4.1.5 Equivalent Isotropically Radiated Power

Result: **Pass**

Test Specification
Test standard : RSS-247 Issue 2 February 2017 Clause 5.4(a)&(d)
Limits : For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz: 4 Watt (36dBm)
Kind of test site : Shielded Room

Test Setup

Date of testing : 27.11.2019~25.12.2019
Input voltage : AC 120V, 60Hz
Operational mode : Test mode of BLE, LoRa DTS, LoRa FHSS, FSK FHSS
Test channel : Lo, Mi, Hi
Temperature : 21.1°C
Relative humidity : 57%
Atmospheric pressure : 101 kPa

Table 5: Test result of E.I.R.P. for BLE, LoRa DTS, LoRa FHSS and FSK FHSS

Modulation Type and Operation band	Channel	Channel Frequency (MHz)	Peak Output Power (dBm)	Antenna Gain (dBi)	E.I.R.P. (dBm)	Limit (dBm)
1. BLE 2402MHz~2480MHz	Low Channel	2402	2.56	2.44	5.00	36
	Mid Channel	2440	2.43	2.44	4.87	36
	High Channel	2480	1.3	2.44	3.74	36
2. LoRa 500KHz DTS 902.5MHz~926.5	Low Channel	902.5	19.99	-1.69	18.30	36
	Mid Channel	914.5	20.03	-1.69	18.34	36
	High Channel	926.5	20.02	-1.69	18.33	36
3. LoRa 500KHz DTS 903MHz~914.2MHz	Low Channel	903	20.28	-1.69	18.59	36
	Mid Channel	907.8	20.64	-1.69	18.95	36
	High Channel	914.2	20.35	-1.69	18.66	36
4. LoRa 500KHz DTS 923.3MHz~926.9MHz	Low Channel	923.3	20.25	-1.69	18.56	36
	Mid Channel	925.1	20.27	-1.69	18.58	36
	High Channel	926.9	20.22	-1.69	18.53	36
5. LoRa 250KHz FHSS 902.3MHz~926.7MHz	Low Channel	902.3	20.60	-1.69	18.91	36
	Mid Channel	914.3	20.27	-1.69	18.58	36
	High Channel	926.7	20.33	-1.69	18.64	36
6. LoRa 125KHz FHSS 902.3MHz~914.9MHz	Low Channel	902.3	20.90	-1.69	19.21	36
	Mid Channel	908.5	20.82	-1.69	19.13	36
	High Channel	914.9	20.64	-1.69	18.95	36

7. LoRa 125KHz FHSS 902.2MHz~927.8MHz	Low Channel	902.2	21.23	-1.69	19.54	36
	Mid Channel	915	20.91	-1.69	19.22	36
	High Channel	927.8	20.49	-1.69	18.80	36
8. FSK 150Kbps FHSS 902.4MHz~927.6MHz	Low Channel	902.4	20.08	-1.69	18.38	36
	Mid Channel	914.8	20.32	-1.69	18.63	36
	High Channel	927.6	19.07	-1.69	17.38	36
9. FSK 50Kbps FHSS 902.2MHz~927.8MHz	Low Channel	902.2	20.86	-1.69	19.17	36
	Mid Channel	915	20.39	-1.69	18.7	36
	High Channel	927.8	20.06	-1.69	18.91	36
10. FSK 5Kbps FHSS 902.2MHz~927.8MHz	Low Channel	902.2	20.53	-1.69	18.84	36
	Mid Channel	915	20.39	-1.69	18.70	36
	High Channel	927.8	20.23	-1.69	18.54	36
11. FSK 250Kbps FHSS 902.5MHz~927.5MHz	Low Channel	902.5	21.01	-1.69	19.32	36
	Mid Channel	915	20.63	-1.69	18.94	36
	High Channel	927.5	20.31	-1.69	18.62	36

4.1.6 Power Spectral Density

Result: **Pass**

Test Specification

Test standard	:	FCC Part 15.247(e)
		RSS-247 Issue 2 February 2017 Clause 5.2(b)
Basic standard	:	ANSI C63.10: 2013
Limits	:	Not more than 8 dBm in any 3 kHz band
Kind of test site	:	Shielded Room

Test Setup

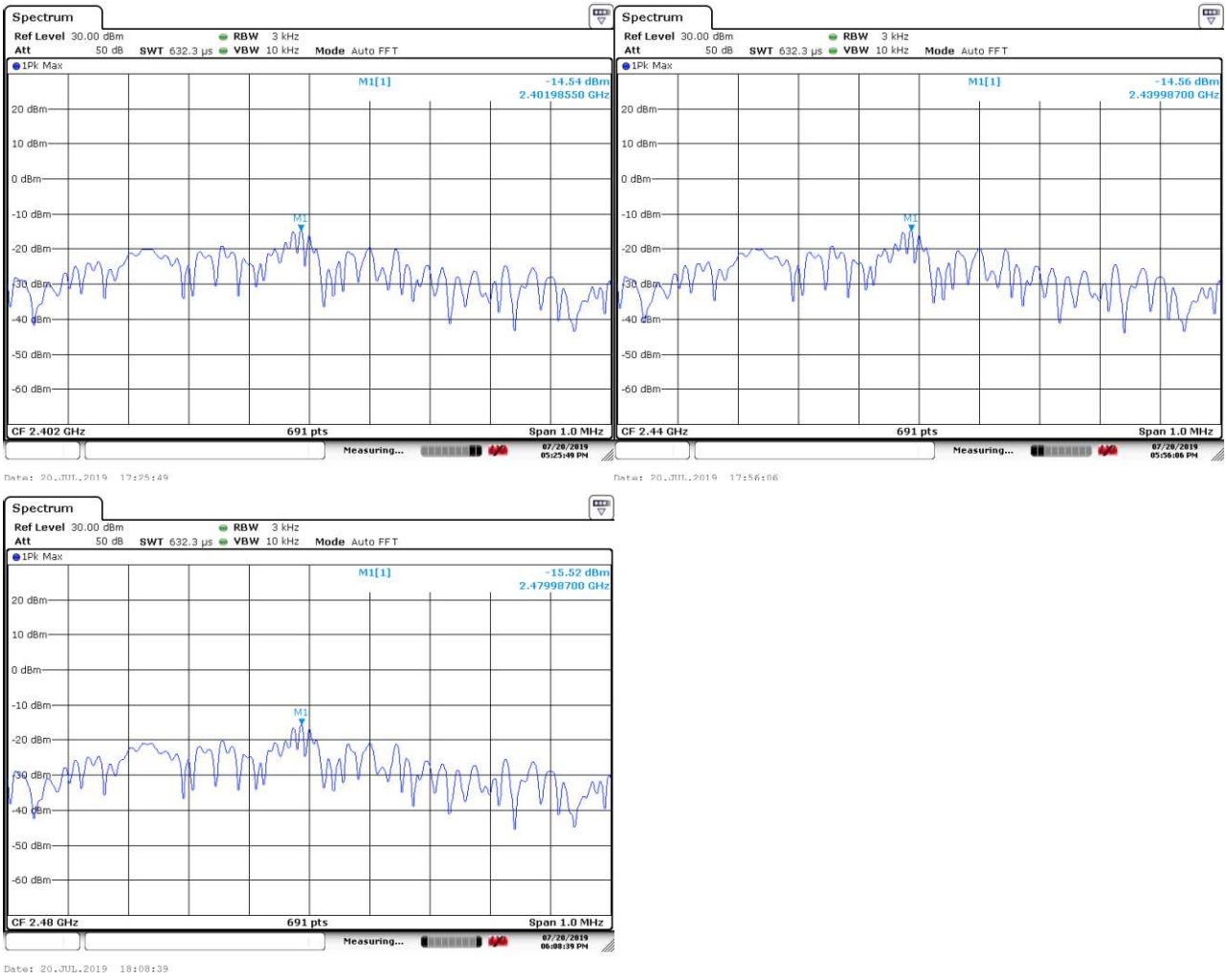
Date of testing	:	27.11.2019~28.11.2019
Input voltage	:	AC 120V, 60Hz
Operational mode	:	On, BLE, LoRa DTS
Test channel	:	Lo, Mi, Hi
Temperature	:	21°C
Relative humidity	:	57%
Atmospheric pressure	:	101 kPa

Table 6: Test result of Power Spectral Density for BLE, LoRa DTS

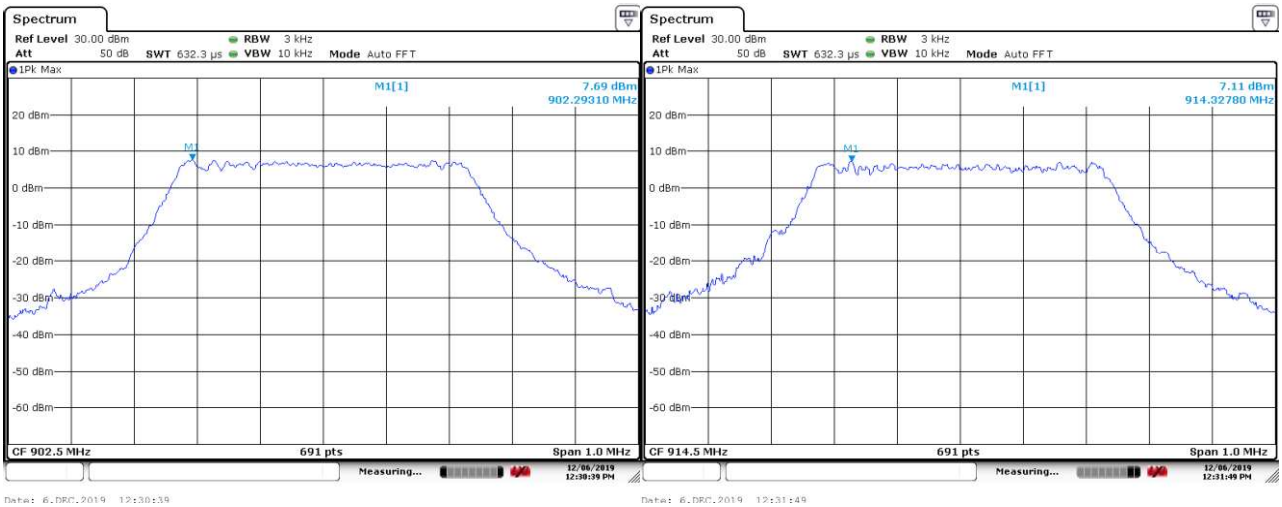
Modulation Type and Operation band	Channel	Channel Frequency (MHz)	Measured Power Density (dBm)	Limit (dBm)	Result
1. BLE 2402MHz~2480MHz	Low Channel	2402	-14.54	8.0	Pass
	Mid Channel	2440	-14.56	8.0	Pass
	High Channel	2480	-15.52	8.0	Pass
2. LoRa 500KHz DTS 902.5MHz~926.5	Low Channel	902.5	7.69	8.0	Pass
	Mid Channel	914.5	7.11	8.0	Pass
	High Channel	926.5	7.05	8.0	Pass
3. LoRa 500KHz DTS 903MHz~914.2MHz	Low Channel	903	7.64	8.0	Pass
	Mid Channel	907.8	7.58	8.0	Pass
	High Channel	914.2	7.60	8.0	Pass
4. LoRa 500KHz DTS 923.3MHz~926.9MHz	Low Channel	923.3	7.57	8.0	Pass
	Mid Channel	925.1	7.56	8.0	Pass
	High Channel	926.9	7.31	8.0	Pass

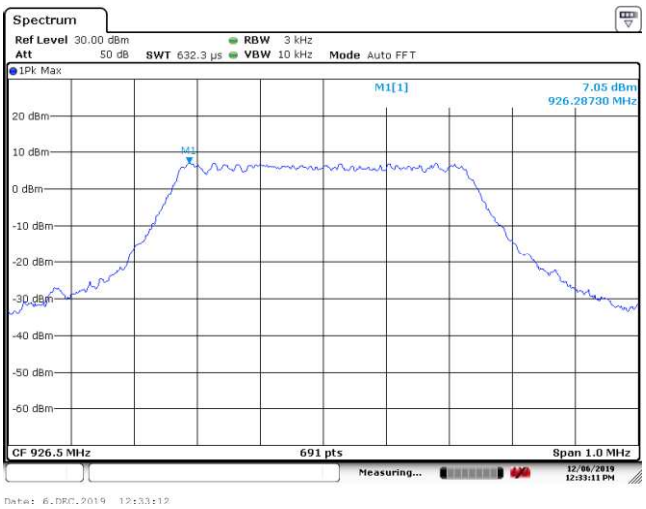
Figure 4: Power Spectral Density

1. BLE, Maximum Conducted Output Power, 2402MHz~2480MHz



2. LoRa 500KHz DTS, Maximum Conducted Output Power, 902.5MHz~926.5





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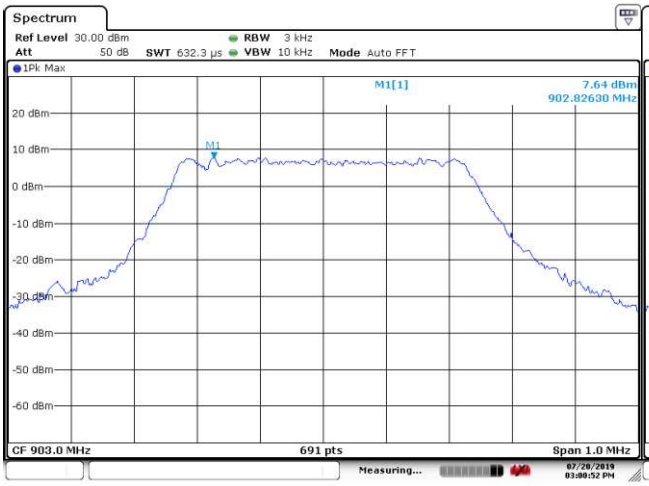
3. LoRa 500KHz DTS, Maximum Conducted Output Power, 903MHz~914.2MHz



