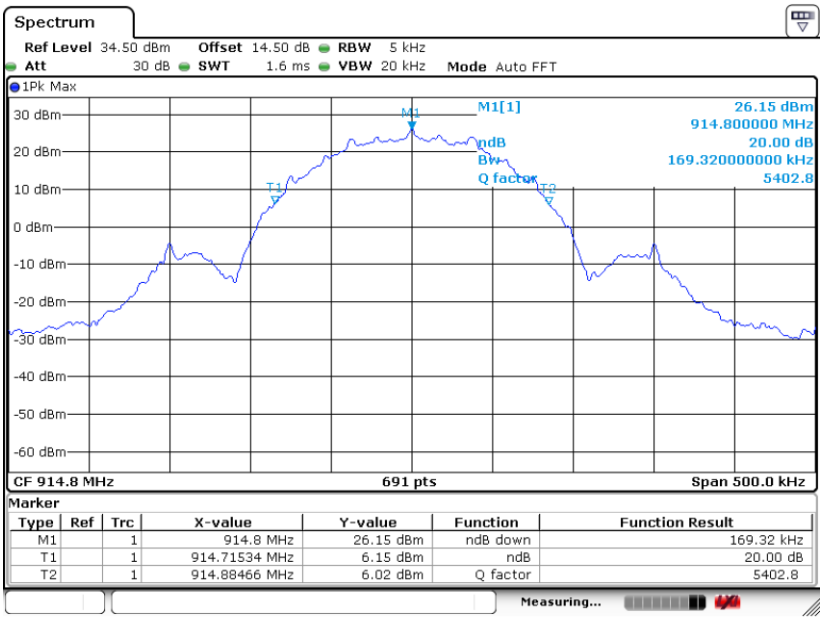
<Data Rate 150kbps>

20 dB Bandwidth Plot on Low Channel



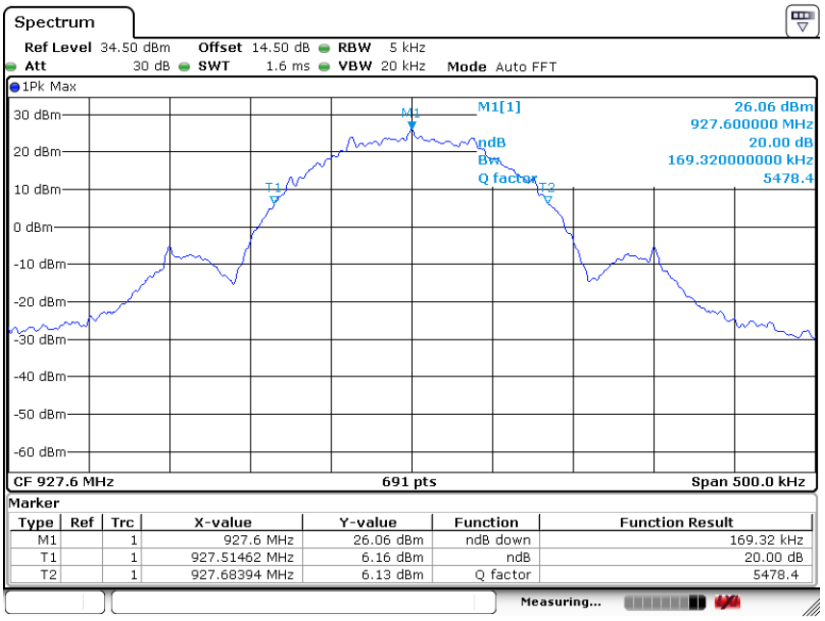
Date: 4.NOV.2020 09:16:22

20 dB Bandwidth Plot on Mid Channel



Date: 4.NOV.2020 09:15:00

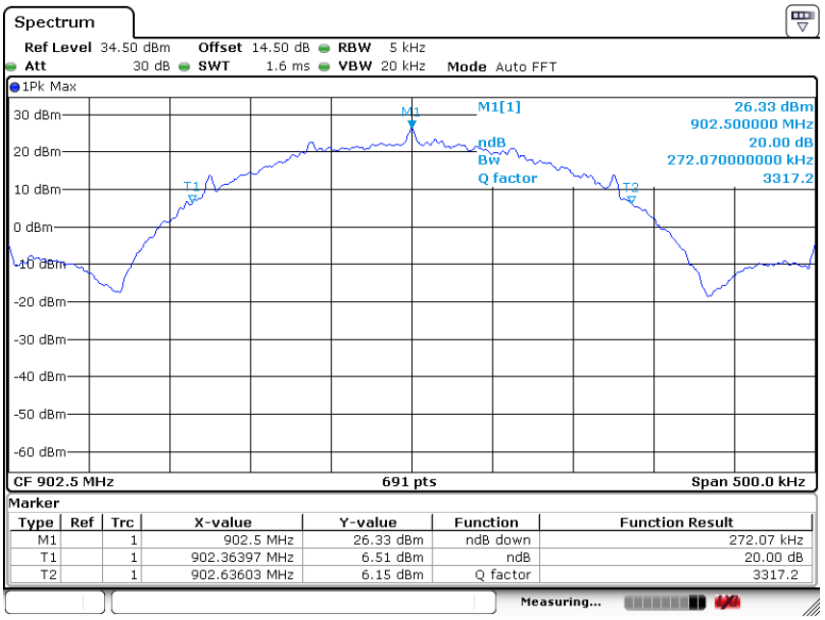
20 dB Bandwidth Plot on High Channel



Date: 4.NOV.2020 09:18:17

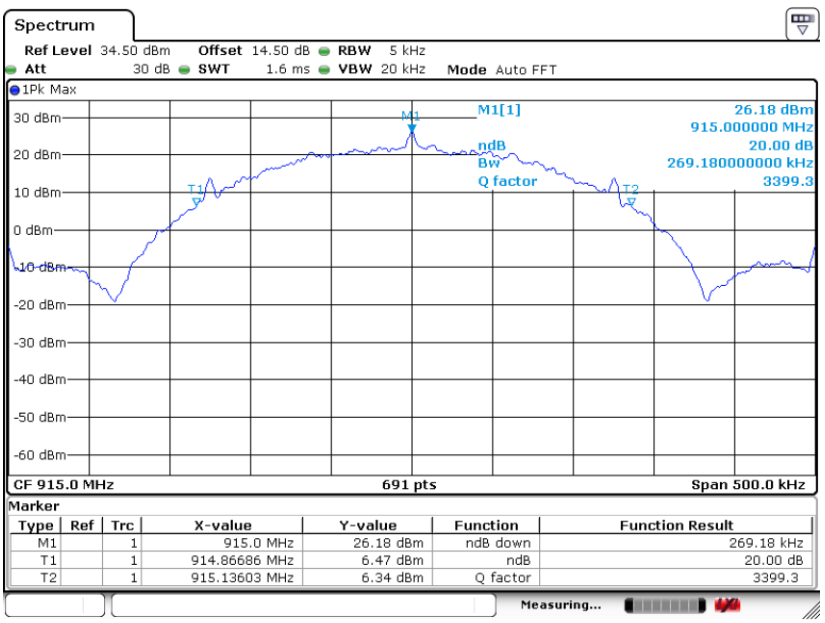
<Data Rate 250kbps>

20 dB Bandwidth Plot on Low Channel



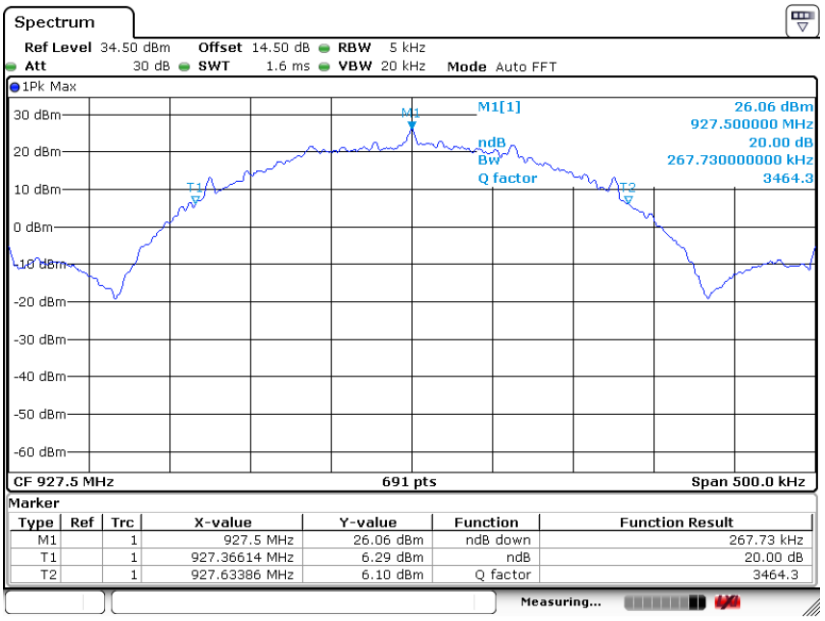
Date: 4.NOV.2020 09:20:31

20 dB Bandwidth Plot on Mid Channel



Date: 4.NOV.2020 09:21:36

20 dB Bandwidth Plot on High Channel

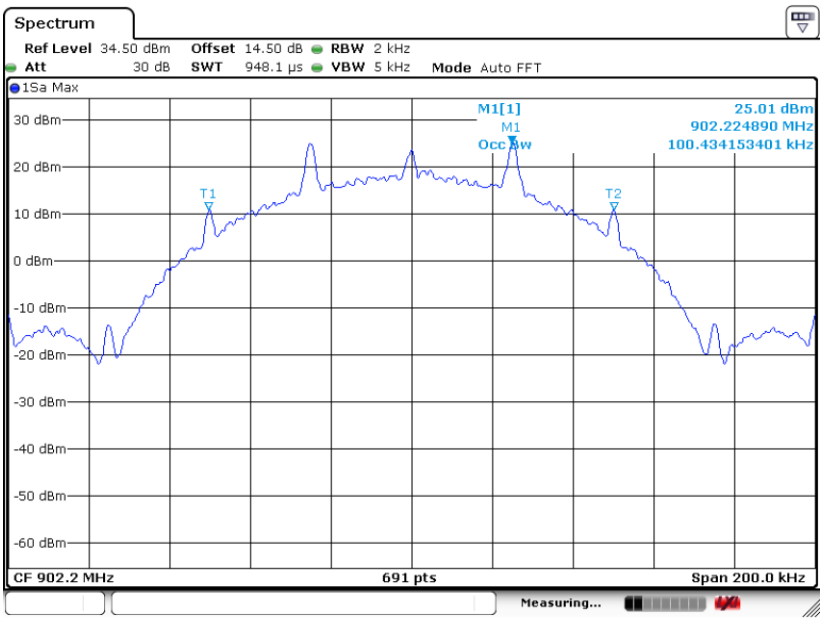


3.4.6 Test Result of 99% Occupied Bandwidth

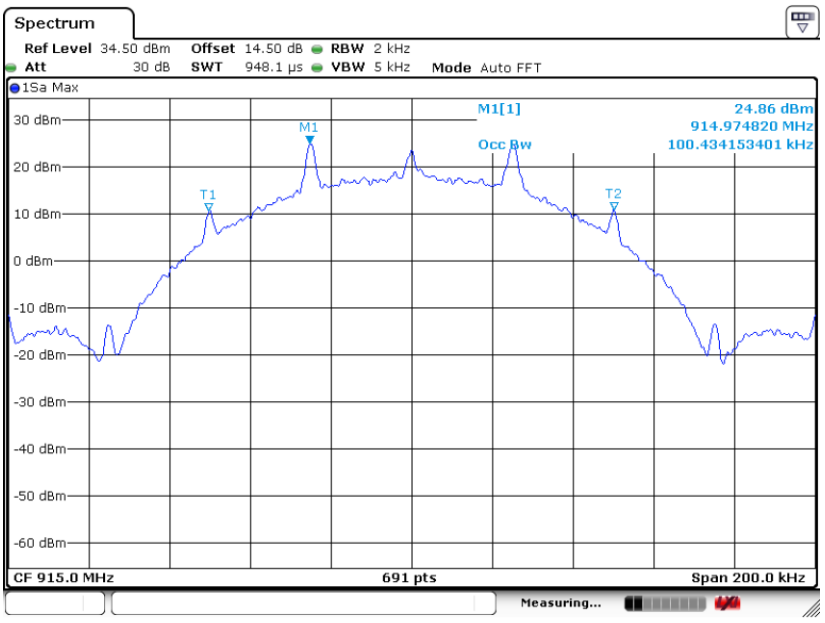
Please refer to Appendix A.

<Data Rate 50kbps>

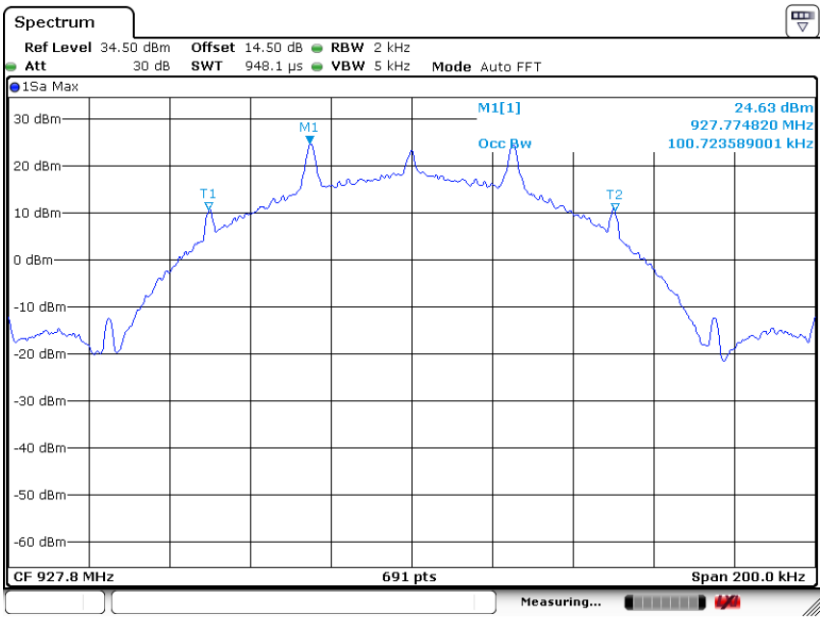
99% Occupied Bandwidth Plot on Low Channel