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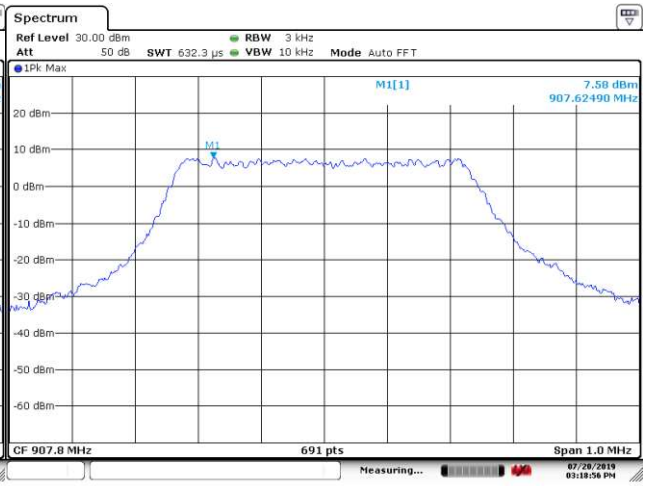

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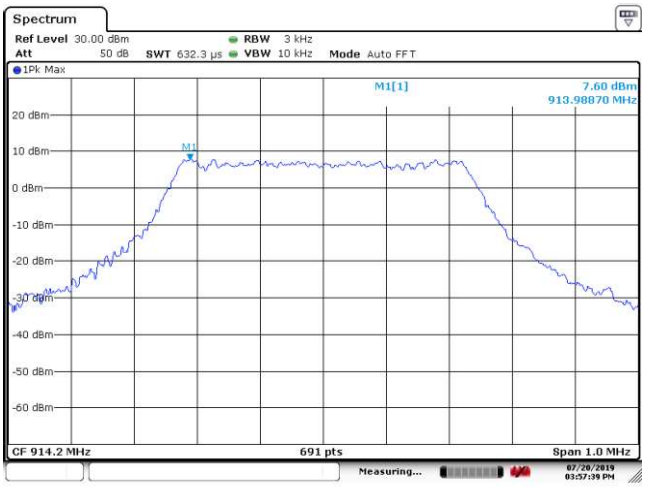
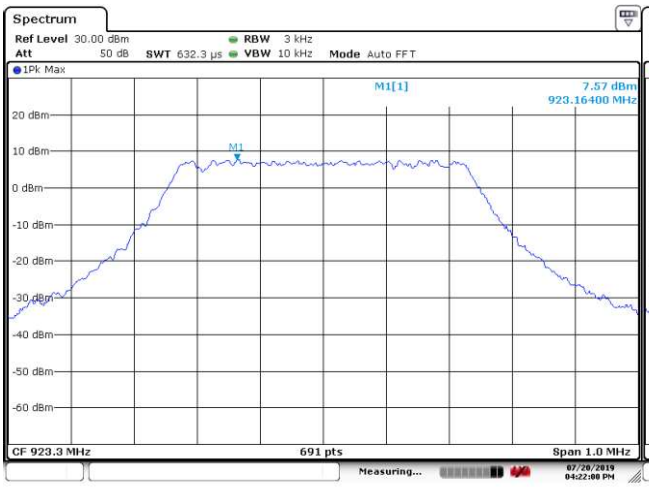


Date: 20.JUL.2019 15:57:39

4. LoRa 500KHz DTS, Maximum Conducted Output Power, 923.3MHz~926.9MHz



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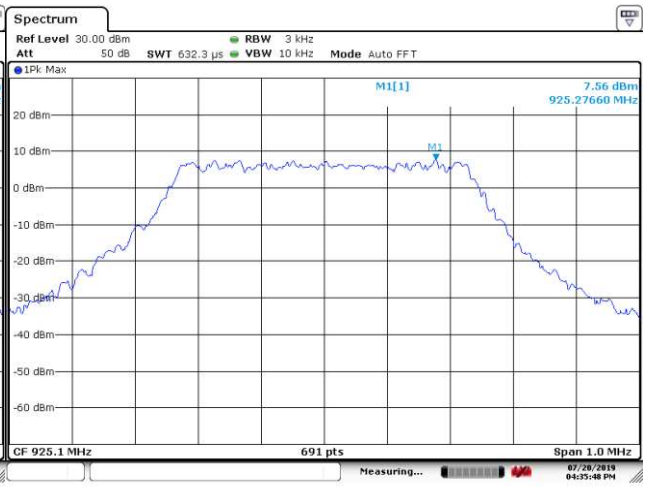

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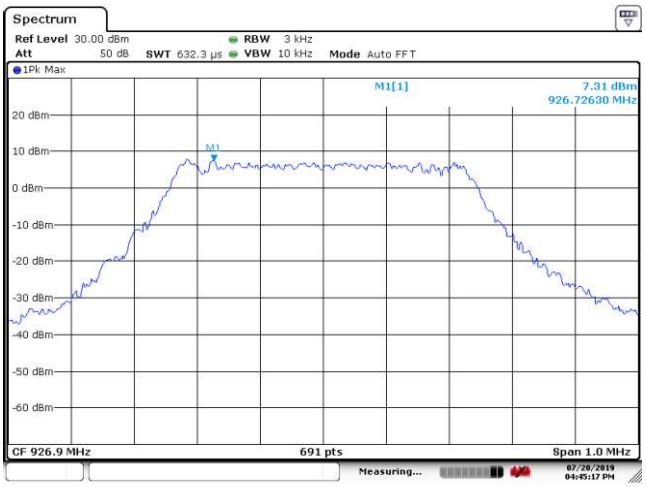


Date: 20.JUL.2019 16:45:17

4.1.7 Conducted Spurious Emissions Measured in 100 kHz Bandwidth

Result: **Pass**

Test Specification		
Test standard	:	FCC Part 15.247(d) RSS-247 Issue 2 February 2017 Clause 5.5
Basic standard	:	ANSI C63.10: 2013
Limits	:	20dB (below that in the 100kHz bandwidth within the band that contains the highest level of the desired power);
Kind of test site	:	Shielded Room

Test Setup

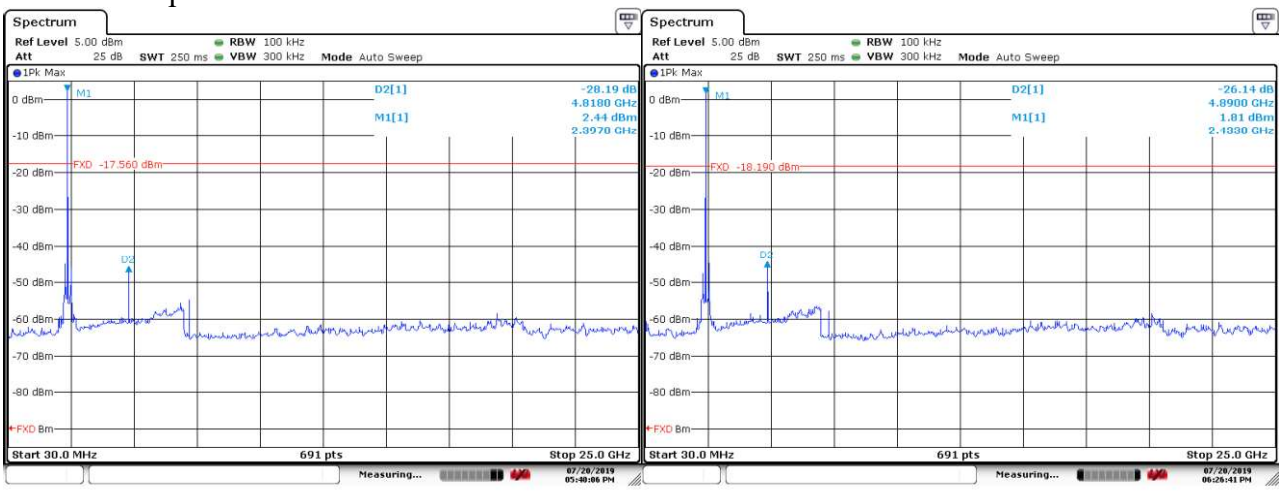
Date of testing	:	27.11.2019~25.12.2019
Input voltage	:	AC 120V, 60Hz
Operational mode	:	Test mode of BLE, LoRa DTS, LoRa FHSS, FSK FHSS
Test channel	:	Lo, Mi, Hi
Temperature	:	21.1°C
Relative humidity	:	57%
Atmospheric pressure	:	101 kPa

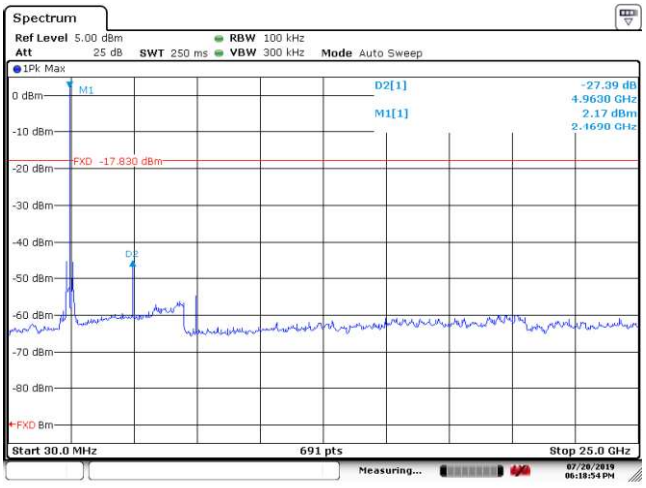
All emissions are more than 20dB below fundamental, compliance is achieved as well.

Figure 5: Conducted Spurious Emission

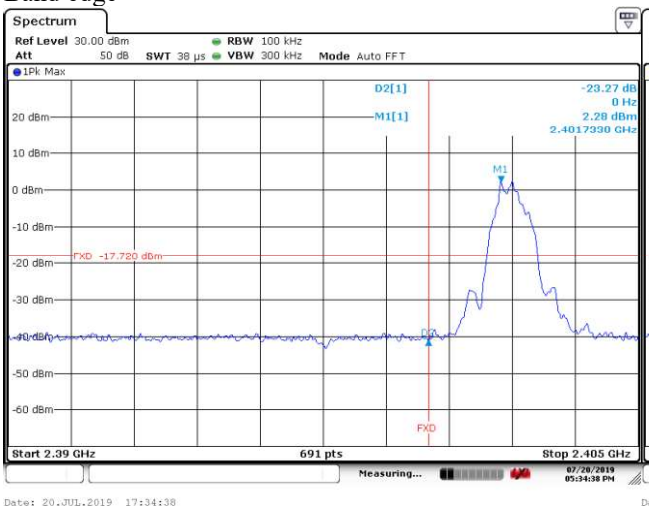
1. BLE, Conducted Spurious Emission and Band edge, 2402MHz~2480MHz