99% Occupied Bandwidth Plot on Mid Channel



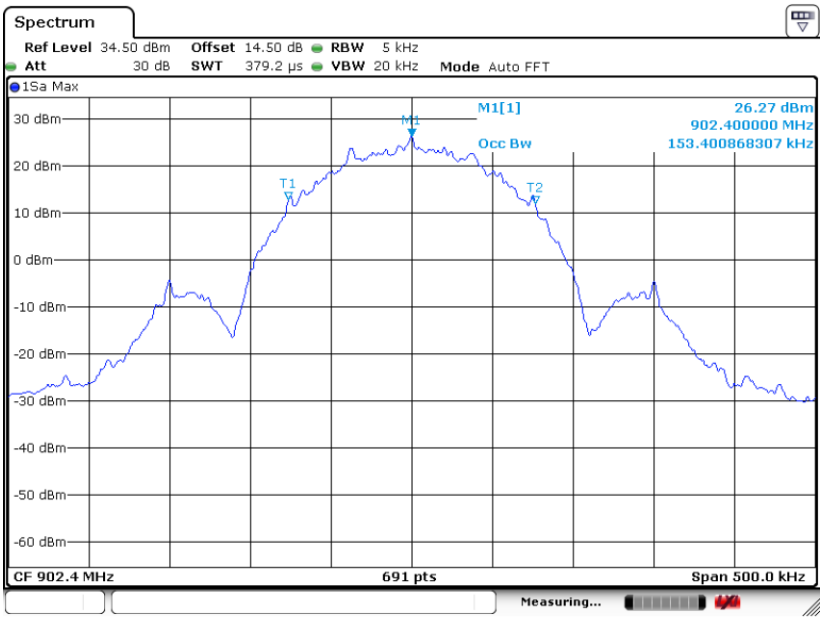
99% Occupied Bandwidth Plot on High Channel



Date: 4.NOV.2020 10:10:31

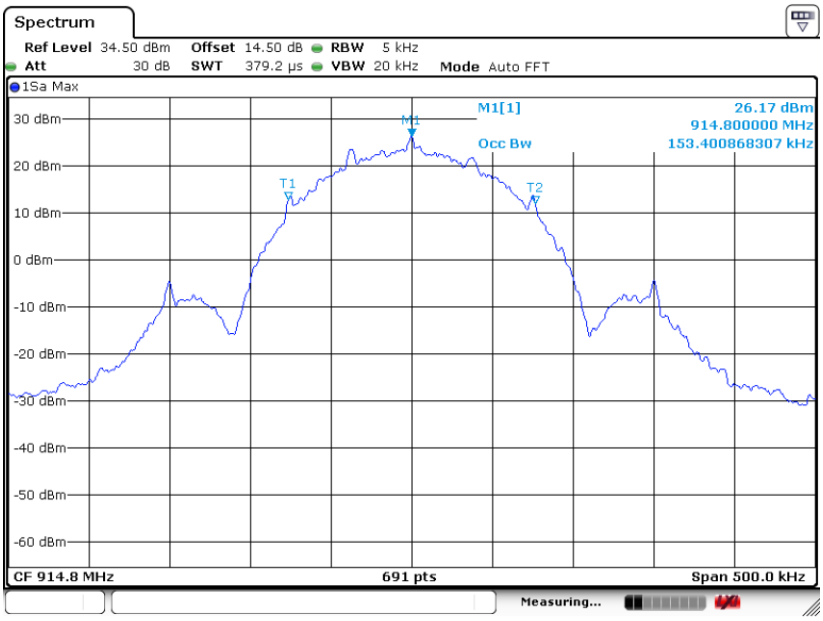
<Data Rate 150kbps>

99% Occupied Bandwidth Plot on Low Channel



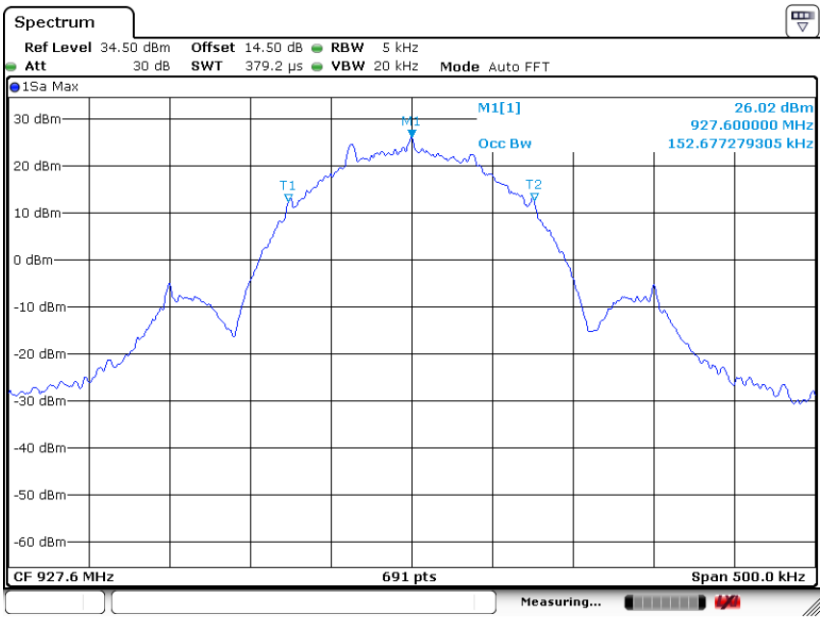
Date: 4.NOV.2020 10:22:36

99% Occupied Bandwidth Plot on Mid Channel



Date: 4.NOV.2020 10:21:11

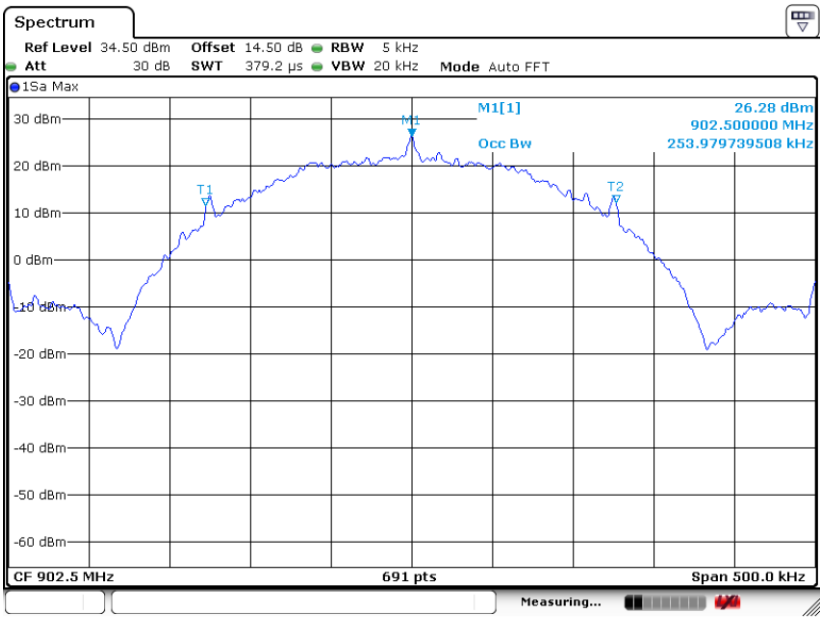
99% Occupied Bandwidth Plot on High Channel



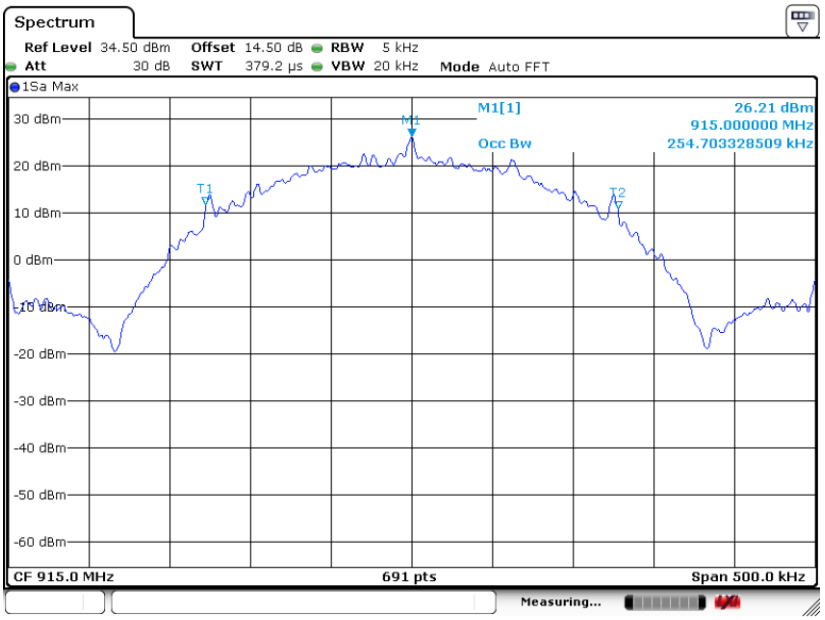
Date: 4.NOV.2020 10:18:20

<Data Rate 250kbps>

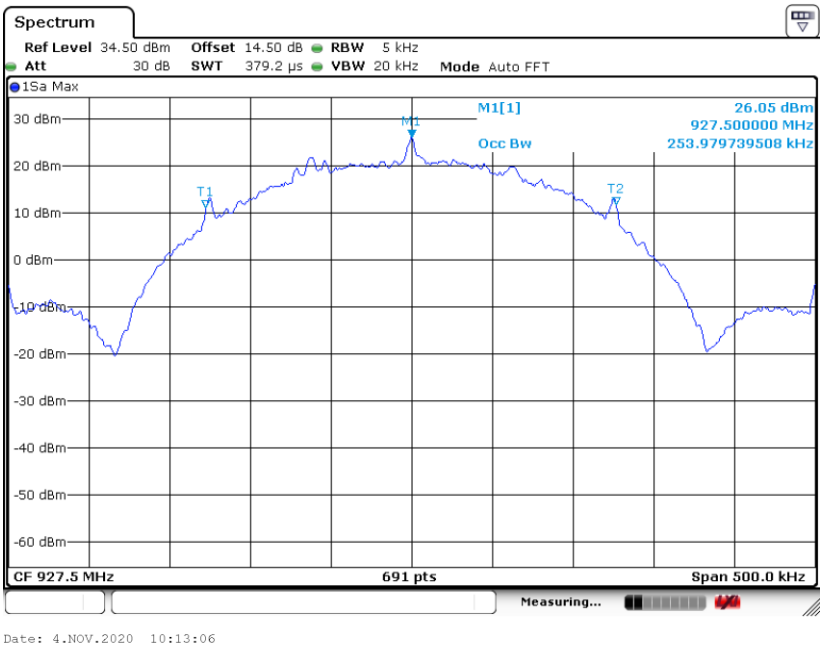
99% Occupied Bandwidth Plot on Low Channel



99% Occupied Bandwidth Plot on Mid Channel



99% Occupied Bandwidth Plot on High Channel



Note : The occupied channel bandwidth is maintained within the band of operation for all of the modulations.

3.5 Output Power Measurement

3.5.1 Limit of Output Power

The maximum peak conducted output power of the intentional radiator shall not exceed the following: For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

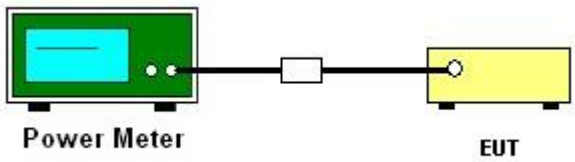
3.5.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.5.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.5.
2. The RF output of EUT was connected to the power meter by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Measure the conducted output power with cable loss and record the results in the test report.
5. Measure and record the results in the test report.

3.5.4 Test Setup



3.5.5 Test Result of Peak Output Power

Please refer to Appendix A.

3.6 Conducted Band Edges Measurement

3.6.1 Limit of Band Edges

In any 100 kHz bandwidth outside the intentional radiation frequency band, the radio frequency power shall be at least 20 dB below the highest level of the radiated power. In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits.

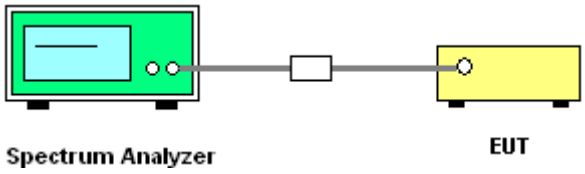
3.6.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.6.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.6.
2. Set to the maximum power setting and enable the EUT transmit continuously.
3. Set RBW = 100kHz, VBW = 300kHz. Band edge emissions must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100kHz RBW. The attenuation shall be 30 dB instead of 20 dB when RMS conducted output power procedure is used.
4. Enable hopping function of the EUT and then repeat step 2. and 3.
5. Measure and record the results in the test report.

3.6.4 Test Setup



3.6.5 Test Result of Conducted Band Edges

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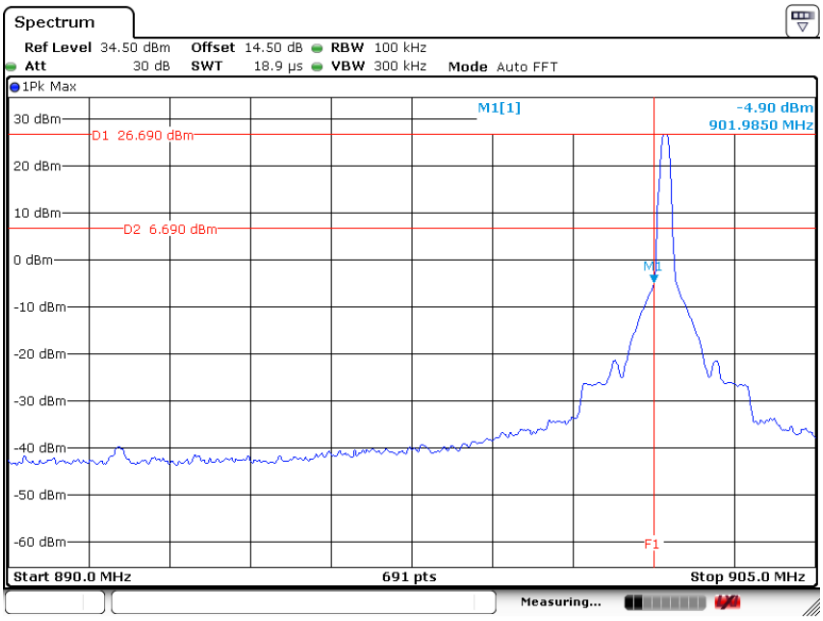
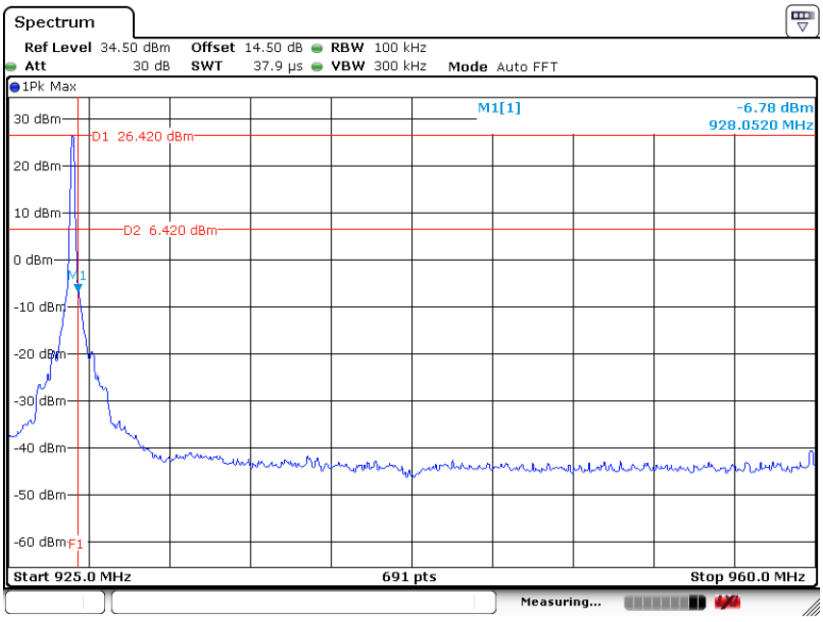
Low Band Edge Plot