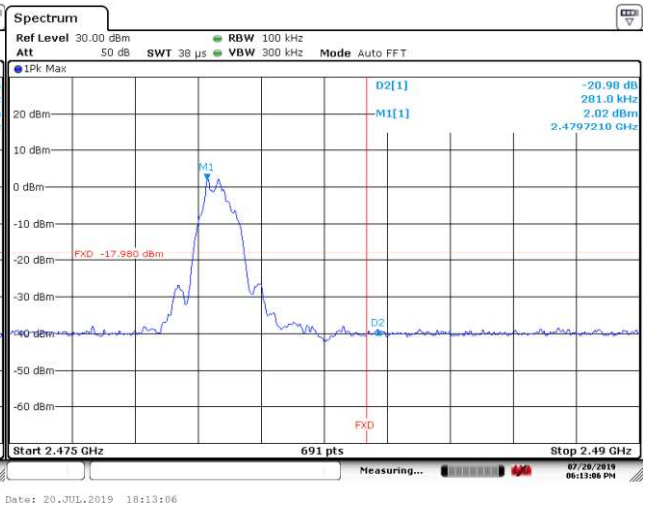
Conducted Spurious Emission





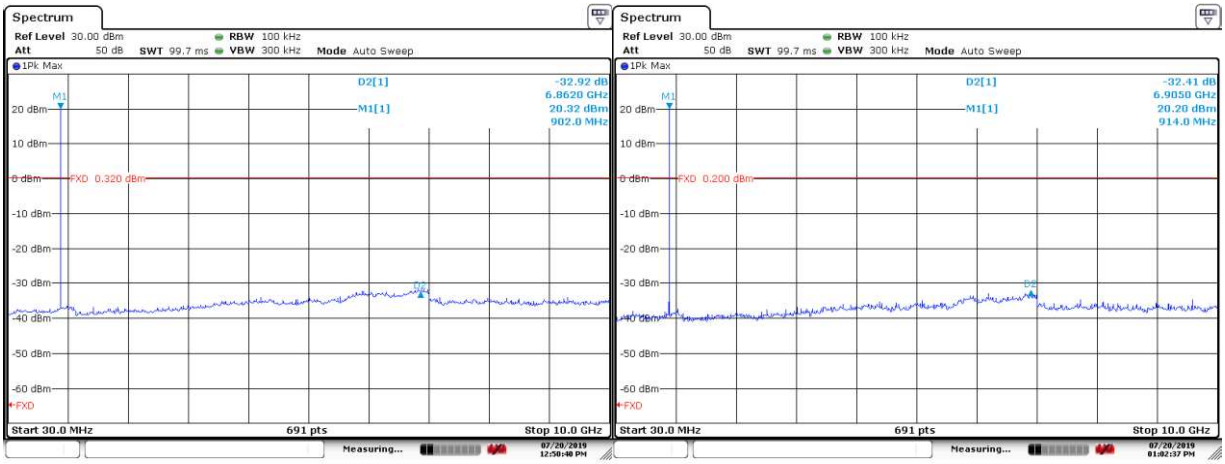
Band edge

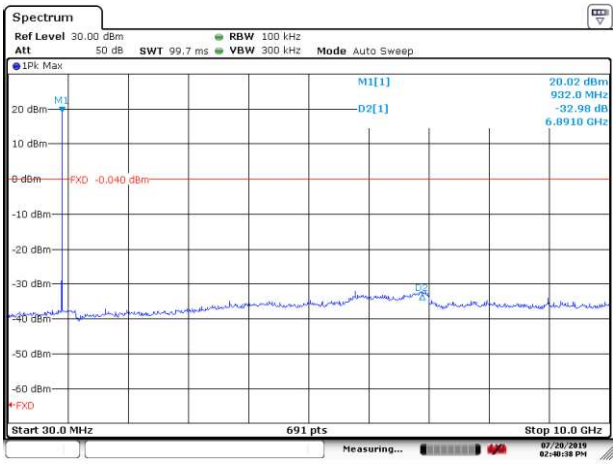




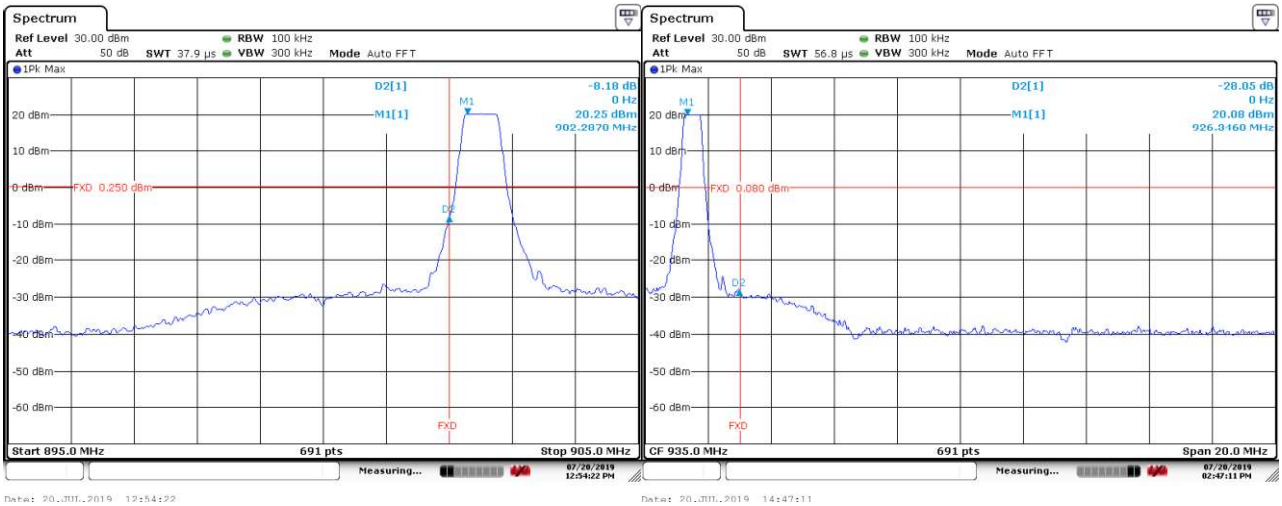
2. LoRa 500KHz DTS, Conducted Spurious Emission and Band edge, 902.5MHz~926.5

Conducted Spurious Emission



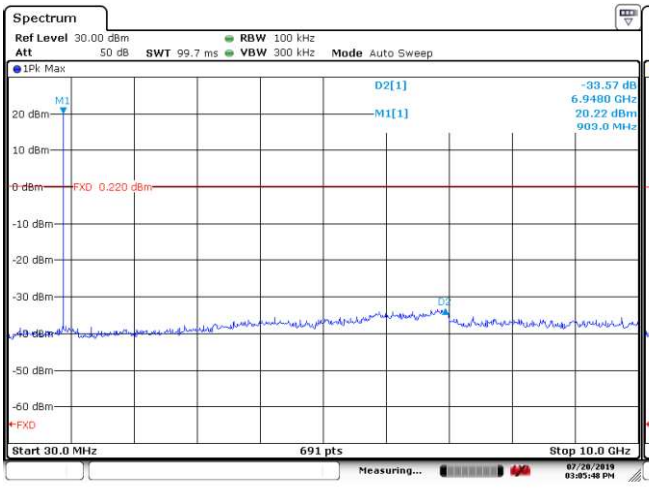


Band edge



3. LoRa 500KHz DTS, Conducted Spurious Emission and Band edge, 903MHz~914.2MHz

Conducted Spurious Emission



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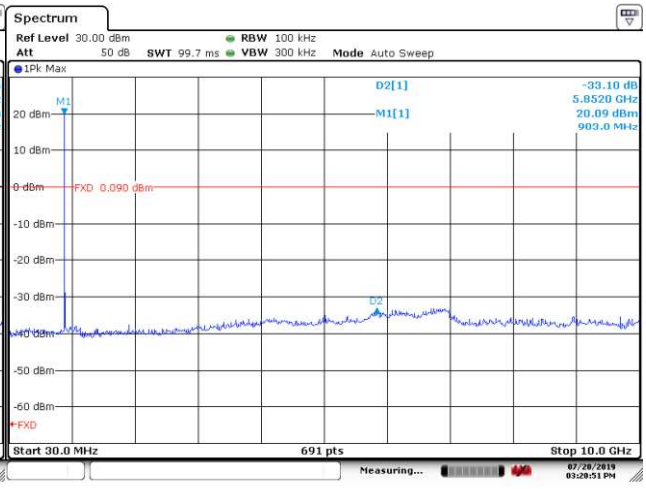

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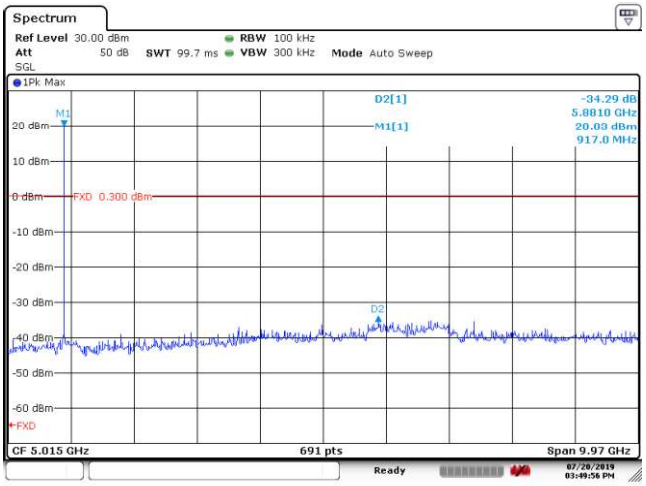
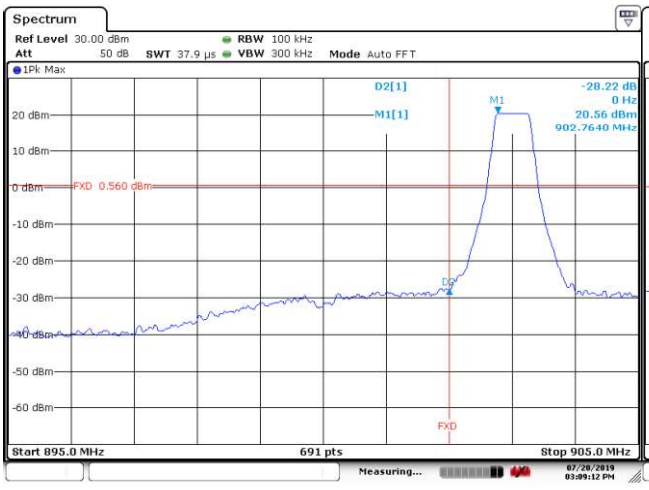


Date: 20.JUL.2019 15:49:56

Band edge



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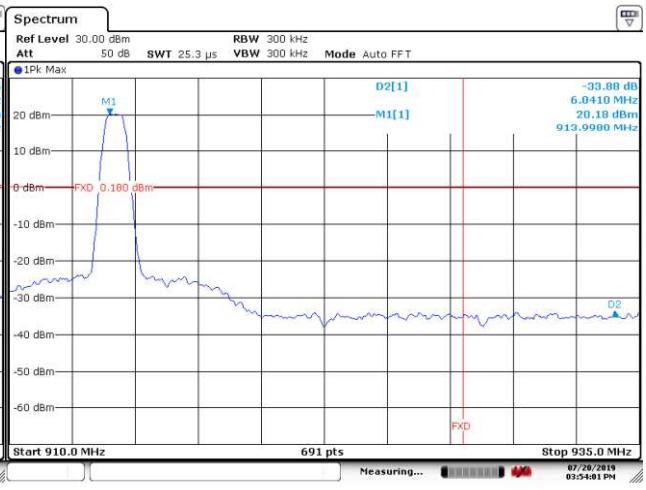

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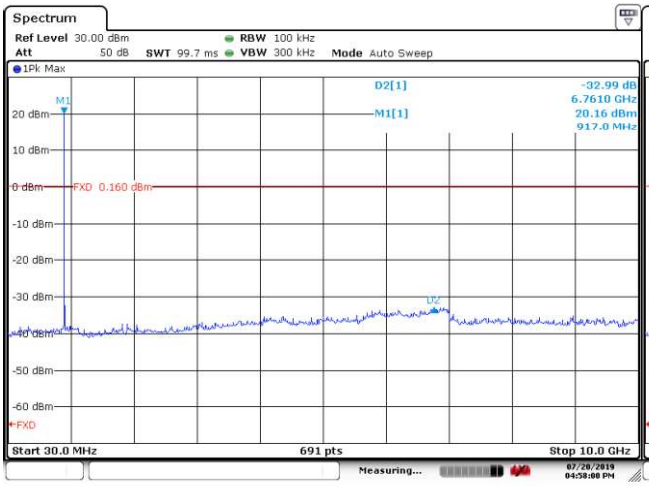
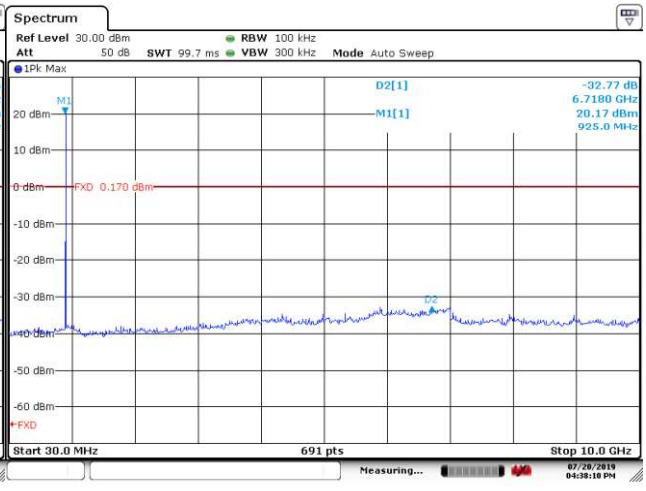
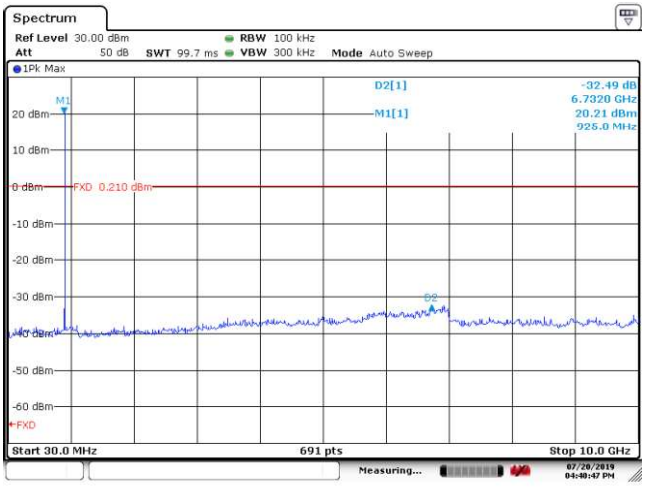
4. LoRa 500KHz DTS, Conducted Spurious Emission and Band edge, 923.3MHz~926.9MHz

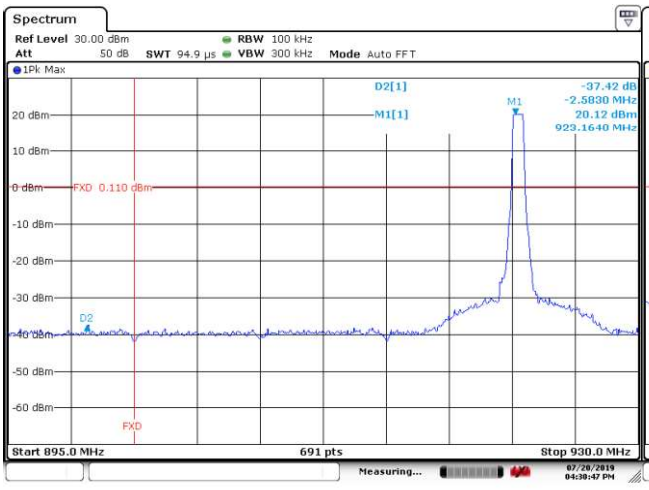
Conducted Spurious Emission

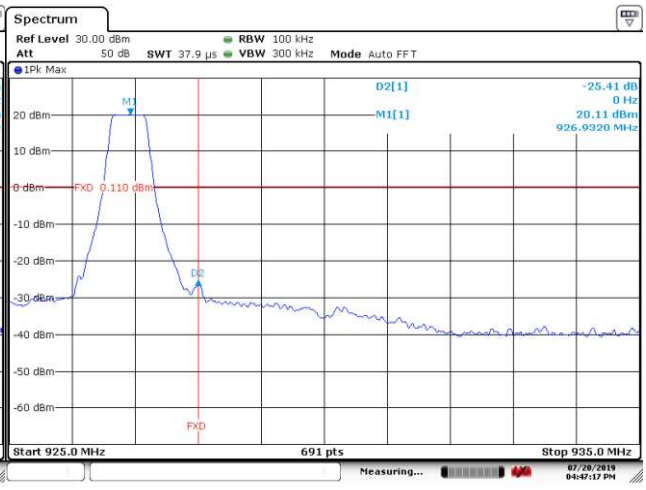






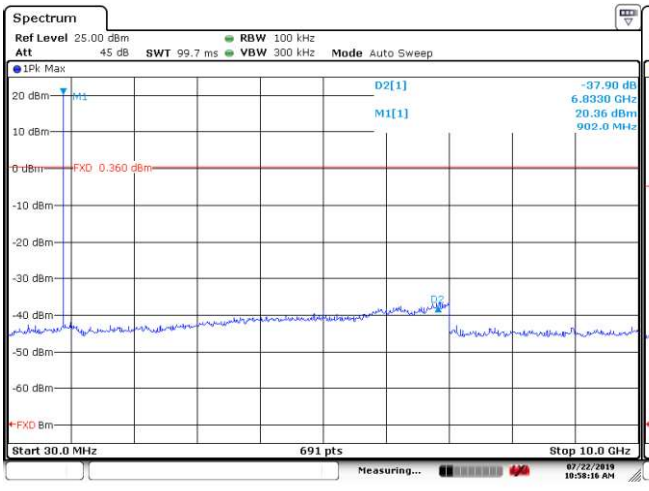
Band edge





5. LoRa 250KHz FHSS, Conducted Spurious Emission and Band edge, 902.3MHz~926.7MHz

Conducted Spurious Emission



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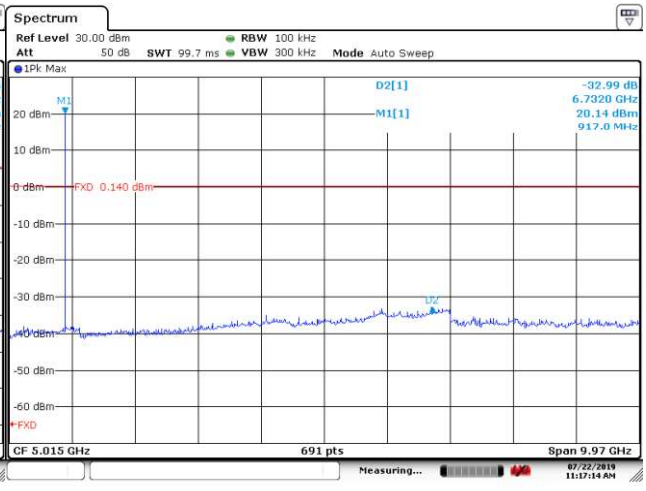

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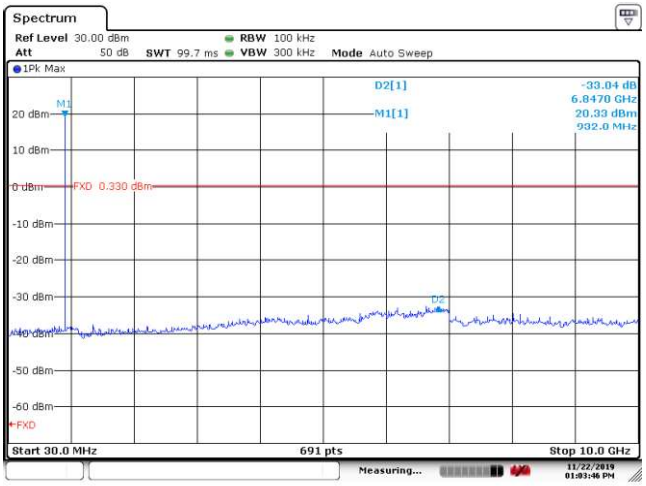
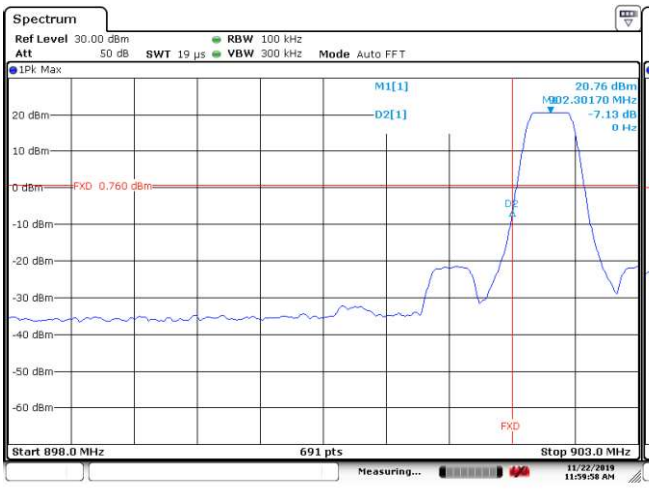


Date: 22.NOV.2019 13:03:46

Band edge



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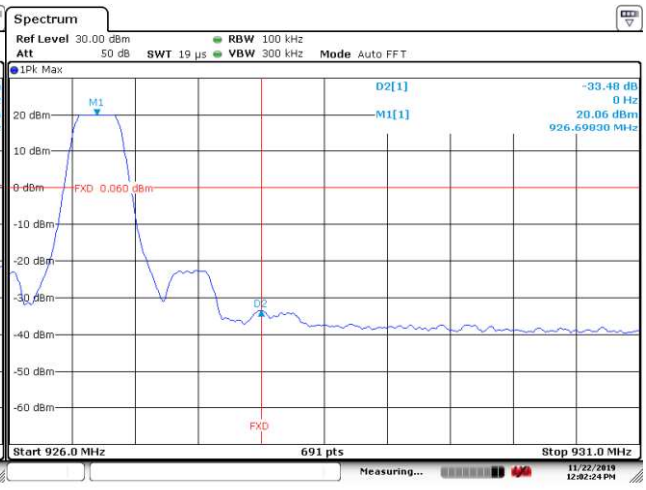

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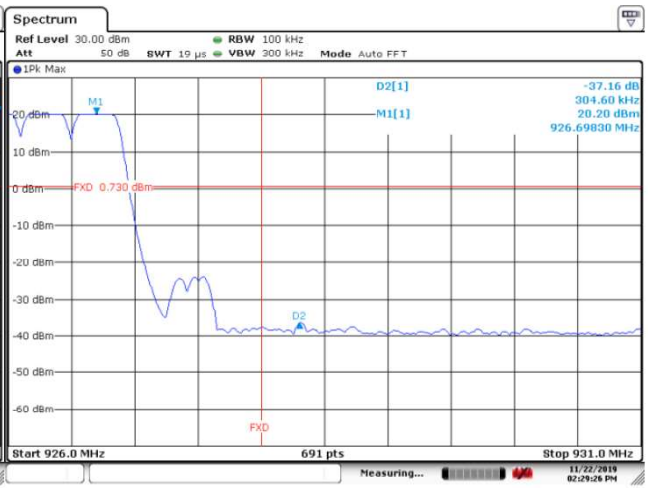
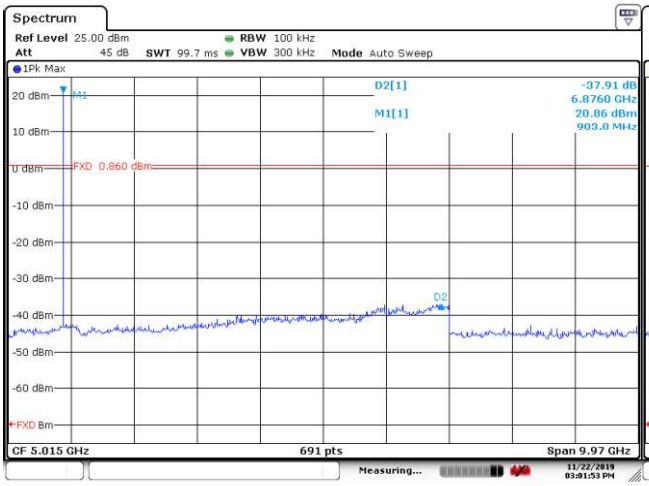


6. LoRa 125KHz FHSS, Conducted Spurious Emission, 902.3MHz~914.9MHz

Conducted Spurious Emission



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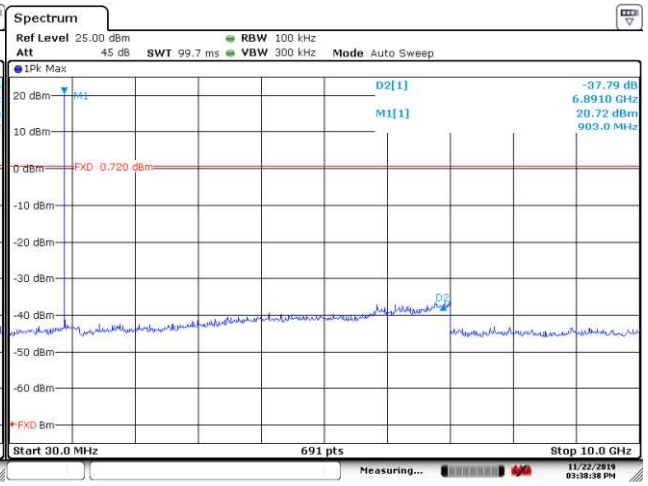

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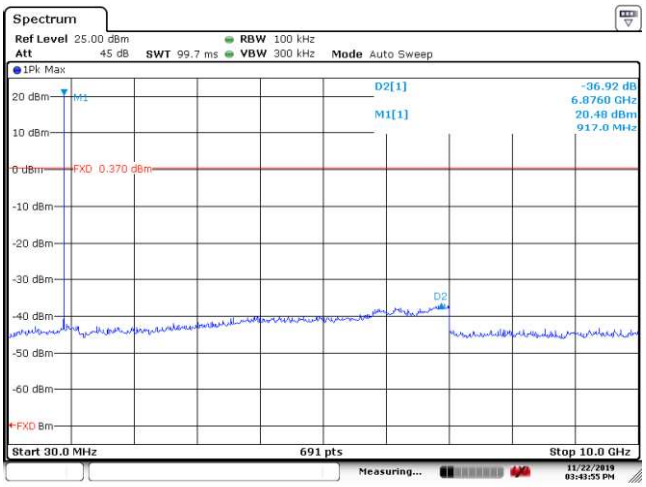