Date: 4.NOV.2020 13:44:00

High Band Edge Plot



Date: 4.NOV.2020 13:46:28

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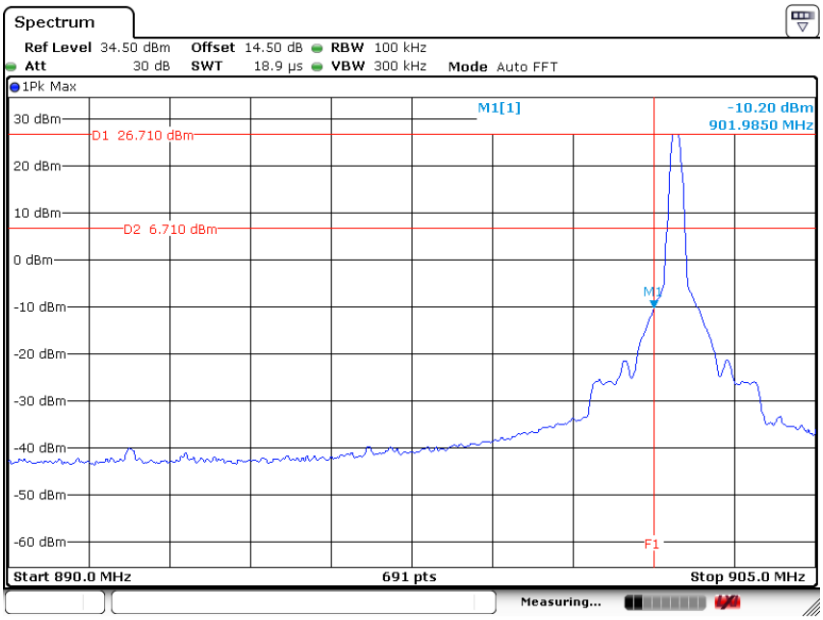
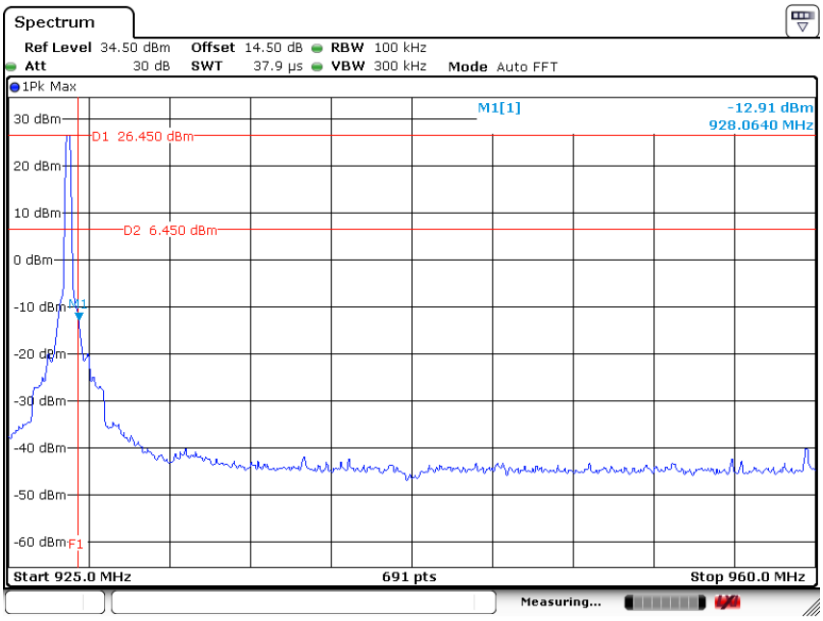
Low Band Edge Plot



Date: 4.NOV.2020 13:51:02

High Band Edge Plot



Date: 4.NOV.2020 13:47:50

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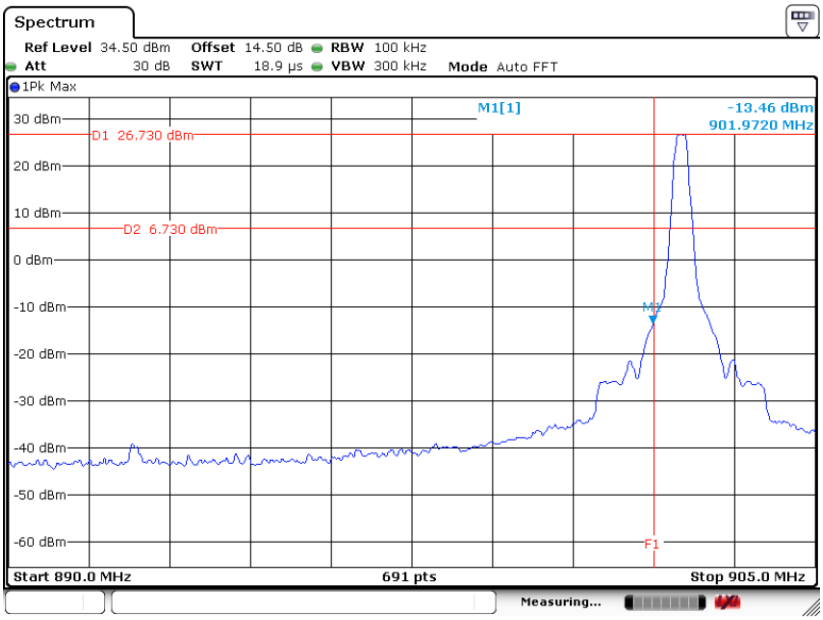
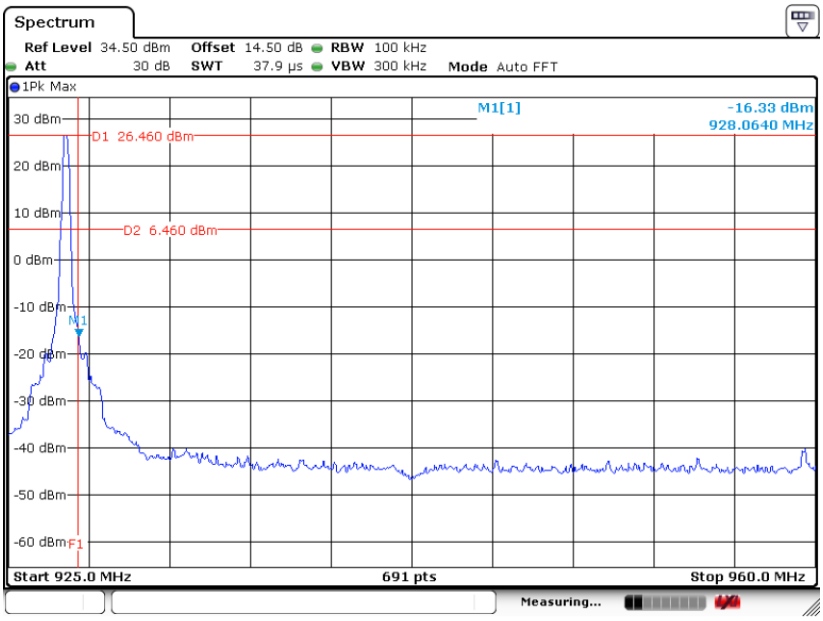
Low Band Edge Plot



Date: 4.NOV.2020 13:40:27

High Band Edge Plot

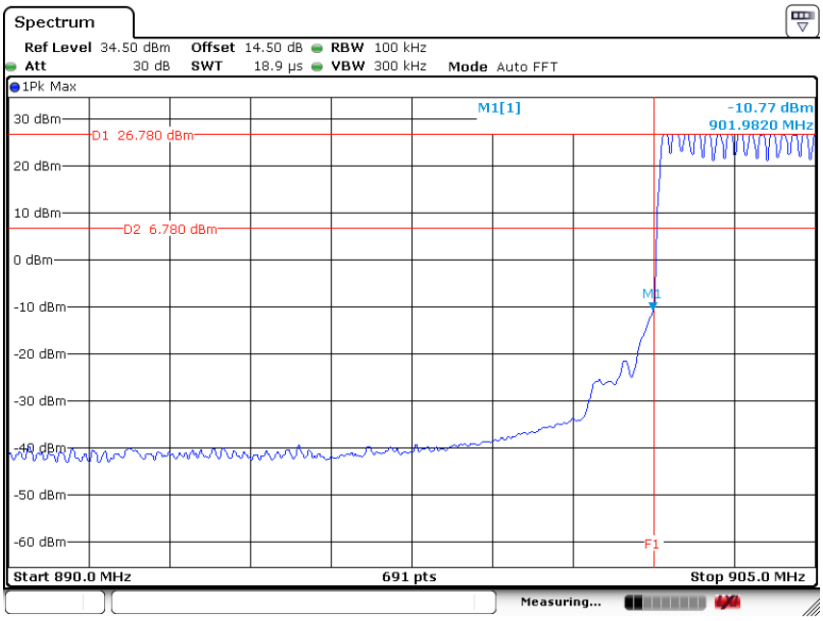


Date: 4.NOV.2020 13:37:29

3.6.6 Test Result of Conducted Hopping Mode Band Edges

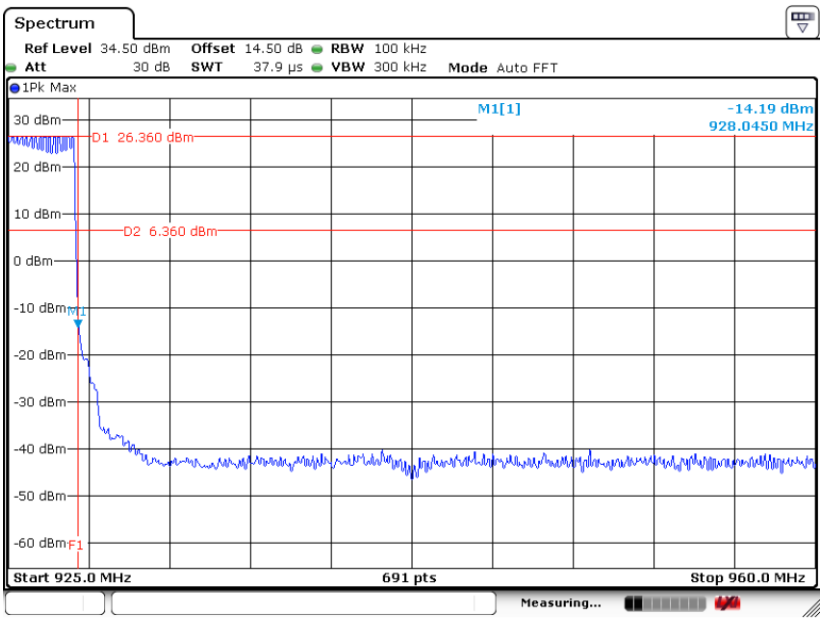
<Data Rate 50kbps>

Hopping Mode Low Band Edge Plot



Date: 4.NOV.2020 13:53:16

Hopping Mode High Band Edge Plot



Date: 4.NOV.2020 13:55:30

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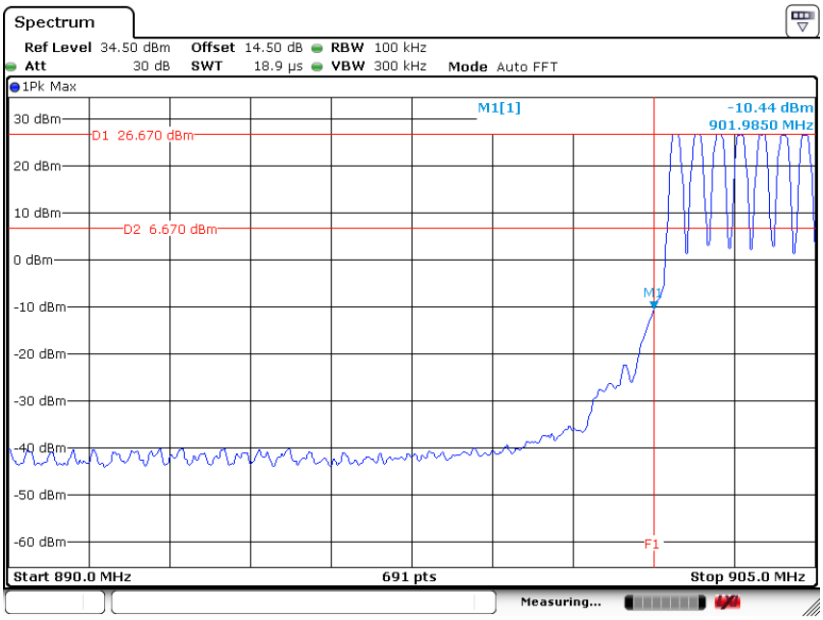
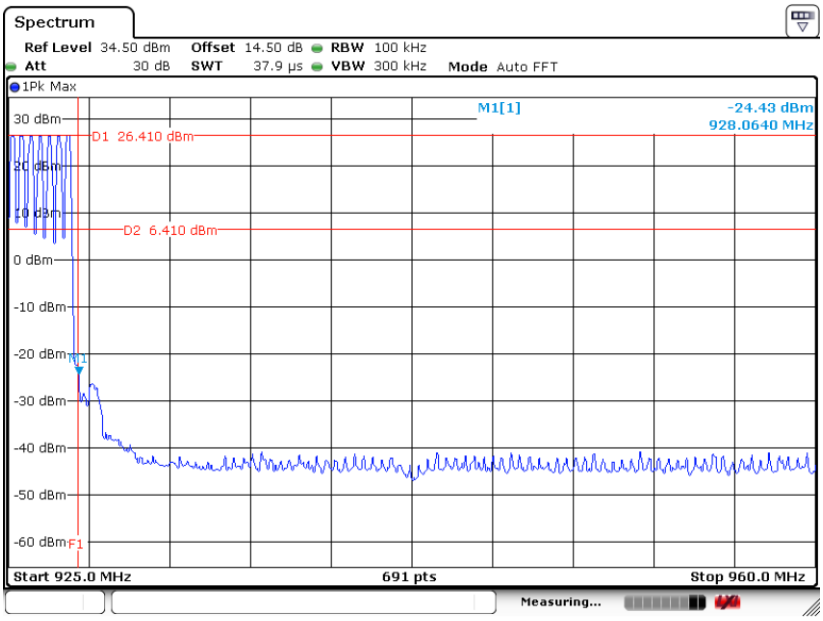
Hopping Mode Low Band Edge Plot



Hopping Mode High Band Edge Plot



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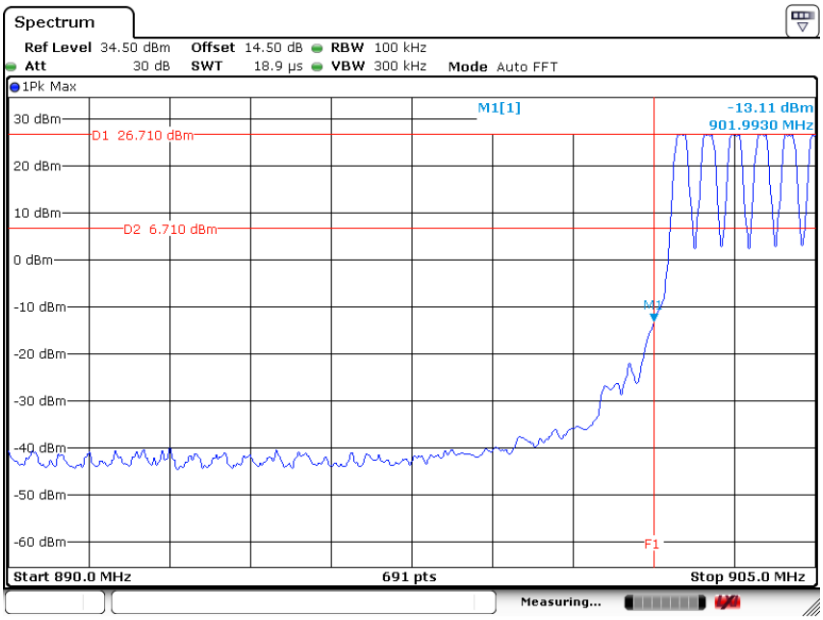
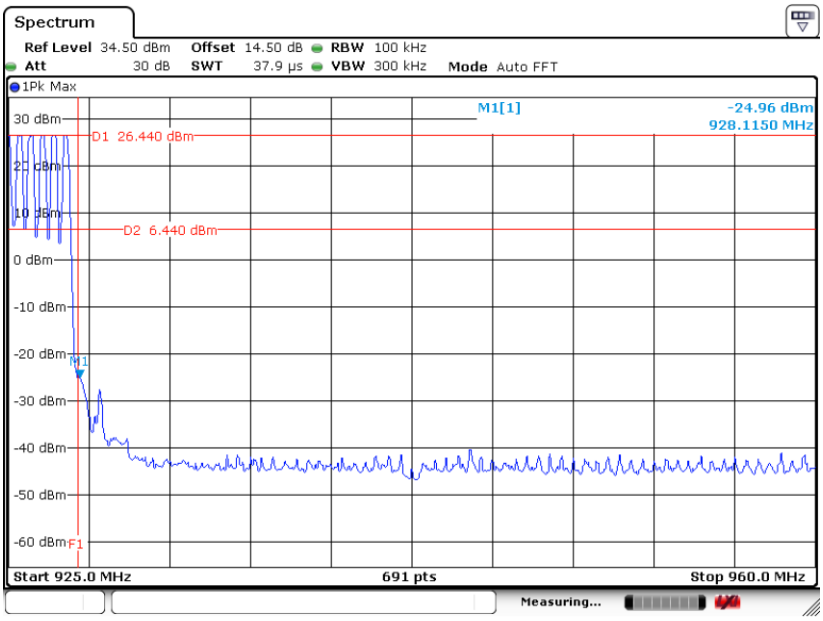
Hopping Mode Low Band Edge Plot



Date: 4.NOV.2020 14:02:09

Hopping Mode High Band Edge Plot



Date: 4.NOV.2020 14:03:35

3.7 Conducted Spurious Emission Measurement

3.7.1 Limit of Spurious Emission Measurement

In any 100 kHz bandwidth outside the intentional radiation frequency band, the radio frequency power shall be at least 20 dB below the highest level of the radiated power. In addition, radiated emissions which fall in the restricted bands must also comply with the radiated emission limits.

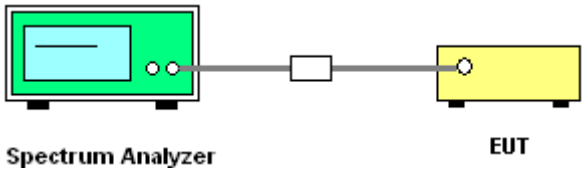
3.7.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.7.3 Test Procedure

1. The testing follows ANSI C63.10-2013 clause 7.8.8.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set RBW = 100 kHz, VBW = 300kHz, scan up through 10th harmonic. All harmonics / spurs must be at least 20 dB down from the highest emission level within the authorized band as measured with a 100 kHz RBW.
5. Measure and record the results in the test report.
6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

3.7.4 Test Setup



3.7.5 Test Result of Conducted Spurious Emission

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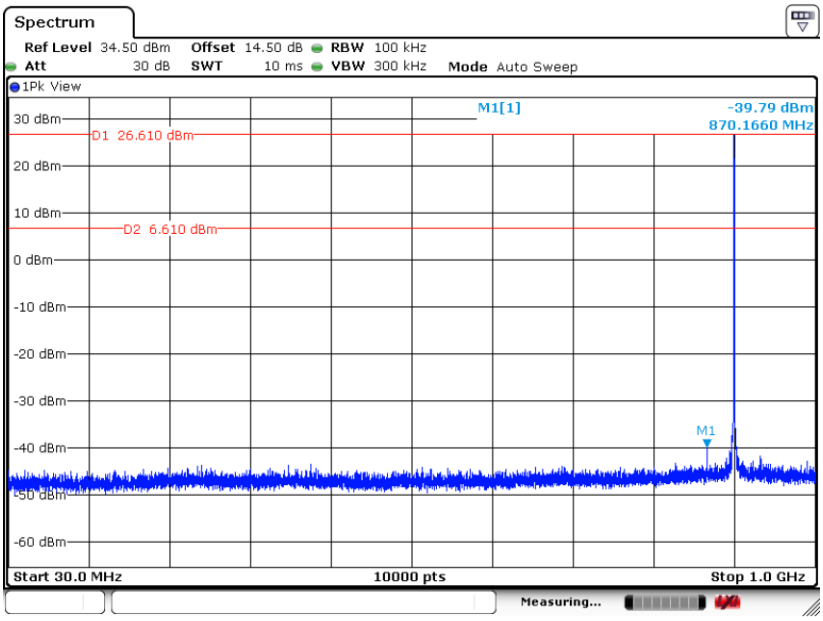
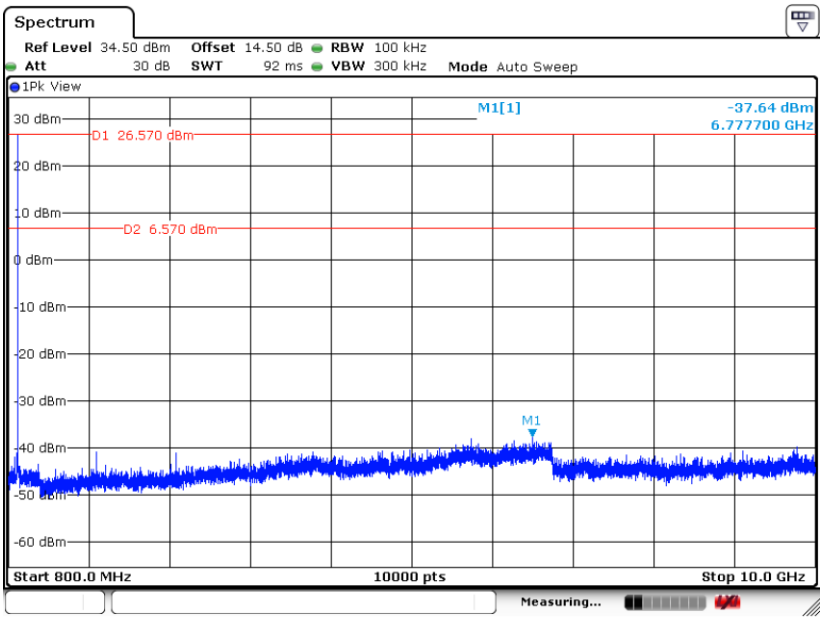
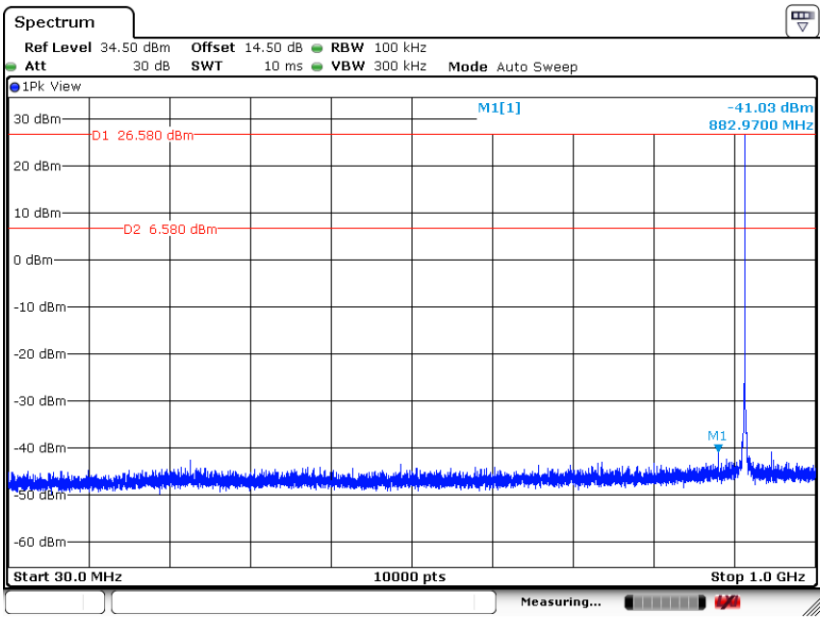
Low CH CSE Plot between 30MHz ~ 1 GHz