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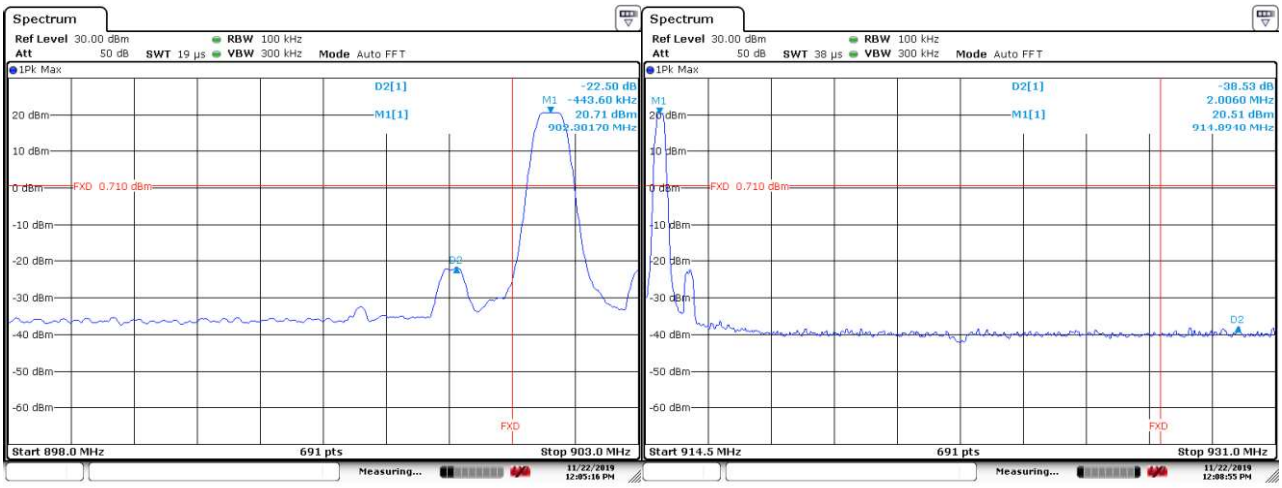
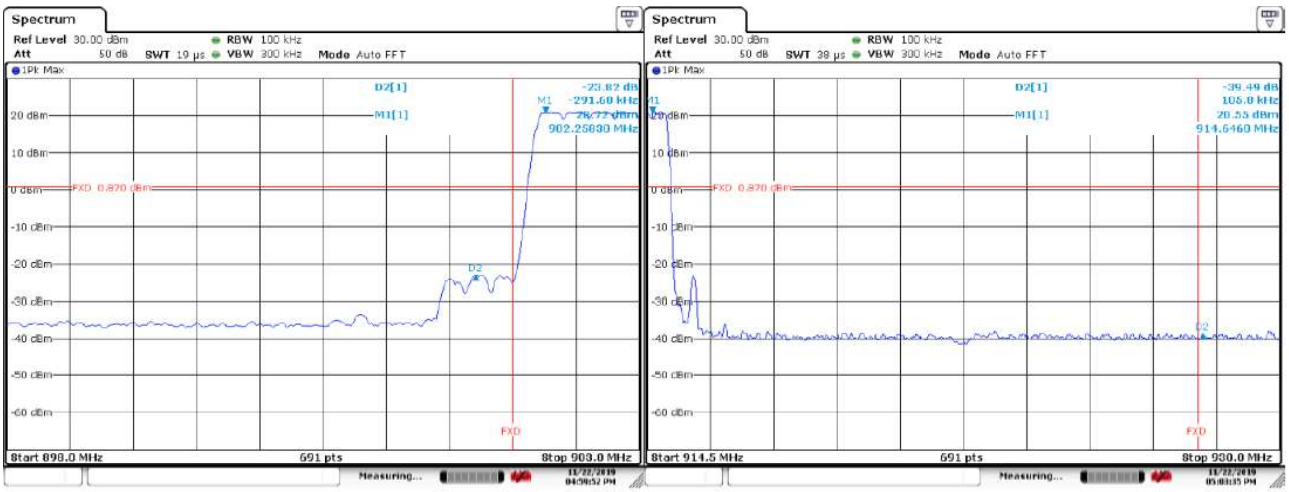
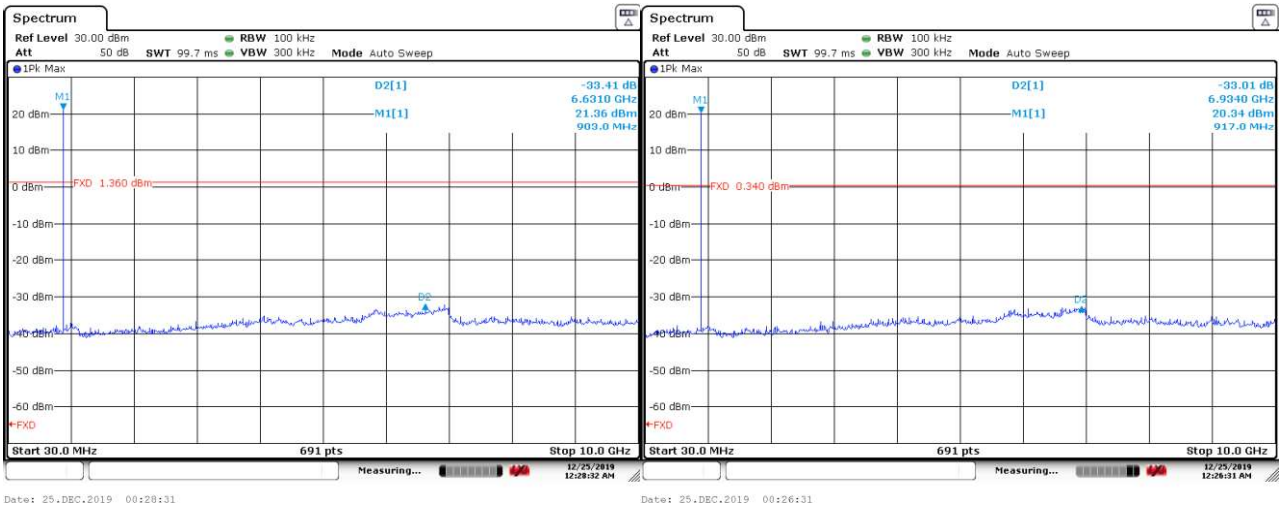
Band edge

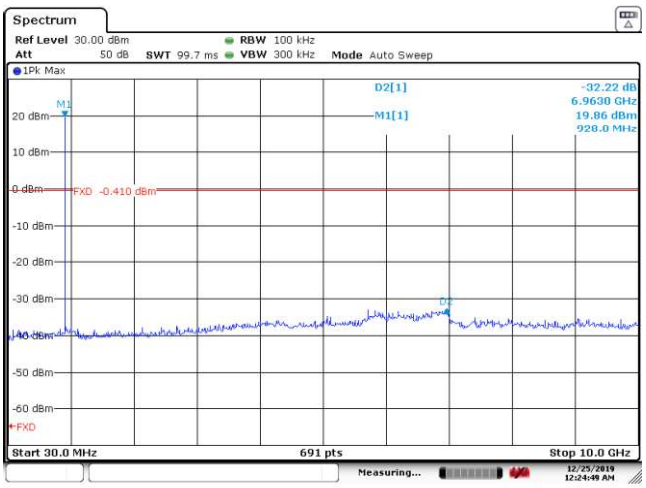




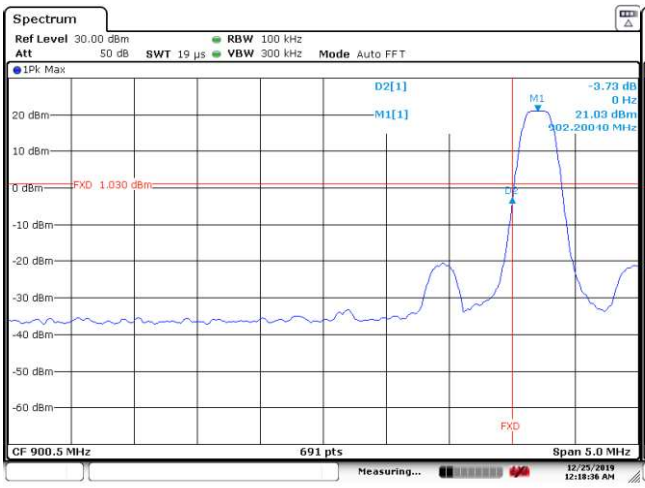
7. LoRa 125KHz FHSS, Conducted Spurious Emission, 902.2MHz~927.8MHz

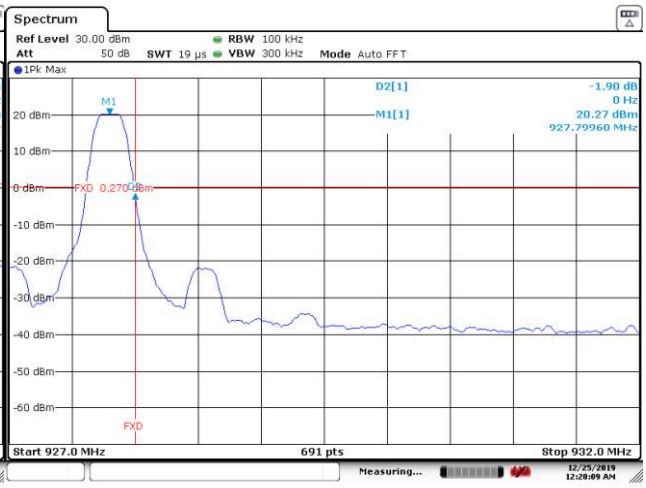
Conducted Spurious Emission

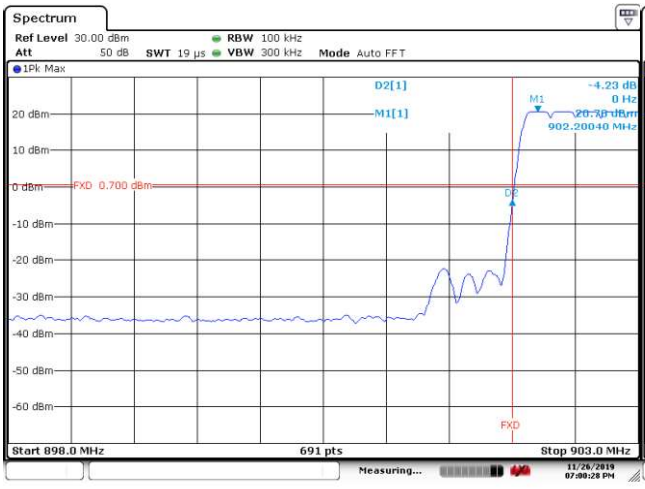



Spectrum
Ref Level 30.00 dBm
RBW 100 kHz
Att 50 dB
SWT 99.7 ms
VBW 300 kHz
Mode Auto Sweep
1Pk Max
D2[1]
-32.22 dB
6.9630 GHz
M1[1]
19.86 dBm
928.0 MHz
FXD -0.410 dBm
Start 30.0 MHz
691 pts
Stop 10.0 GHz
Measuring...
12/25/2019
12:24:49 AM

Band edge


Spectrum
Ref Level 30.00 dBm
RBW 100 kHz
Att 50 dB
SWT 19 µs
VBW 300 kHz
Mode Auto FFT
1Pk Max
D2[1]
-3.73 dB
0 Hz
M1[1]
21.03 dBm
902.20040 MHz
FXD 1.030 dBm
CF 900.5 MHz
691 pts
Span 5.0 MHz
Measuring...
12/25/2019
12:18:36 AM


Spectrum
Ref Level 30.00 dBm
RBW 100 kHz
Att 50 dB
SWT 19 µs
VBW 300 kHz
Mode Auto FFT
1Pk Max
D2[1]
-1.90 dB
0 Hz
M1[1]
20.27 dBm
927.79960 MHz
FXD 0.270 dBm
Start 927.0 MHz
691 pts
Stop 932.0 MHz
Measuring...
12/25/2019
12:20:09 AM


Spectrum
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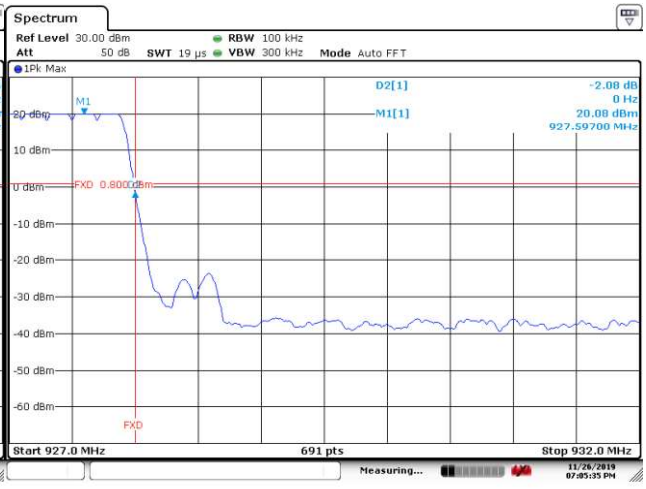
RBW 100 kHz
Att 50 dB
SWT 19 µs
VBW 300 kHz
Mode Auto FFT
1Pk Max
D2[1]
-4.23 dB
0 Hz
M1[1]
902.20040 MHz
FXD 0.700 dBm
Start 898.0 MHz
691 pts
Stop 903.0 MHz
Measuring...
11/26/2019
07:00:28 PM


Spectrum
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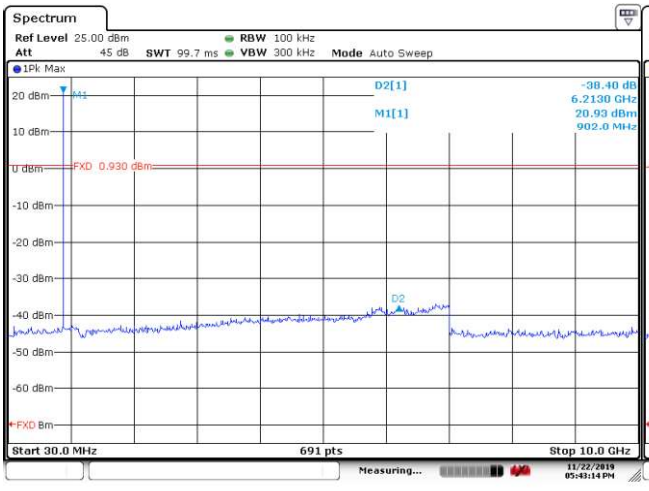
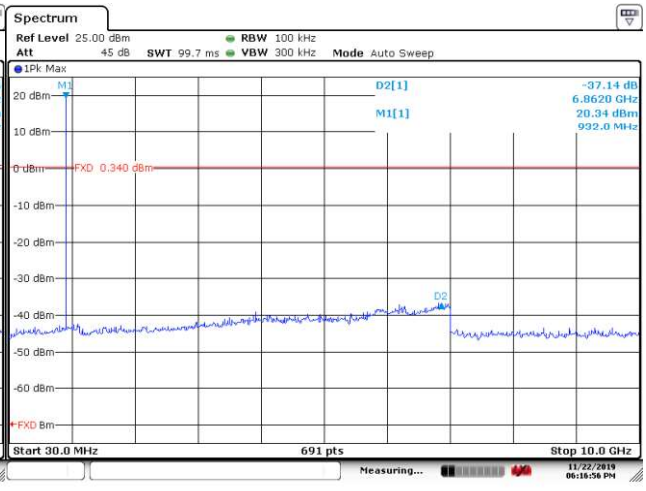
RBW 100 kHz
Att 50 dB
SWT 19 µs
VBW 300 kHz
Mode Auto FFT
1Pk Max
D2[1]
-2.08 dB
0 Hz
M1[1]
20.08 dBm
927.59700 MHz
FXD 0.800 dBm
Start 927.0 MHz
691 pts
Stop 932.0 MHz
Measuring...
11/26/2019
07:05:35 PM