Low CH CSE Plot between 800 MHz ~ 10 GHz

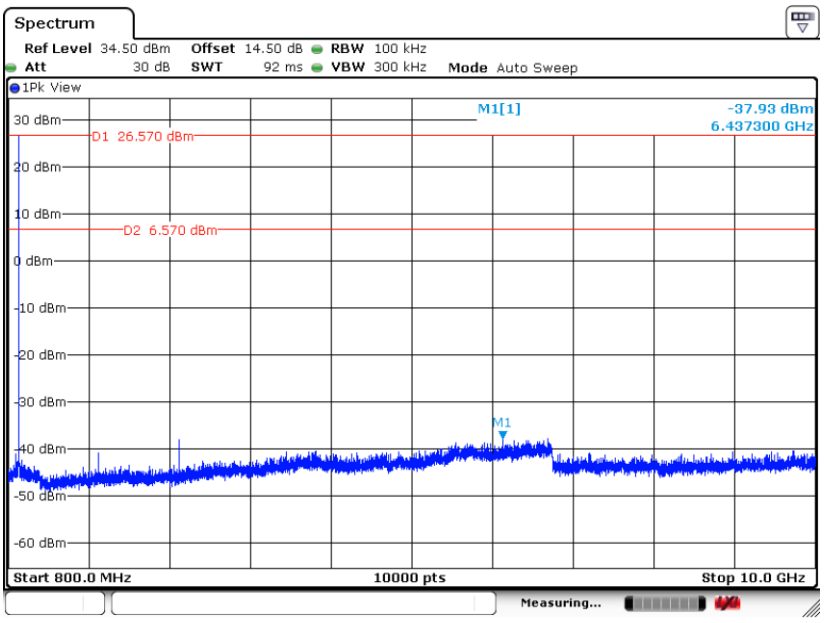


Mid CH CSE Plot between 30MHz ~ 1 GHz



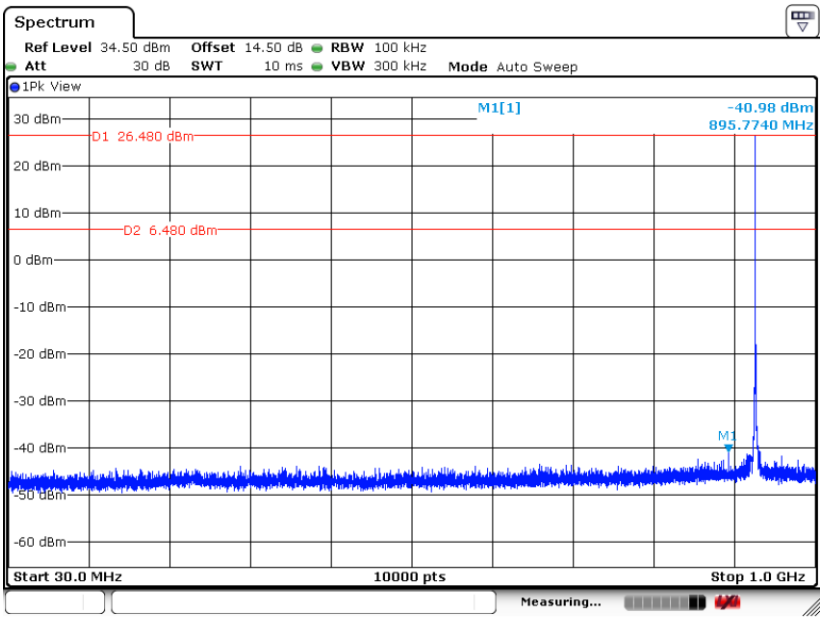
Date: 4.NOV.2020 12:58:02

Mid CH CSE Plot between 800 MHz ~ 10 GHz



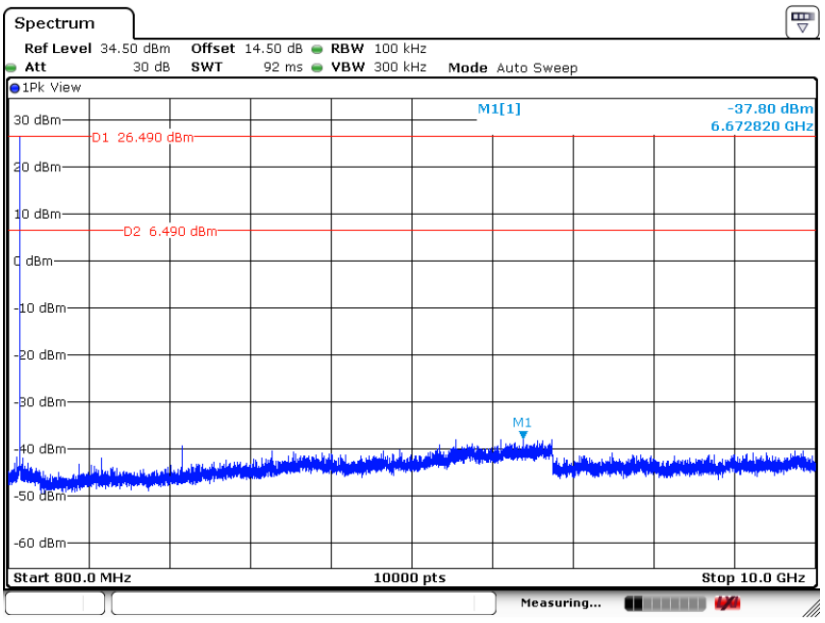
Date: 4.NOV.2020 12:56:53

High CH CSE Plot between 30MHz ~ 1 GHz



Date: 4.NOV.2020 12:59:02

High CH CSE Plot between 800 MHz ~ 10 GHz



Date: 4.NOV.2020 13:00:03

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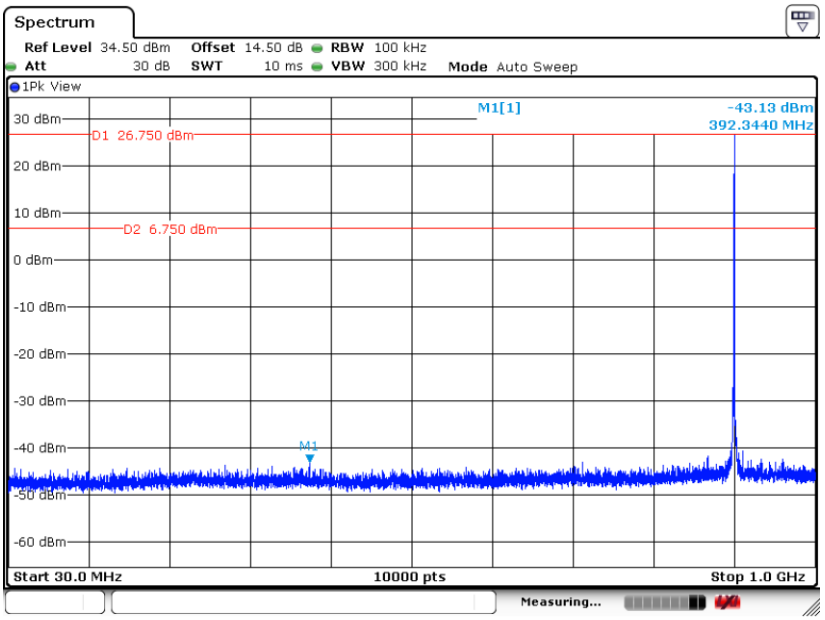
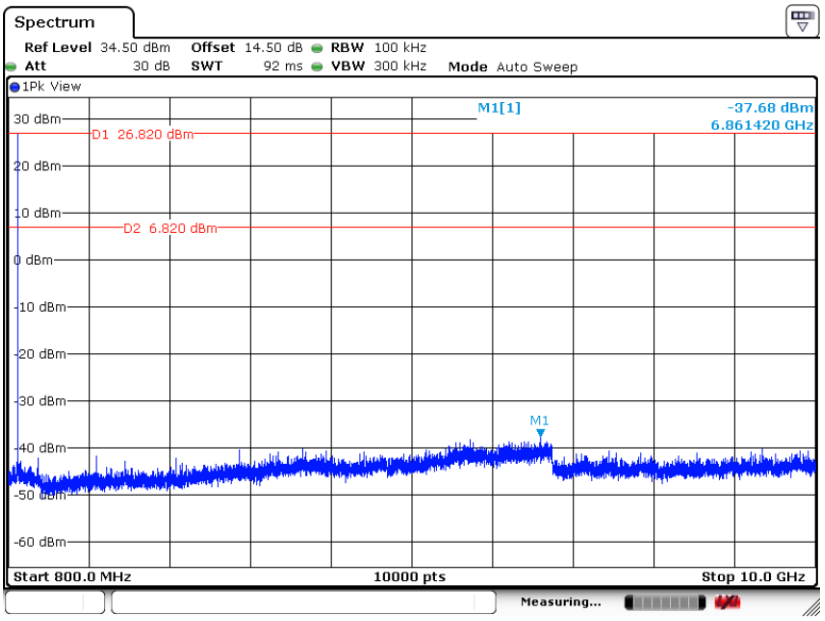
Low CH CSE Plot between 30MHz ~ 1 GHz



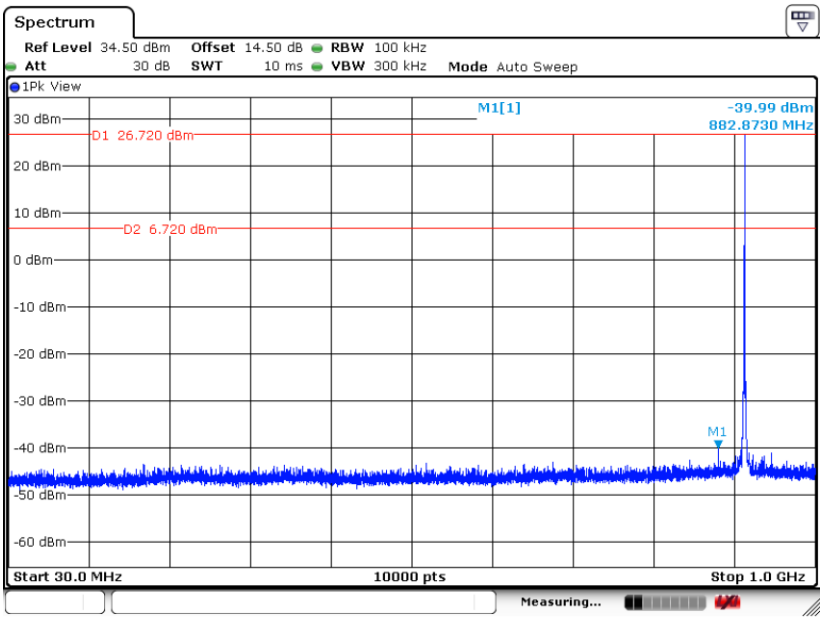
Date: 4.NOV.2020 13:02:24

Low CH CSE Plot between 800 MHz ~ 10 GHz

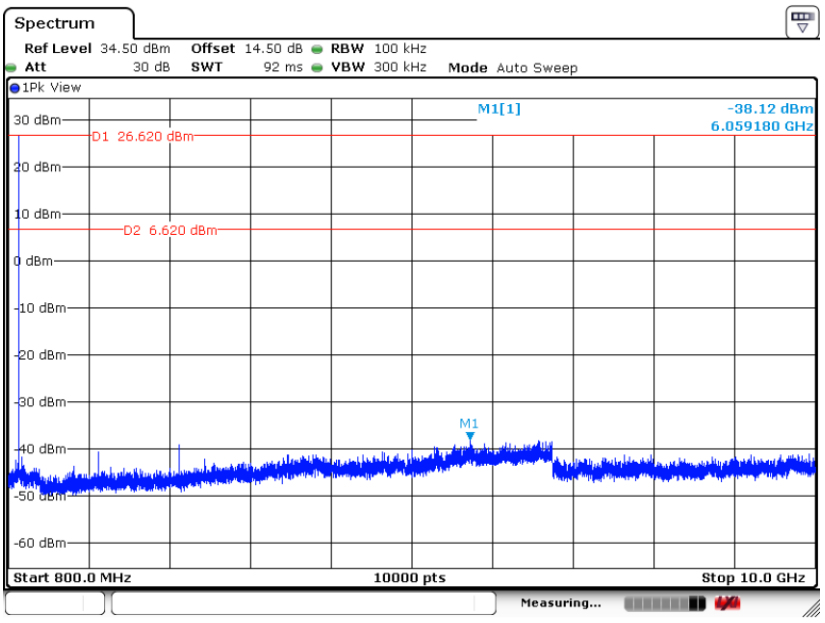


Date: 4.NOV.2020 13:01:33

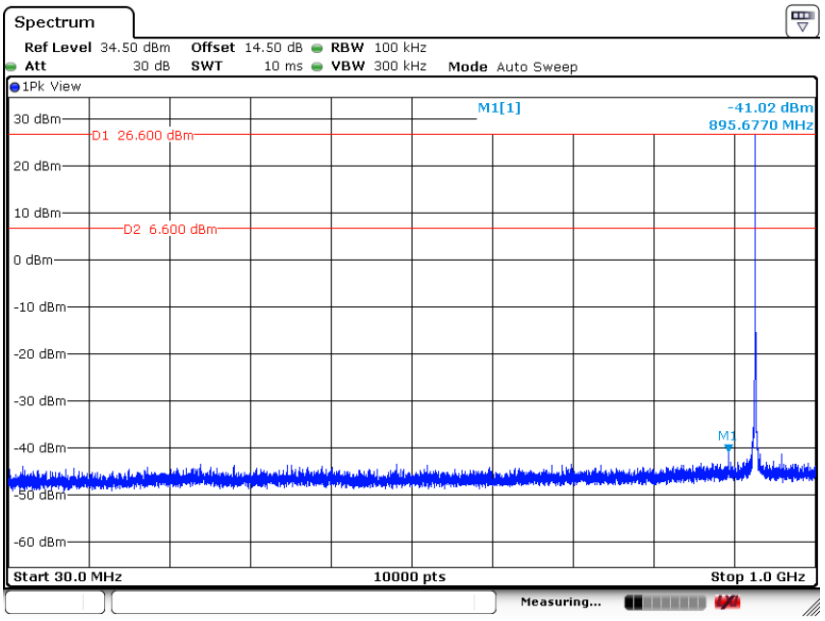
Mid CH CSE Plot between 30MHz ~ 1 GHz



Mid CH CSE Plot between 800 MHz ~ 10 GHz

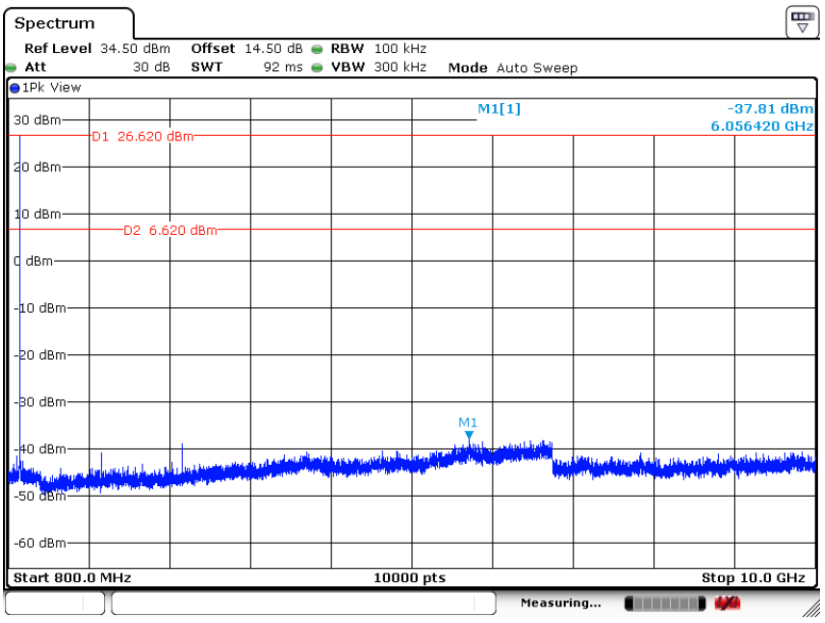


High CH CSE Plot between 30MHz ~ 1 GHz



Date: 4.NOV.2020 13:21:08

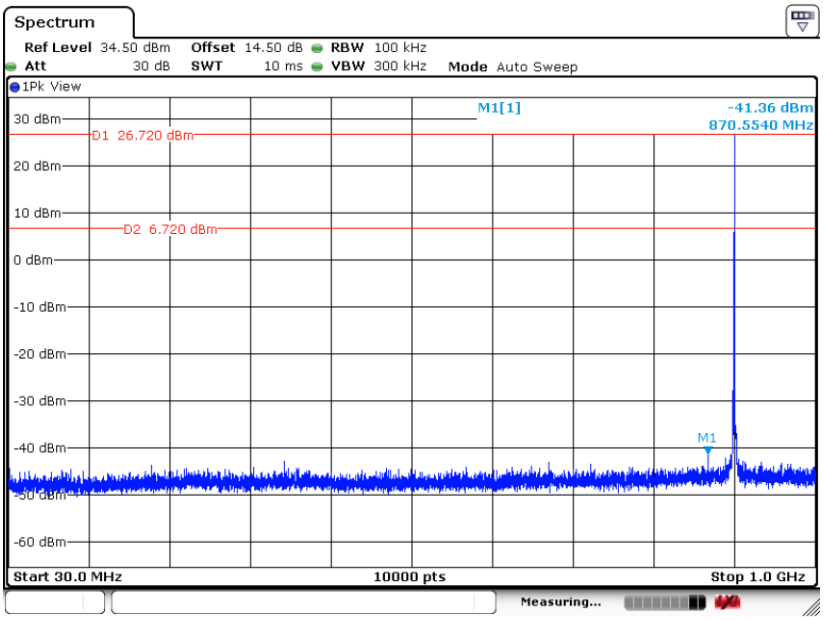
High CH CSE Plot between 800 MHz ~ 10 GHz



Date: 4.NOV.2020 13:20:20

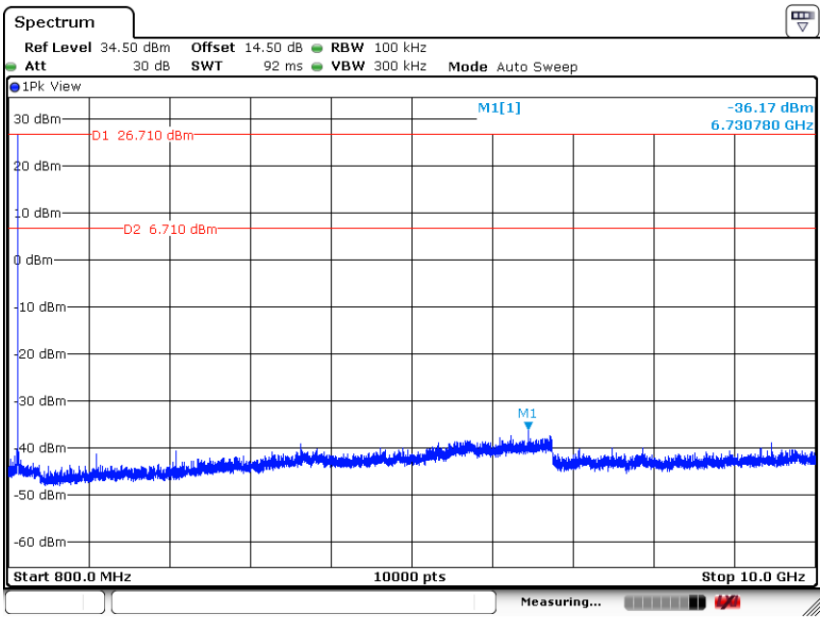
<Data Rate 250kbps>

Low CH CSE Plot between 30MHz ~ 1 GHz



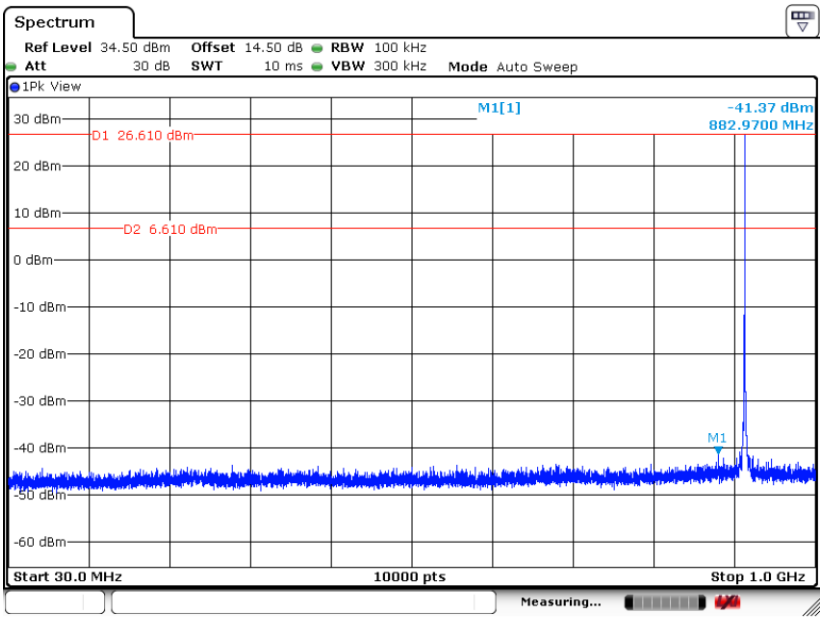
Date: 4.NOV.2020 13:23:32

Low CH CSE Plot between 800 MHz ~ 10 GHz



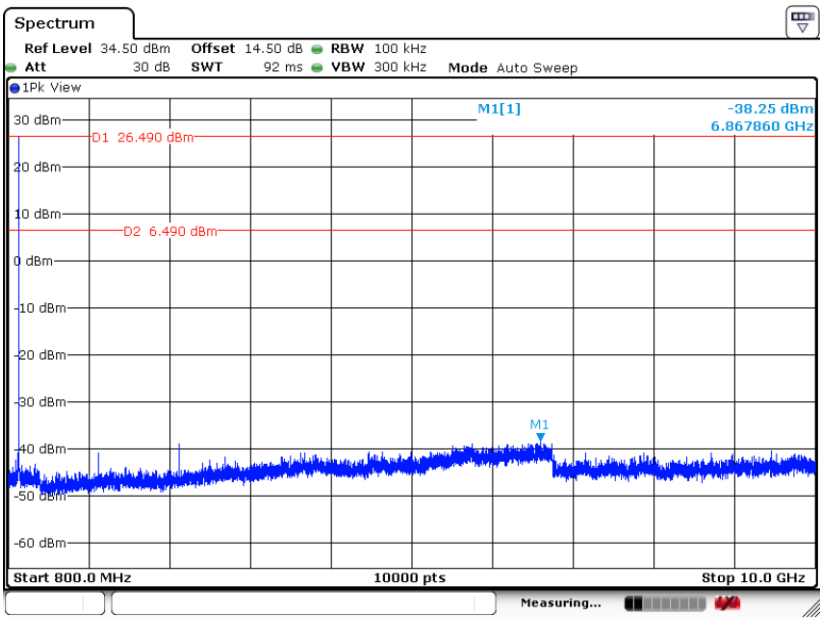
Date: 4.NOV.2020 13:25:46

Mid CH CSE Plot between 30MHz ~ 1 GHz



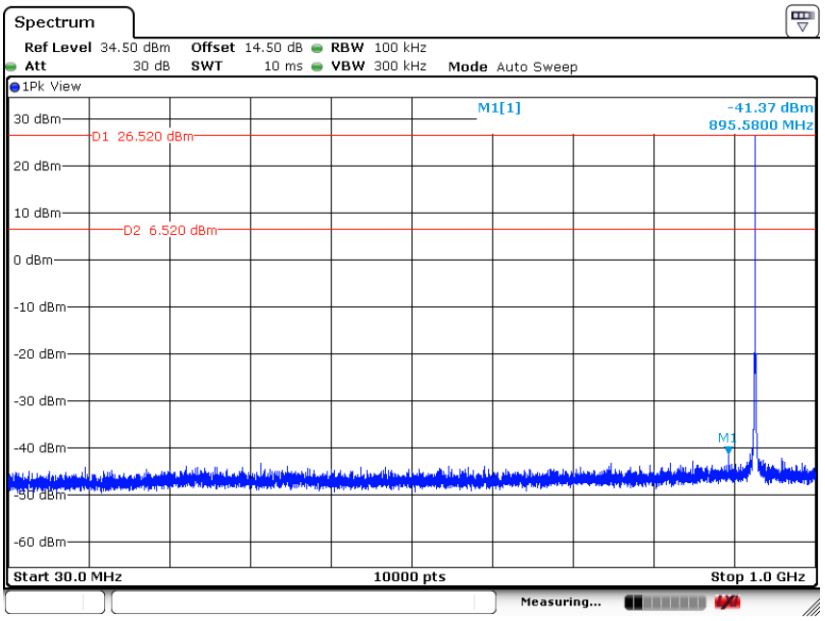
Date: 4.NOV.2020 13:27:59

Mid CH CSE Plot between 800 MHz ~ 10 GHz



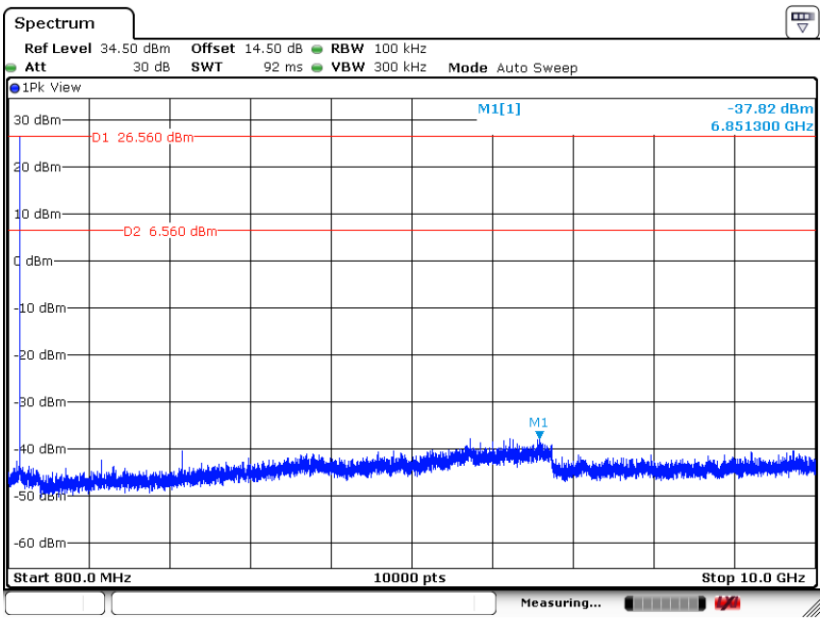
Date: 4.NOV.2020 13:27:20

High CH CSE Plot between 30MHz ~ 1 GHz



Date: 4.NOV.2020 13:29:03

High CH CSE Plot between 800 MHz ~ 10 GHz



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3.8 Radiated Band Edges and Spurious Emission Measurement

3.8.1 Limit of Radiated Band Edges and Spurious Emission

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. In addition, radiated emissions which fall in the restricted bands must also comply with the limits as below.

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

3.8.2 Measuring Instruments

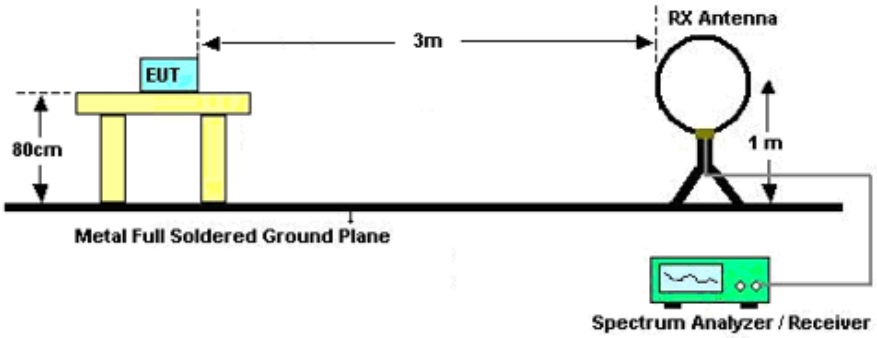
The measuring equipment is listed in the section 4 of this test report.

3.8.3 Test Procedures

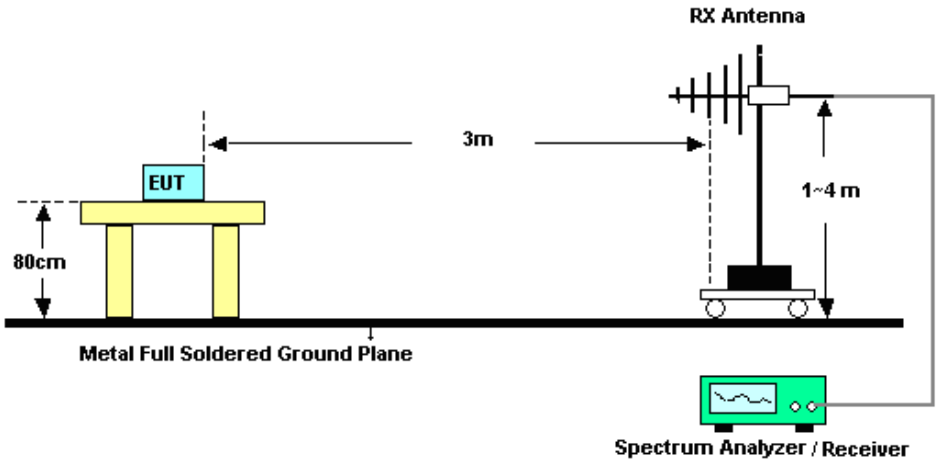
1. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
2. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
3. For each suspected emission, the EUT was arranged to its worst case and then tune the Antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level to comply with the guidelines.
4. Set to the maximum power setting and enable the EUT transmit continuously.
5. Use the following spectrum analyzer settings:
   (1) Span shall wide enough to fully capture the emission being measured;
   (2) Set RBW=100 kHz for f < 1 GHz, RBW=1MHz for f>1GHz ; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold for peak
6. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
7. For testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
8. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than average limit (that means the emission level in average mode also complies with the limit in average mode), then peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.

3.8.4 Test Setup

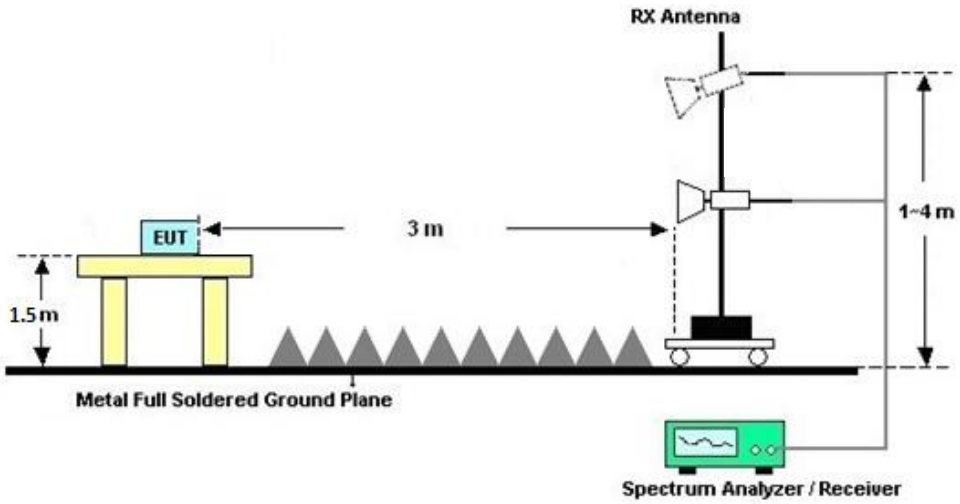
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



3.8.5 Test Results of Radiated Spurious Emissions (9 kHz ~ 30 MHz)

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line was not reported.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

3.8.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix C.

3.8.7 Test Result of Radiated Spurious Emission (30MHz ~ 10th Harmonic)

Please refer to Appendix C.

3.9 AC Conducted Emission Measurement

3.9.1 Limit of AC Conducted Emission

For equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table.

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

*Decreases with the logarithm of the frequency.

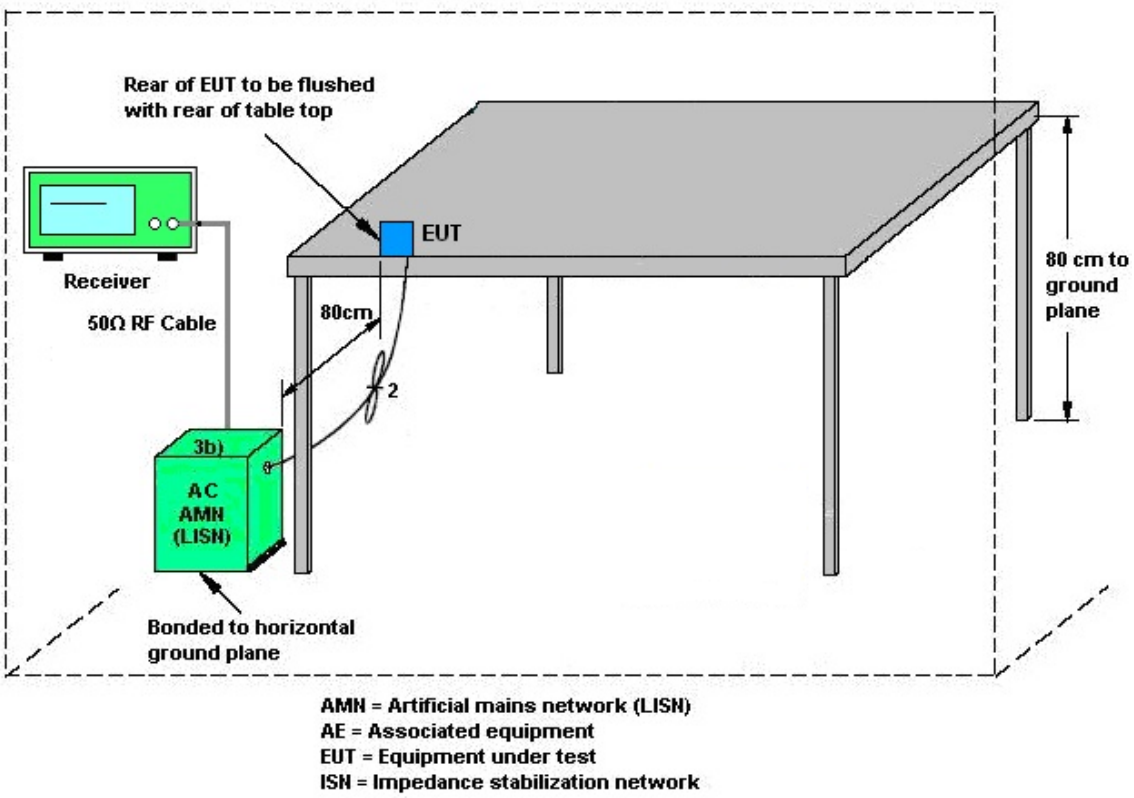
3.9.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.9.3 Test Procedures

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 microhenry LISN should be used.
6. Both sides of AC line were checked for maximum conducted interference.
7. The frequency range from 150 kHz to 30 MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

3.9.4 Test Setup



AMN = Artificial mains network (LISN)
AE = Associated equipment
EUT = Equipment under test
ISN = Impedance stabilization network

3.9.5 Test Result of AC Conducted Emission

Please refer to Appendix B.

3.10 Antenna Requirements

3.10.1 Standard Applicable

If directional gain of transmitting antennas is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the rule.

3.10.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.10.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.