8. FSK 150Kbps FHSS, Conducted Spurious Emission and Band edge, 902.4MHz~927.6MHz

Conducted Spurious Emission



Date: 22.NOV.2019 17:43:14



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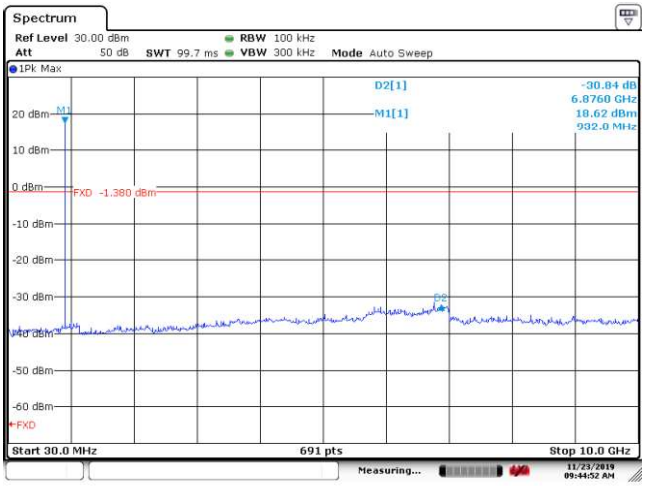
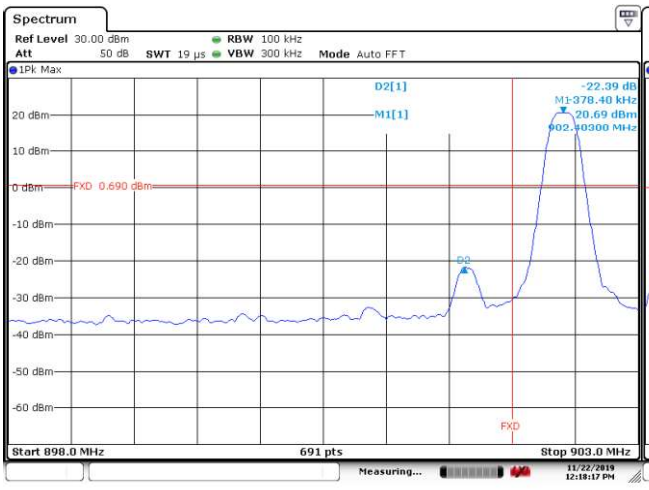


Date: 23.NOV.2019 09:44:52

Band edge



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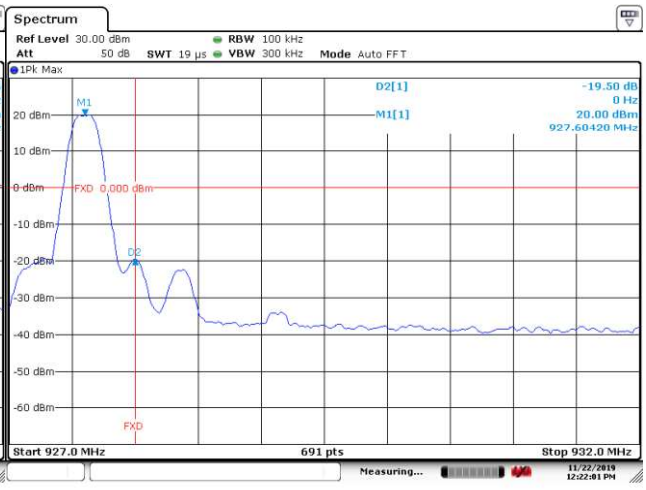

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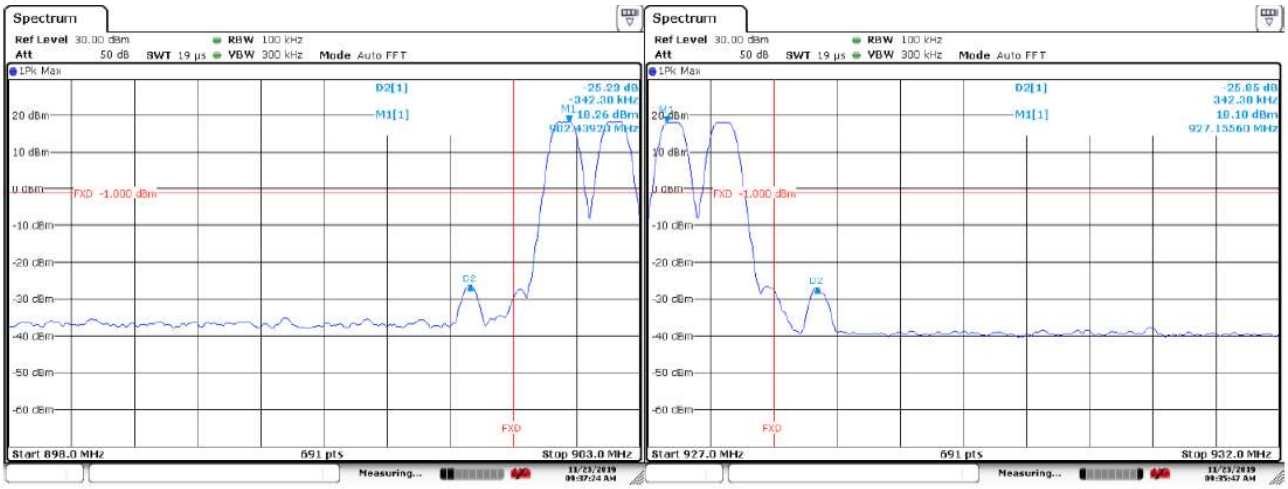
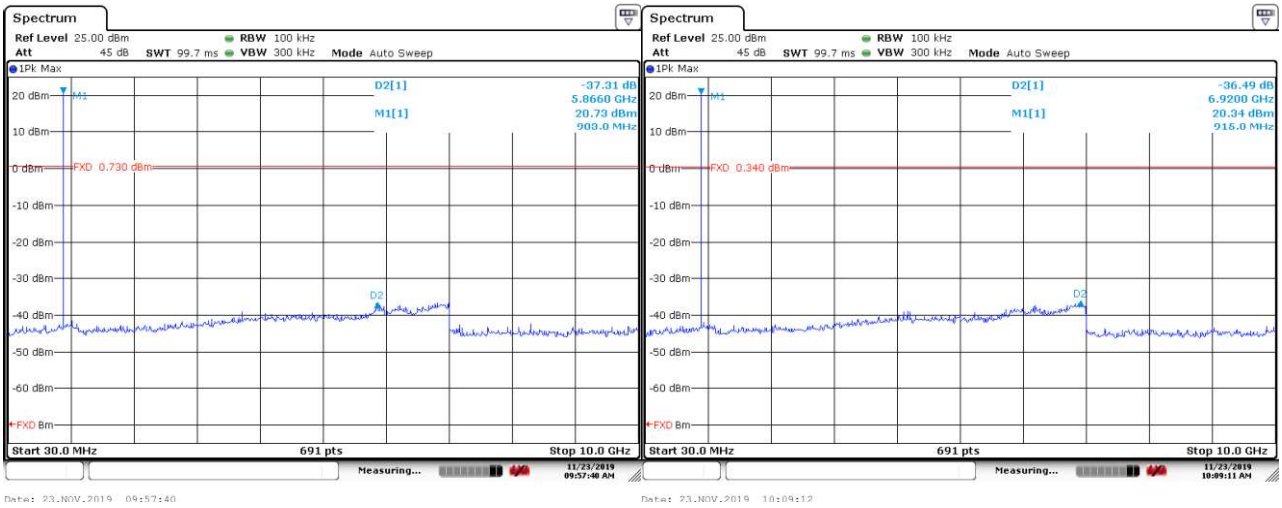
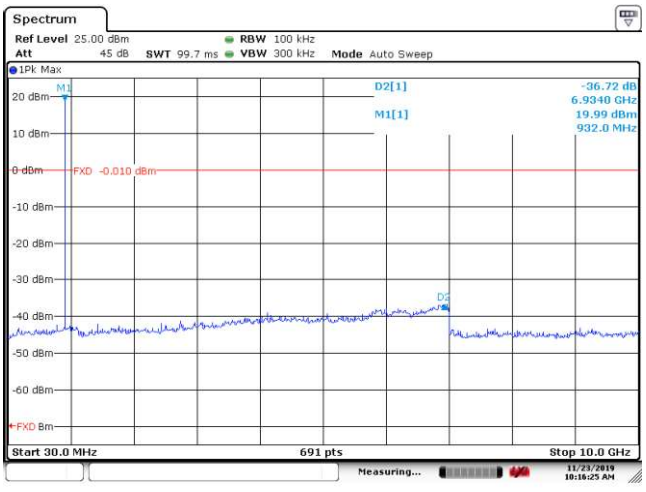


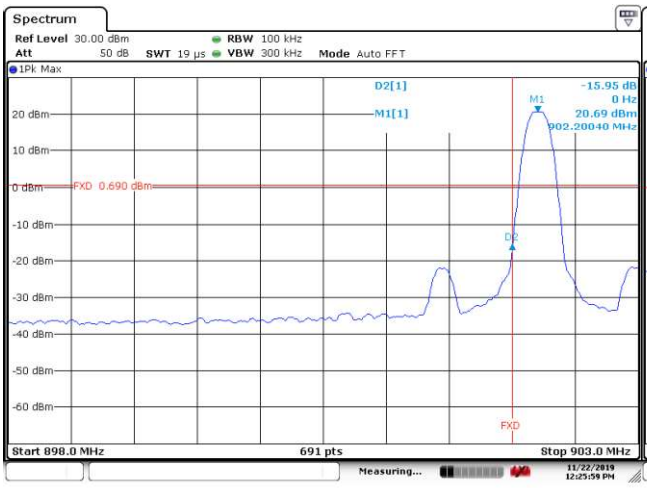
9. FSK 50Kbps FHSS, Conducted Spurious Emission and Band edge, 902.2MHz~927.8MHz

Conducted Spurious Emission





Band edge



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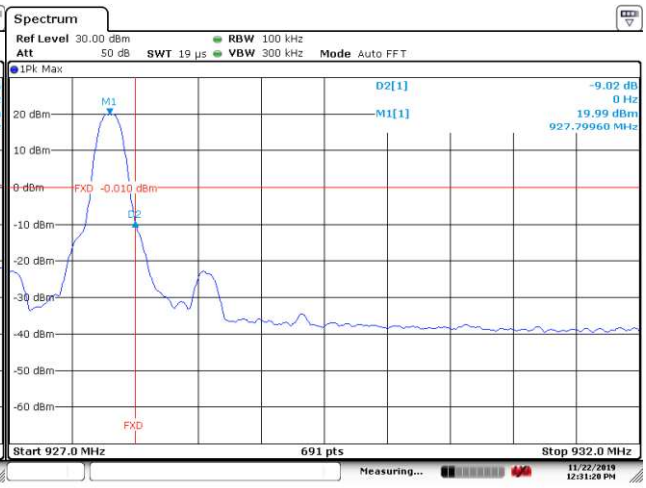

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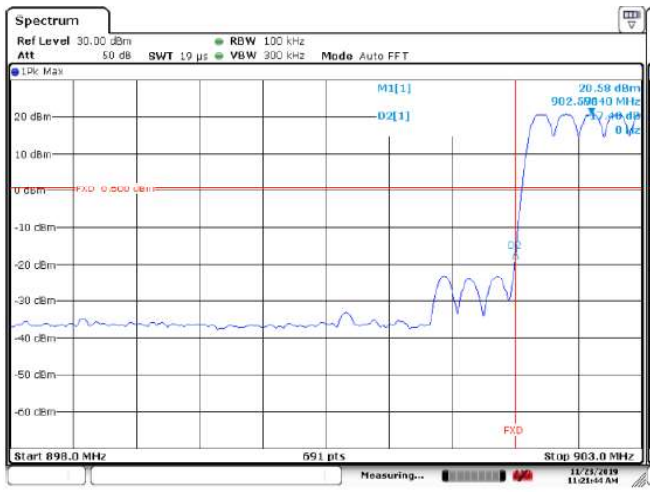
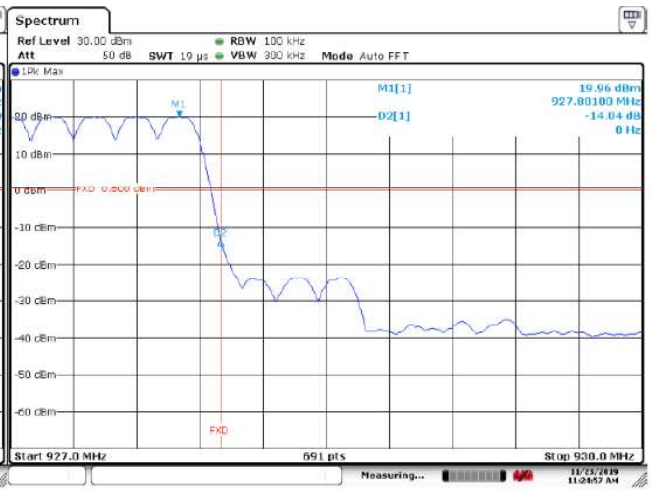
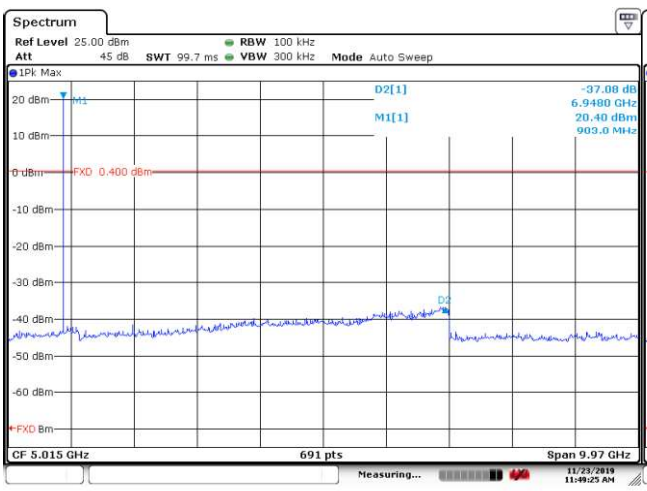


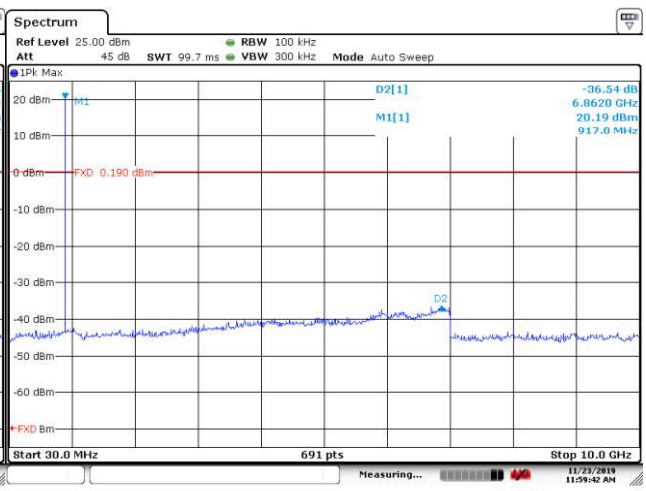


10. FSK 5Kbps FHSS, Conducted Spurious Emission and Band edge, 902.2MHz~927.8MHz

Conducted Spurious Emission



Date: 23.NOV.2019 11:49:24



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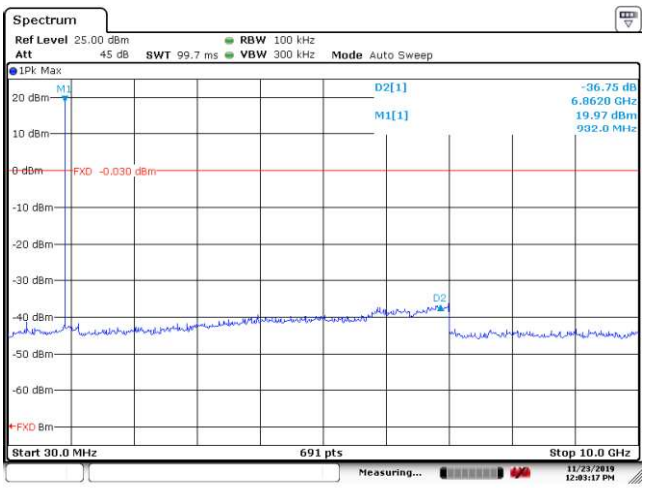
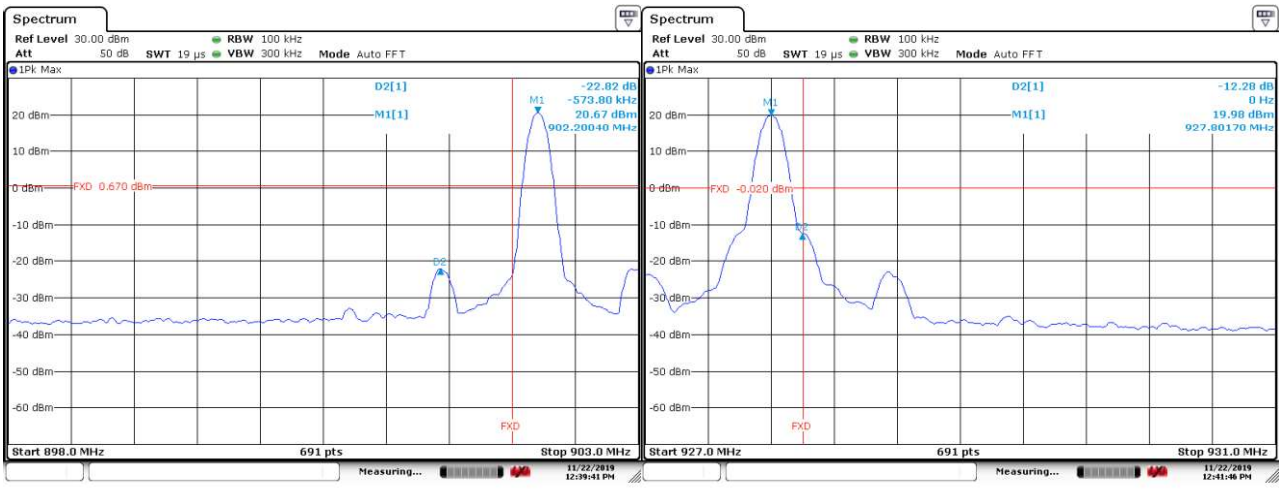


Band edge



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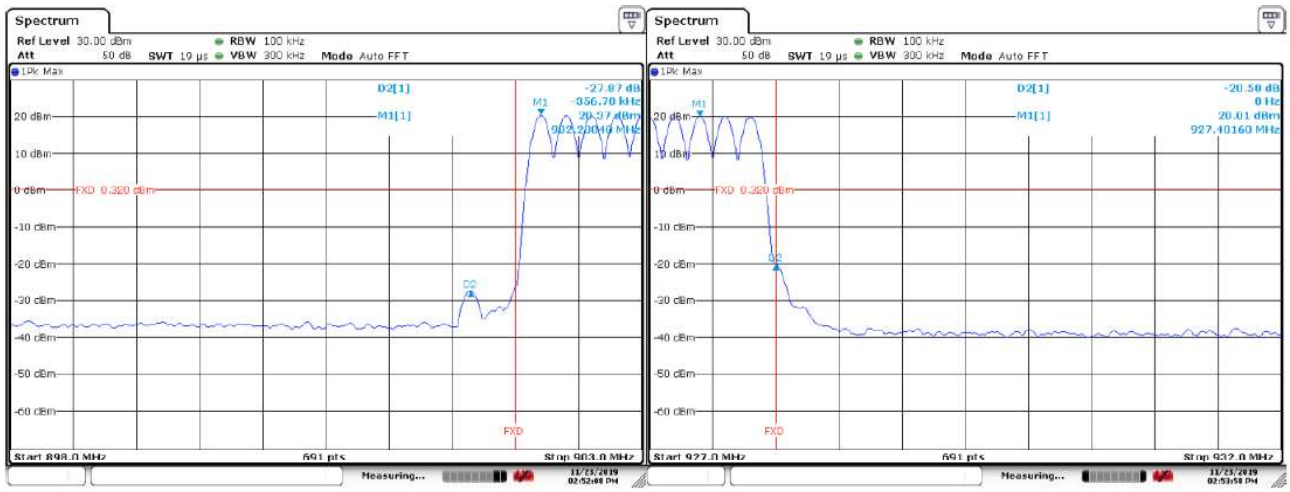
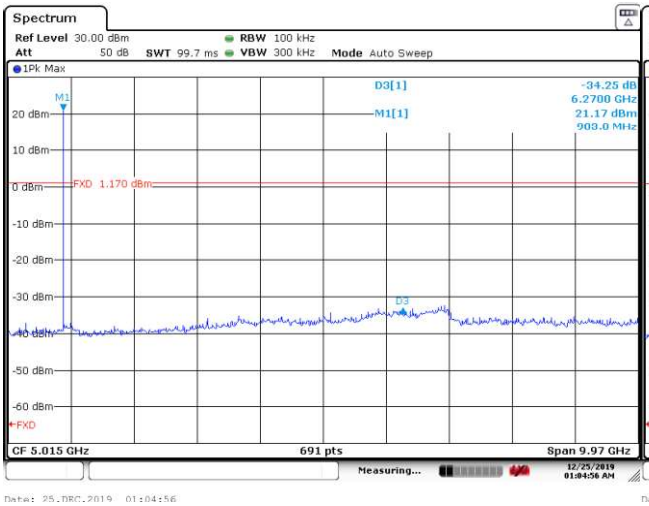
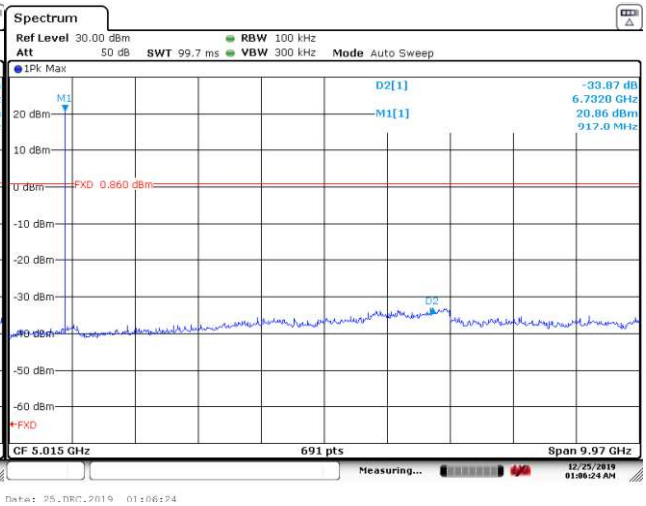
Date: 22.NOV.2019 12:41:46