4 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Spectrum Analyzer	R&S	FSV40	101040	10Hz~40GHz	Nov. 01, 2020	Nov. 04, 2020	Oct. 31, 2021	Conducted (TH01-KS)
Pulse Power Senor	Anritsu	MA2411B	0917070	300MHz~40GHz	Jan. 08, 2020	Nov. 04, 2020	Jan. 07, 2021	Conducted (TH01-KS)
Power Meter	Anritsu	ML2495A	1005002	50MHz Bandwidth	Jan. 08, 2020	Nov. 04, 2020	Jan. 07, 2021	Conducted (TH01-KS)
EMI Test Receiver	Keysight	N9038A	MY56400004	3Hz~8.5GHz;Max 30dBm	Oct. 17, 2020	May 27, 2021	Oct. 16, 2021	Radiation (03CH04-KS)
EXA Spectrum Analyzer	Keysight	N9010A	MY55150208	10Hz-44GHz	Apr. 12, 2021	May 27, 2021	Apr. 11, 2022	Radiation (03CH04-KS)
Loop Antenna	R&S	HFH2-Z2	100321	9kHz~30MHz	Nov. 01, 2020	May 27, 2021	Oct. 31, 2021	Radiation (03CH04-KS)
Bilog Antenna	TeseQ	CBL6111D	49921	30MHz-1GHz	May 29, 2020	May 27, 2021	May 28, 2021	Radiation (03CH04-KS)
Double Ridge Horn Antenna	ETS-Lindgren	3117	00218652	1GHz~18GHz	Apr. 25, 2021	May 27, 2021	Apr. 24, 2022	Radiation (03CH04-KS)
Amplifier	SONOMA	310N	187289	9KHz ~1GHZ	Apr. 12, 2021	May 27, 2021	Apr. 11, 2022	Radiation (03CH04-KS)
high gain Amplifier	MITEQ	AMF-7D-00101800-30-10P	2025788	1Ghz-18Ghz	Jan. 06, 2021	May 27, 2021	Jan. 05, 2022	Radiation (03CH04-KS)
Amplifier	Keysight	83017A	MY53270203	500MHz~26.5GHz	Apr. 13, 2021	May 27, 2021	Apr. 12, 2022	Radiation (03CH04-KS)
AC Power Source	Chroma	61601	F104090004	N/A	NCR	May 27, 2021	NCR	Radiation (03CH04-KS)
Turn Table	ChamPro	EM 1000-T	060762-T	0~360 degree	NCR	May 27, 2021	NCR	Radiation (03CH04-KS)
Antenna Mast	ChamPro	EM 1000-A	060762-A	1 m~4 m	NCR	May 27, 2021	NCR	Radiation (03CH04-KS)
EMI Receiver	R&S	ESCI7	100768	9kHz~7GHz;	Apr. 21, 2021	May 25, 2021	Apr. 20, 2022	Conduction (CO01-KS)
AC LISN (for auxiliary equipment)	MessTec	AN3016	060103	9kHz~30MHz	Oct. 17, 2020	May 25, 2021	Oct. 16, 2021	Conduction (CO01-KS)
AC LISN	MessTec	AN3016	060105	9kHz~30MHz	Apr. 13, 2021	May 25, 2021	Apr. 12, 2022	Conduction (CO01-KS)
AC Power Source	Chroma	61602	ABP000000811	AC 0V~300V, 45Hz~1000Hz	Oct. 17, 2020	May 25, 2021	Oct. 16, 2021	Conduction (CO01-KS)

NCR: No Calibration Required.

5 Uncertainty of Evaluation

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI 63.10-2013. All the measurement uncertainty value were shown with a coverage K=2 to indicate 95% level of confidence. The measurement data show herein meets or exceeds the CISPR measurement uncertainty values specified in CISPR 16-4-2 and can be compared directly to specified limit to determine compliance.

Uncertainty of Conducted Emission Measurement (150kHz ~ 30MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**2.9dB**

Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**5.0dB**

Uncertainty of Radiated Emission Measurement (1000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**5.0dB**

Appendix A. Conducted Test Results

Report Number : FR151806B

FSK-FHSS-50Kbps

Test Engineer:	Aly Cao	Temperature:	20~26	°C
Test Date:	2020/11/4	Relative Humidity:	40~51	%

TEST RESULTS DATA
20dB and 99% Occupied Bandwidth and Hopping Channel Separation

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	20db BW (MHz)	99% Bandwidth (MHz)	Hopping Channel Separation Measurement (MHz)	Hopping Channel Separation Measurement Limit (MHz)	Pass/Fail
FSK	50Kbps	1	1	902.2	0.103	0.100	0.250	0.103	Pass
FSK	50Kbps	1	65	915	0.103	0.100	0.250	0.103	Pass
FSK	50Kbps	1	129	927.8	0.103	0.101	0.250	0.103	Pass

TEST RESULTS DATA
Dwell Time

Mod.	CH.	DT On-time per hop (ms)	Total hops over 20sec	Dwell Time (sec)	Limits (sec)	Pass/Fail
FSK	hopping	349.412	1.00	0.35	0.4	Pass

TEST RESULTS DATA
Peak Power Table

mode	Freq. (MHz)	NTX	Peak Power (dBm)	Power Limit (dBm)	Test Result
FSK	902.2	1	**26.72**	30.00	Pass
	915	1	26.65	30.00	Pass
	927.8	1	26.48	30.00	Pass

TEST RESULTS DATA
Number of Hopping Frequency

Number of Hopping (Channel)	Limits (Channel)	Pass/Fail
129	> 50	Pass

Report Number : FR151806B

FSK-FHSS-150Kbps

Test Engineer:	Aly Cao	Temperature:	20~26	°C
Test Date:	2020/11/4	Relative Humidity:	40~51	%

TEST RESULTS DATA
20dB and 99% Occupied Bandwidth and Hopping Channel Separation

Mod.	Data Rate	NTX	Freq. (MHz)	20db BW (MHz)	99% Bandwidth (MHz)	Hopping Channel Separation Measurement (MHz)	Hopping Channel Separation Measurement Limit (MHz)	Pass/Fail
FSK	150Kbps	1	902.4	0.174	0.153	0.399	0.174	Pass
FSK	150Kbps	1	914.8	0.169	0.153	0.327	0.169	Pass
FSK	150Kbps	1	927.6	0.169	0.153	0.327	0.169	Pass

TEST RESULTS DATA
Dwell Time

Mod.	CH.	DT On-time per hop (ms)	Total hops over 20sec	Dwell Time (sec)	Limits (sec)	Pass/Fail
FSK	hopping	346.745	1.00	0.35	0.4	Pass

TEST RESULTS DATA
Peak Power Table

mode	Freq. (MHz)	NTX	Peak Power (dBm)	Power Limit (dBm)	Test Result
FSK	902.4	1	**27.04**	30.00	Pass
	914.8	1	26.95	30.00	Pass
	927.6	1	26.91	30.00	Pass

TEST RESULTS DATA
Number of Hopping Frequency

Number of Hopping (Channel)	Limits (Channel)	Pass/Fail
64	> 50	Pass

Report Number : FR151806B

FSK-FHSS-250Kbps

Test Engineer:	Aly Cao	Temperature:	20~26	°C
Test Date:	2020/11/4	Relative Humidity:	40~51	%

TEST RESULTS DATA
20dB and 99% Occupied Bandwidth and Hopping Channel Separation

Mod.	Data Rate	NTX	Freq. (MHz)	20db BW (MHz)	99% Bandwidth (MHz)	Hopping Channel Separation Measurement (MHz)	Hopping Channel Separation Measurement Limit (MHz)	Pass/Fail
FSK	250Kbps	1	902.5	0.272	0.254	0.462	0.272	Pass
FSK	250Kbps	1	915	0.269	0.255	0.403	0.269	Pass
FSK	250Kbps	1	927.5	0.268	0.254	0.399	0.268	Pass

TEST RESULTS DATA
Dwell Time

Mod.	CH.	DT On-time per hop (ms)	Total hops over 20sec	Dwell Time (sec)	Limits (sec)	Pass/Fail
FSK	hopping	387.346	1.00	0.39	0.4	Pass

TEST RESULTS DATA
Peak Power Table

mode	Freq. (MHz)	NTX	Peak Power (dBm)	Power Limit (dBm)	Test Result
FSK	902.5	1	**26.79**	30.00	Pass
	915	1	26.67	30.00	Pass
	927.5	1	26.51	30.00	Pass

TEST RESULTS DATA
Number of Hopping Frequency

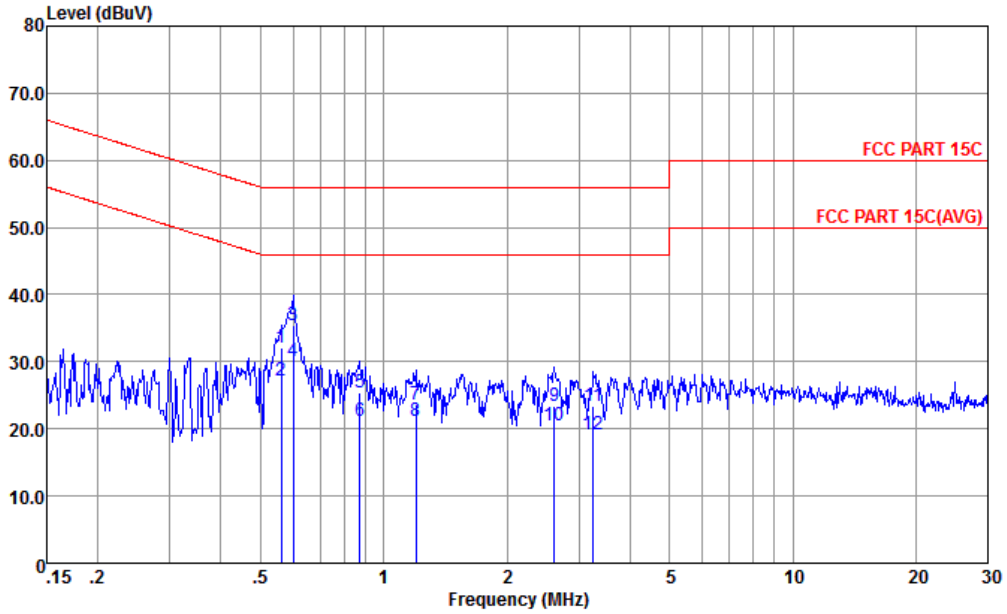
Number of Hopping (Channel)	Limits (Channel)	Pass/Fail
51	> 50	Pass

Power Setting Table Summary (for reference only)

Modulation type	LR1110 power setting
LoRa DTS 500KHz SF5	-11
LoRa DTS 500KHz SF7	0
LoRa DTS 500KHz SF11	0
LoRa FHSS 125KHz SF7	0
LoRa FHSS 125KHz SF9	0
LoRa FHSS 125KHz SF10	0
FSK 50kbps	0
FSK 150kbps	0
FSK 250kbps	0

Appendix B. AC Conducted Emission Test Results

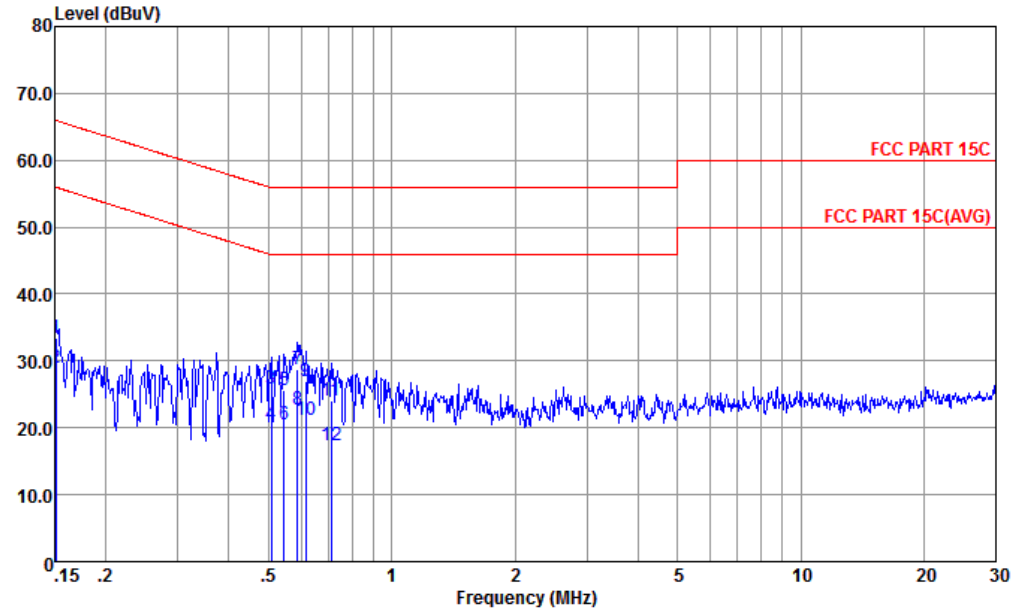
Test Engineer :	Amos Zhang	**Temperature :**	25.3~26.2℃
		Relative Humidity :	38~40%
Test Voltage :	120Vac / 60Hz	**Phase :**	Line



Site : CO01-KS
Condition : FCC PART 15C TWO-LISN-CN02-L LINE

		Freq	Level	Over Limit	Limit Line	Read Level	LISN Factor	Cable Loss	Remark
		MHz	dBuV	dB	dBuV	dBuV	dB	dB	
1		0.561	32.09	-23.91	56.00	12.20	9.65	10.24	QP
2		0.561	27.19	-18.81	46.00	7.30	9.65	10.24	Average
3		0.601	35.49	-20.51	56.00	15.59	9.66	10.24	QP
4	*	0.601	30.09	-15.91	46.00	10.19	9.66	10.24	Average
5		0.876	25.43	-30.57	56.00	5.50	9.69	10.24	QP
6		0.876	21.13	-24.87	46.00	1.20	9.69	10.24	Average
7		1.197	23.60	-32.40	56.00	3.60	9.77	10.23	QP
8		1.197	21.20	-24.80	46.00	1.20	9.77	10.23	Average
9		2.608	23.46	-32.54	56.00	3.20	10.02	10.24	QP
10		2.608	20.46	-25.54	46.00	0.20	10.02	10.24	Average
11		3.258	23.44	-32.56	56.00	3.11	10.09	10.24	QP
12		3.258	19.14	-26.86	46.00	-1.19	10.09	10.24	Average

Test Engineer :	Amos Zhang	**Temperature :**	25.3~26.2℃
		Relative Humidity :	38~40%
Test Voltage :	120Vac / 60Hz	**Phase :**	Neutral



Site : CO01-KS
Condition : FCC PART 15C TWO-LISN-CN02-N NEUTRAL

		Freq	Level	Over Limit	Limit Line	Read Level	LISN Factor	Cable Loss	Remark
		MHz	dBuV	dB	dBuV	dBuV	dB	dB	
1		0.151	33.38	-32.58	65.96	13.10	9.80	10.48	QP
2		0.151	29.08	-26.88	55.96	8.80	9.80	10.48	Average
3		0.507	25.76	-30.24	56.00	5.79	9.73	10.24	QP
4		0.507	20.56	-25.44	46.00	0.59	9.73	10.24	Average
5		0.546	25.56	-30.44	56.00	5.59	9.73	10.24	QP
6		0.546	20.56	-25.44	46.00	0.59	9.73	10.24	Average
7		0.589	28.76	-27.24	56.00	8.79	9.73	10.24	QP
8	*	0.589	22.76	-23.24	46.00	2.79	9.73	10.24	Average
9		0.617	26.86	-29.14	56.00	6.89	9.73	10.24	QP
10		0.617	21.16	-24.84	46.00	1.19	9.73	10.24	Average
11		0.712	24.16	-31.84	56.00	4.20	9.72	10.24	QP
12		0.712	17.36	-28.64	46.00	-2.60	9.72	10.24	Average

Note:

1. Level(dBμV) = Read Level(dBμV) + LISN Factor(dB) + Cable Loss(dB)
2. Over Limit(dB) = Level(dBμV) – Limit Line(dBμV)

Appendix C. Radiated Spurious Emission

FSK FHSS 50kbps (Band Edge @ 3m)

FSK FHSS	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
		(MHz)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
902.2MHz		870.02	38.03	-52.26	90.29	36.73	29.24	4.32	32.26	167	132	P	H
		902.03	110.29	-	-	108.74	29.36	4.39	32.2	167	132	P	H
		934.04	42.39	-47.9	90.29	39.72	30.33	4.47	32.13	167	132	P	H
		870.02	37.34	-50.72	88.06	36.04	29.24	4.32	32.26	170	132	P	V
		902.03	108.06	-	-	106.51	29.36	4.39	32.2	170	132	P	V
		934.04	41.11	-46.95	88.06	38.44	30.33	4.47	32.13	170	132	P	V
915MHz		882.63	40.81	-56.02	96.83	39.43	29.27	4.34	32.23	166	5	P	H
		914.64	116.83	-	-	114.84	29.74	4.42	32.17	166	5	P	H
		946.65	46.13	-50.7	96.83	43.03	30.71	4.5	32.11	166	5	P	H
		882.63	36.77	-51.73	88.5	35.39	29.27	4.34	32.23	154	132	P	V
		914.64	108.5	-	-	106.51	29.74	4.42	32.17	154	132	P	V
		946.65	43.81	-44.69	88.5	40.71	30.71	4.5	32.11	154	132	P	V
927.8MHz		895.24	42.19	-55.76	97.95	40.74	29.29	4.37	32.21	100	356	P	H
		927.25	117.95	-	-	115.53	30.12	4.45	32.15	100	356	P	H
		959.26	44.61	-53.34	97.95	41.4	30.76	4.53	32.08	100	356	P	H
		895.24	39.87	-51.38	91.25	38.42	29.29	4.37	32.21	162	299	P	V
		927.25	111.25	-	-	108.83	30.12	4.45	32.15	162	299	P	V
		959.26	44.24	-47.01	91.25	41.03	30.76	4.53	32.08	162	299	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line. 3. Non-restricted band limit is 100kHz-PSD down 20dB.												

FSK FHSS 50kbps (Harmonic @ 3m)

FSK FHSS	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
902.2MHz		1801	49.81	-40.48	90.29	79.21	27.98	6.27	63.65	300	0	P	H
		1801	43.68	-44.38	88.06	73.08	27.98	6.27	63.65	100	0	P	V
915MHz		1828	54.59	-42.24	96.83	83.77	28.15	6.31	63.64	100	360	P	H
		8236	46.84	-27.16	74	60.35	36.61	13.64	63.76	100	360	P	H
		1828	47.59	-40.91	88.5	76.77	28.15	6.31	63.64	300	360	P	V
		8236	46.2	-27.8	74	59.71	36.61	13.64	63.76	300	360	P	V
927.8MHz		1855	62.58	-35.37	97.95	91.64	28.23	6.34	63.63	300	360	P	H
		2782	43.29	-30.71	74	65.32	32.59	7.83	62.45	300	360	P	H
		8353	48.21	-25.79	74	61.69	36.51	13.63	63.62	300	360	P	H
		1855	54.89	-36.36	91.25	83.95	28.23	6.34	63.63	100	360	P	V
		8353	46.8	-27.2	74	60.28	36.51	13.63	63.62	100	360	P	V
		9280	47.95	-43.3	91.25	60.05	37.56	14.39	64.05	100	360	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line. 3. Non-restricted band limit is 100kHz-PSD down 20dB.												

FSK FHSS 150kbps (Band Edge @ 3m)

FSK FHSS	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
		(MHz)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
902.4MHz		870.02	44.06	-51.45	95.51	42.76	29.24	4.32	32.26	100	360	P	H
		902.03	115.51	-	-	113.96	29.36	4.39	32.2	100	360	P	H
		934.04	45.98	-49.53	95.51	43.31	30.33	4.47	32.13	100	360	P	H
		870.02	37.54	-51.18	88.72	36.24	29.24	4.32	32.26	174	310	P	V
		902.03	108.72	-	-	107.17	29.36	4.39	32.2	174	310	P	V
		934.04	38.9	-49.82	88.72	36.23	30.33	4.47	32.13	174	310	P	V
914.8MHz		914.64	108.5	-	-	106.51	29.74	4.42	32.17	282	300	P	H
		946.65	42.33	-46.17	88.5	39.23	30.71	4.5	32.11	282	300	P	H
		914.64	108.34	-	-	106.35	29.74	4.42	32.17	257	301	P	V
		946.65	41.19	-47.15	88.34	38.09	30.71	4.5	32.11	257	301	P	V
927.6MHz		895.24	42.39	-55.59	97.98	40.94	29.29	4.37	32.21	100	358	P	H
		927.25	117.98	-	-	115.56	30.12	4.45	32.15	100	358	P	H
		959.26	45.55	-52.43	97.98	42.34	30.76	4.53	32.08	100	358	P	H
		895.24	38.15	-53.36	91.51	36.7	29.29	4.37	32.21	157	302	P	V
		927.25	111.51	-	-	109.09	30.12	4.45	32.15	157	302	P	V
		959.26	44.7	-46.81	91.51	41.49	30.76	4.53	32.08	157	302	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line. 3. Non-restricted band limit is 100kHz-PSD down 20dB.												

FSK FHSS 150kbps (Harmonic @ 3m)

FSK FHSS	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
902.4MHz		1801	51.07	-44.44	95.51	80.47	27.98	6.27	63.65	300	360	P	H
		1801	42.86	-45.86	88.72	72.26	27.98	6.27	63.65	300	360	P	V
914.8MHz		1828	54.49	-34.01	88.5	83.67	28.15	6.31	63.64	100	360	P	H
		1828	47.38	-40.96	88.34	76.56	28.15	6.31	63.64	300	360	P	V
927.6MHz		1855	55.48	-42.5	97.98	84.54	28.23	6.34	63.63	300	0	P	H
		8344	47.14	-26.86	74	60.63	36.52	13.63	63.64	300	0	P	H
		1855	49.01	-42.5	91.51	78.07	28.23	6.34	63.63	100	0	P	V
		8353	52.16	-21.84	74	65.64	36.51	13.63	63.62	100	23	P	V
		8353	50.1	-3.9	54	63.58	36.51	13.63	63.62	100	23	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line. 3. Non-restricted band limit is 100kHz-PSD down 20dB.												

FSK FHSS 250kbps (Band Edge @ 3m)

FSK FHSS	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
		(MHz)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
902.5MHz		870.02	39.45	-51	90.45	38.15	29.24	4.32	32.26	100	301	P	H
		902.03	110.45	-	-	108.9	29.36	4.39	32.2	100	301	P	H
		934.04	42.66	-47.79	90.45	39.99	30.33	4.47	32.13	100	301	P	H
		902.03	105.46	-	-	103.91	29.36	4.39	32.2	100	301	P	V
915MHz		914.64	112.64	-	-	110.65	29.74	4.42	32.17	176	129	P	H
		946.65	42.78	-49.86	92.64	39.68	30.71	4.5	32.11	176	129	P	H
		914.64	108.62	-	-	106.63	29.74	4.42	32.17	160	133	P	V
		946.65	42.57	-46.05	88.62	39.47	30.71	4.5	32.11	160	133	P	V
927.5MHz		895.24	41.6	-56.22	97.82	40.15	29.29	4.37	32.21	100	0	P	H
		927.25	117.82	-	-	115.4	30.12	4.45	32.15	100	0	P	H
		959.26	46.01	-51.81	97.82	42.8	30.76	4.53	32.08	100	0	P	H
		895.24	38.54	-52.75	91.29	37.09	29.29	4.37	32.21	156	303	P	V
		927.25	111.29	-	-	108.87	30.12	4.45	32.15	156	303	P	V
		959.26	44.09	-47.2	91.29	40.88	30.76	4.53	32.08	156	303	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line. 3. Non-restricted band limit is 100kHz-PSD down 20dB.												

FSK FHSS 250kbps (Harmonic @ 3m)

FSK FHSS	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
902.5MHz		1801	47.39	-43.06	90.45	76.79	27.98	6.27	63.65	300	0	P	H
		1801	41.23	-44.23	85.46	70.63	27.98	6.27	63.65	100	0	P	V
915MHz		1828	50.04	-42.6	92.64	79.22	28.15	6.31	63.64	300	0	P	H
		8236	47.43	-26.57	74	60.94	36.61	13.64	63.76	300	0	P	H
		9154	49.05	-24.95	74	61.13	37.53	14.3	63.91	300	0	P	H
		1828	44.21	-44.41	88.62	73.39	28.15	6.31	63.64	100	0	P	V
		8236	49.9	-24.1	74	63.41	36.61	13.64	63.76	100	0	P	V
		9154	50.06	-23.94	74	62.14	37.53	14.3	63.91	100	0	P	V
927.5MHz		1855	54.71	-43.11	97.82	83.77	28.23	6.34	63.63	300	0	P	H
		1855	48.42	-42.87	91.29	77.48	28.23	6.34	63.63	100	0	P	V
		8344	49.38	-24.62	74	62.87	36.52	13.63	63.64	100	0	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line. 3. Non-restricted band limit is 100kHz-PSD down 20dB.												

Emission below 1GHz

FSK FHSS	Note	Frequency (MHz)	Level (dBµV/m)	Over Limit (dB)	Limit Line (dBµV/m)	Read Level (dBµV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
Below 1GHz FSK FHSS 150kbps		30	20.04	-19.96	40	33.22	25.36	0.46	39	-	-	P	H
		40.67	20.75	-19.25	40	40.07	19.01	0.55	38.88	-	-	P	H
		59.1	19.99	-20.01	40	45.89	11.92	0.7	38.52	-	-	P	H
		96.93	18.52	-24.98	43.5	40.75	15.55	0.96	38.74	-	-	P	H
		817.64	33.16	-12.84	46	34.88	28.72	3.19	33.63	-	-	P	H
		959.26	40.83	-5.17	46	38.53	30.69	3.47	31.86	139	121	P	H
		30	20.64	-19.36	40	33.82	25.36	0.46	39	-	-	P	V
		39.7	22.46	-17.54	40	41.26	19.56	0.54	38.9	-	-	P	V
		66.86	17.9	-22.1	40	43.83	11.91	0.76	38.6	-	-	P	V
		307.42	19.42	-26.58	46	35.75	19.2	1.83	37.36	-	-	P	V
		821.52	29.74	-16.26	46	31.41	28.74	3.2	33.61	-	-	P	V
		959.26	38.65	-7.35	46	36.35	30.69	3.47	31.86	233	150	P	V
Remark	1. No other spurious found. 2. All results are PASS against limit line.												

For co-location:

FSK FHSS 50kbps + BLE (BE @ 3m)

	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
BLE CH39		2483.68	58.45	-15.55	74	54.98	32.69	7.32	36.54	339	181	P	H
		2483.56	48.3	-5.7	54	44.83	32.69	7.32	36.54	339	181	A	H
		2480	100.9	-	-	97.43	32.69	7.32	36.54	339	181	P	H
		2480	100.34	-	-	96.87	32.69	7.32	36.54	339	181	A	H
		2483.5	58.04	-15.96	74	54.57	32.69	7.32	36.54	382	235	P	V
		2484.7	46.51	-7.49	54	43.04	32.69	7.32	36.54	382	235	A	V
		2480	97.18	-	-	93.71	32.69	7.32	36.54	382	235	P	V
		2480	96.66	-	-	93.19	32.69	7.32	36.54	382	235	A	V
FSK 50kbps 915MHz		882.63	43.55	-53.86	97.41	42.17	29.27	4.34	32.23	155	230	P	H
		914.64	117.41	-	-	115.42	29.74	4.42	32.17	155	230	P	H
		945.68	48.91	-48.5	97.41	45.84	30.68	4.5	32.11	155	230	P	H
		882.63	40.4	-50.13	90.53	39.02	29.27	4.34	32.23	139	214	P	V
		914.64	110.53	-	-	108.54	29.74	4.42	32.17	139	214	P	V
		946.65	43.16	-47.37	90.53	40.06	30.71	4.5	32.11	139	214	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line. 3. Non-restricted band limit is 100kHz-PSD down 20dB.												

FSK FHSS 50kbps + BLE (Harmonic@ 3m)

	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
		(MHz)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
BLE CH39		4961	43.02	-30.98	74	61.21	34.77	10.45	63.41	100	360	P	H
		7443	45.05	-28.95	74	59.65	36.44	12.83	63.87	100	360	P	H
		4961	42.27	-31.73	74	60.46	34.77	10.45	63.41	100	360	P	V
		7443	44.9	-29.1	74	59.5	36.44	12.83	63.87	100	360	P	V
FSK 50kbps 915MHz		1830	54.97	-43.1	98.07	84.15	28.15	6.31	63.64	300	0	P	H
		2746	45.19	-28.81	74	67.32	32.56	7.77	62.46	300	0	P	H
		8238	45.91	-28.09	74	59.42	36.61	13.64	63.76	300	0	P	H
		1830	46.65	-42.2	88.85	75.83	28.15	6.31	63.64	300	0	P	V
		8238	48.71	-25.29	74	62.22	36.61	13.64	63.76	300	0	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line. 3. Non-restricted band limit is 100kHz-PSD down 30dB.												

Note symbol

*	**Fundamental Frequency** which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
!	Test result is **over limit** line.
P/A	**P**eak or **A**verage
H/V	**H**orizontal or **V**ertical

A calculation example for radiated spurious emission is shown as below:

WIFI Ant. 1+2	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
802.11b CH 01 2412MHz		2390	55.45	-18.55	74	54.51	32.22	4.58	35.86	103	308	P	H
		2390	43.54	-10.46	54	42.6	32.22	4.58	35.86	103	308	A	H

1. Level(dBμV/m) =

Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

2. Over Limit(dB) = Level(dBμV/m) – Limit Line(dBμV/m)

For Peak Limit @ 2390MHz:

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 54.51(dBμV) – 35.86 (dB)

= 55.45 (dBμV/m)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 55.45(dBμV/m) – 74(dBμV/m)

= -18.55(dB)

For Average Limit @ 2390MHz:

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 42.6(dBμV) – 35.86 (dB)

= 43.54 (dBμV/m)

2. Over Limit(dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 43.54(dBμV/m) – 54(dBμV/m)

= -10.46(dB)

Both peak and average measured complies with the limit line, so test result is “PASS”.