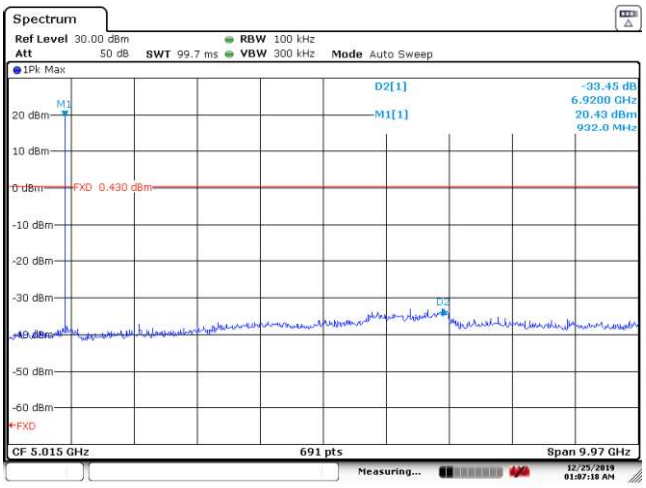


11. FSK 250Kbps FHSS, Conducted Spurious Emission and Band edge, 902.5MHz~927.5MHz

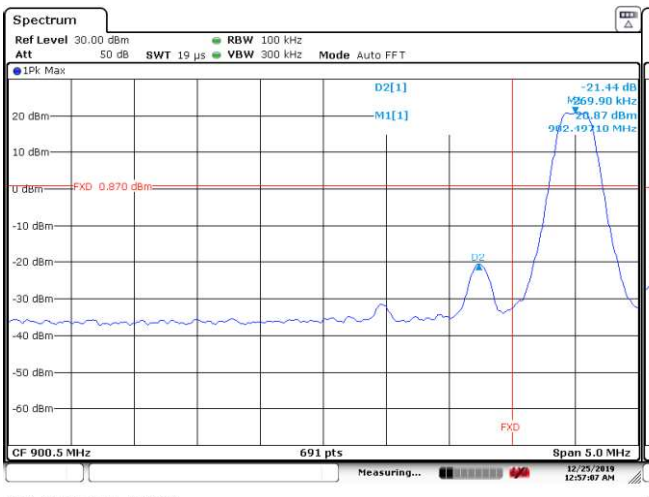
Conducted Spurious Emission

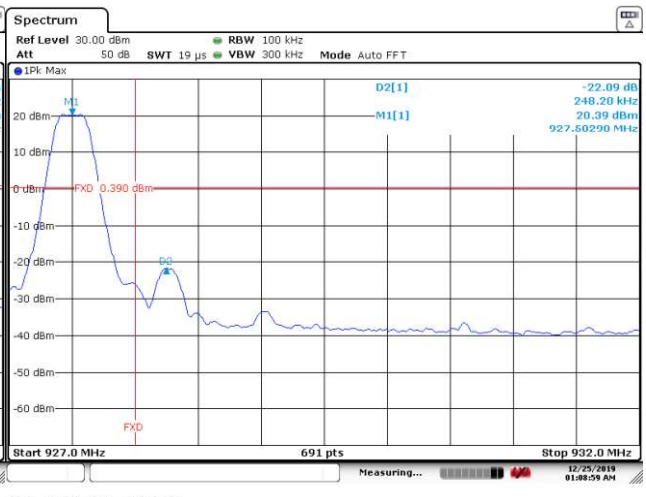


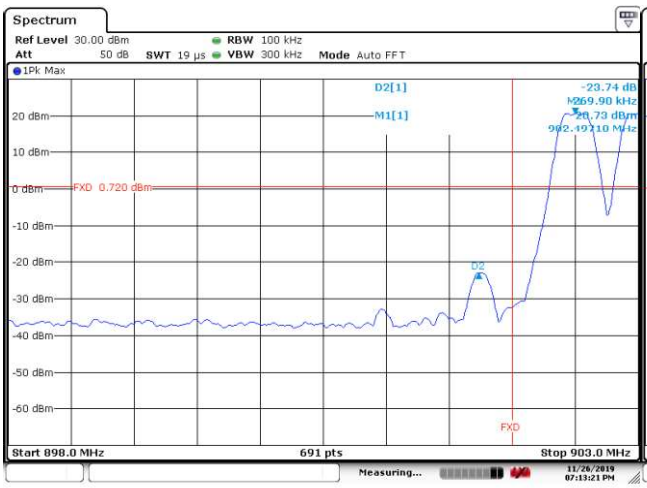




Band edge







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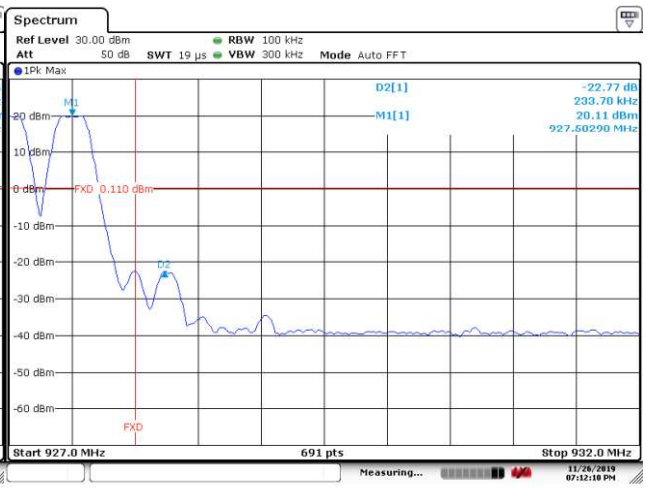


Date: 26.NOV.2019 19:12:10

4.1.8 Carrier Separation Measurement

Result: **Pass**

Test Specification		
Test standard	:	FCC Part 15.247(a)(1) RSS-247 Issue 2 February 2017 Clause 5.1(b)
Basic standard	:	ANSI C63.10: 2013
Limits	:	At least 20 dB bandwidth or 25kHz, whichever is greater.
Kind of test site	:	Shielded Room

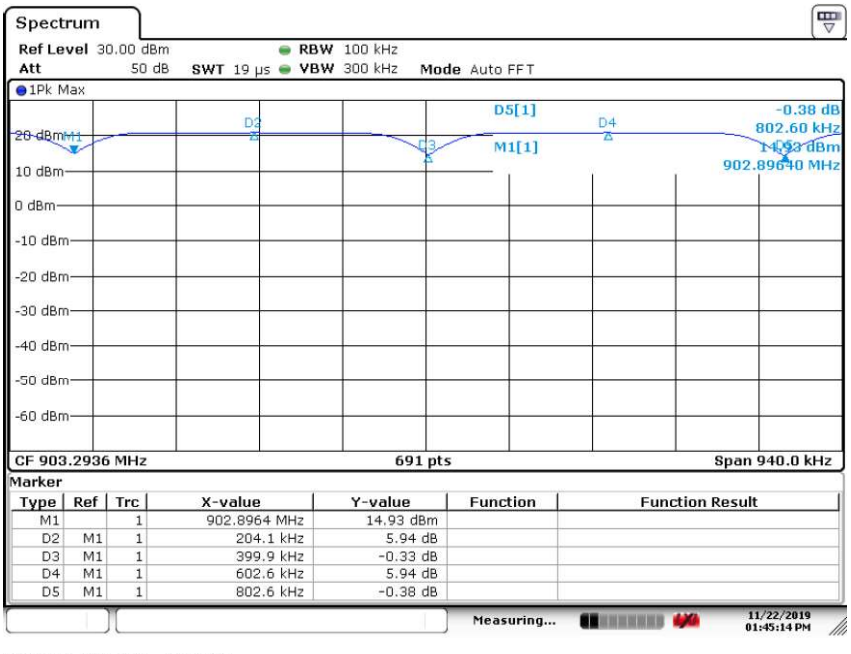
Test Setup

Date of testing	:	27.11.2019~25.12.2019
Input voltage	:	AC 120V, 60Hz
Operational mode	:	Test mode of LoRa FHSS, FSK FHSS
Temperature	:	20.1°C
Relative humidity	:	57%
Atmospheric pressure	:	101 kPa

Figure 6: Carrier Separation

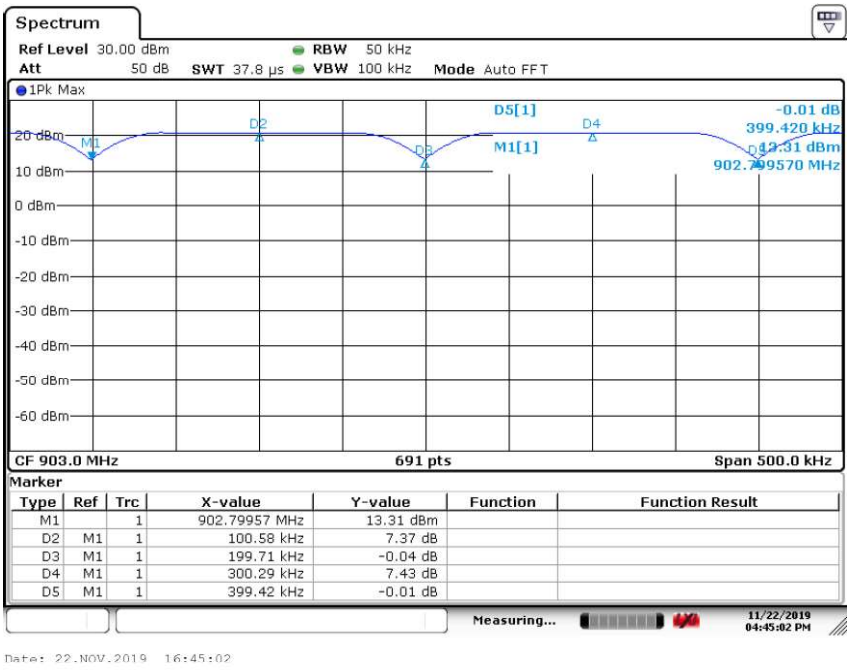
1. LoRa 250KHz FHSS, Carrier Separation, 902.3MHz~926.7MHz

   Carrier Separation: 398.5KHz > 20 dB bandwidth



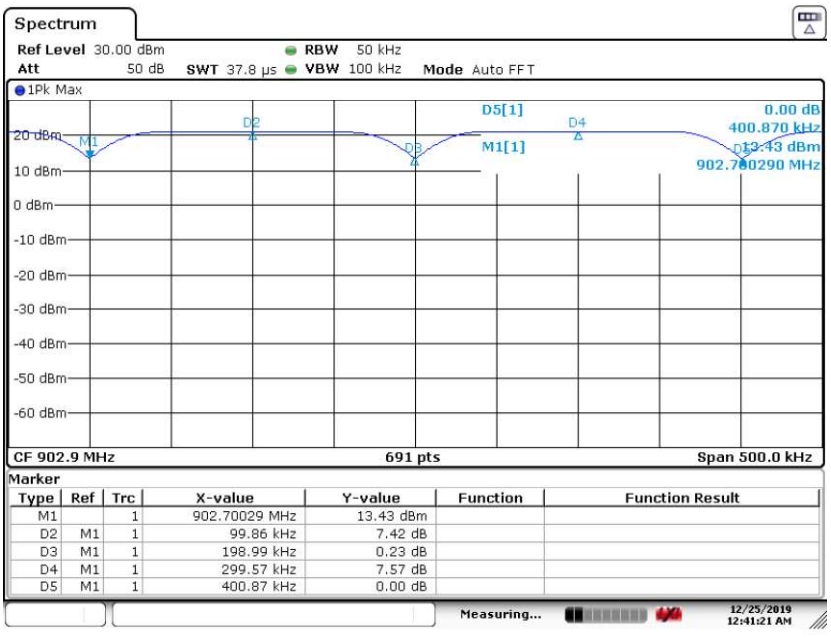
2. LoRa 125KHz FHSS, Carrier Separation, 902.3MHz~914.9MHz

   Carrier Separation: 199.71KHz > 20 dB bandwidth



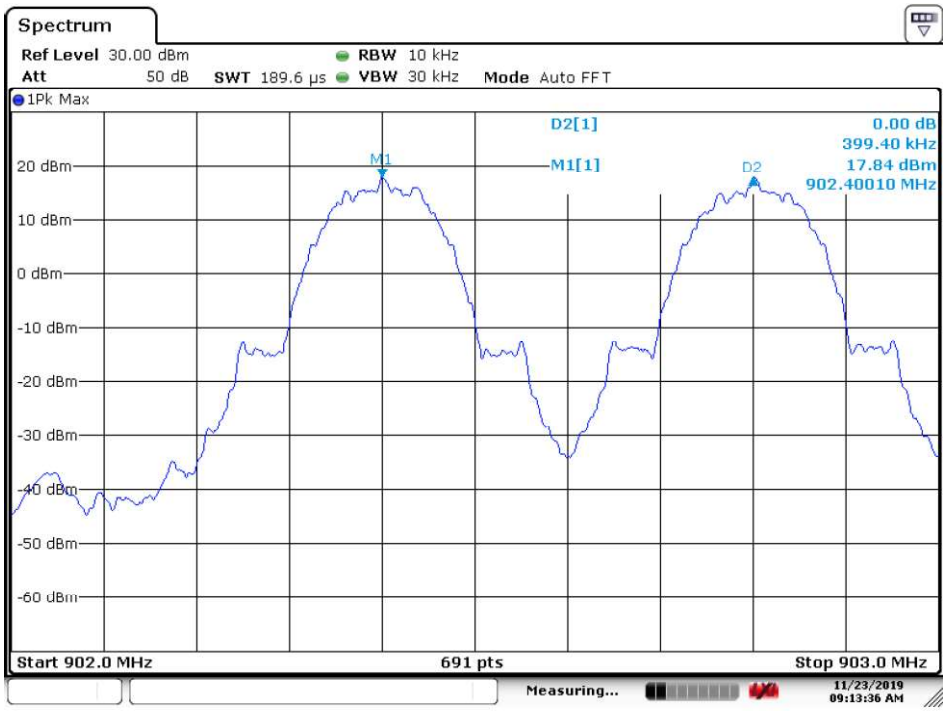
3. 125KHz FHSS, Carrier Separation, 902.2MHz~927.8MHz

   Carrier Separation: 199.71KHz > 20 dB bandwidth



4. FSK 150Kbps FHSS, Carrier Separation, 902.4MHz~927.6MHz

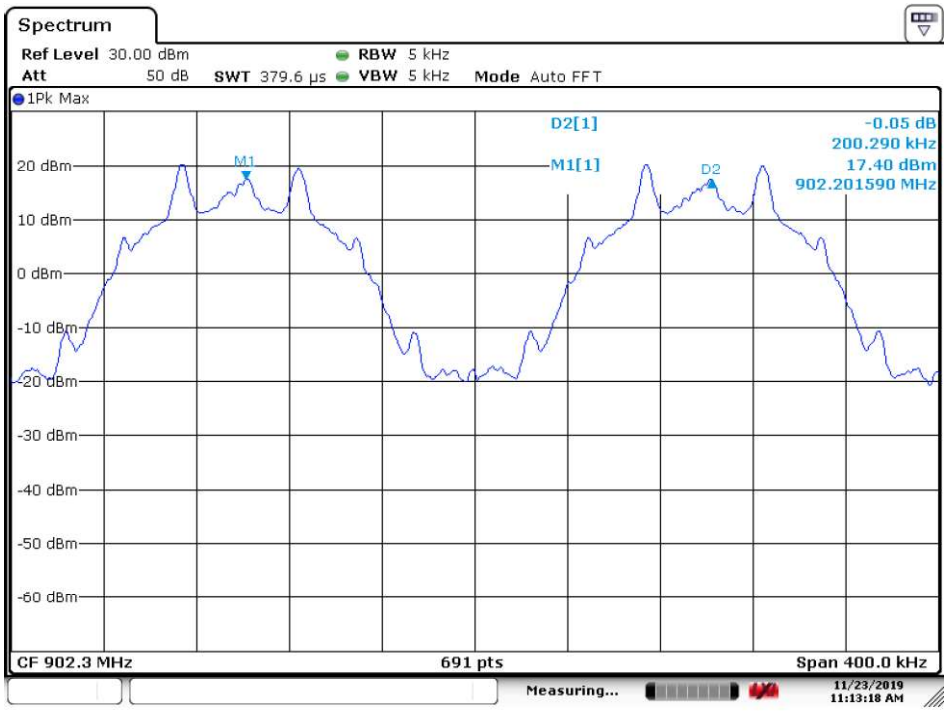
   Carrier Separation: 399.4KHz > 20 dB bandwidth



Date: 23.NOV.2019 09:13:37

5. FSK 50Kbps FHSS, Carrier Separation, 902.2MHz~927.8MHz

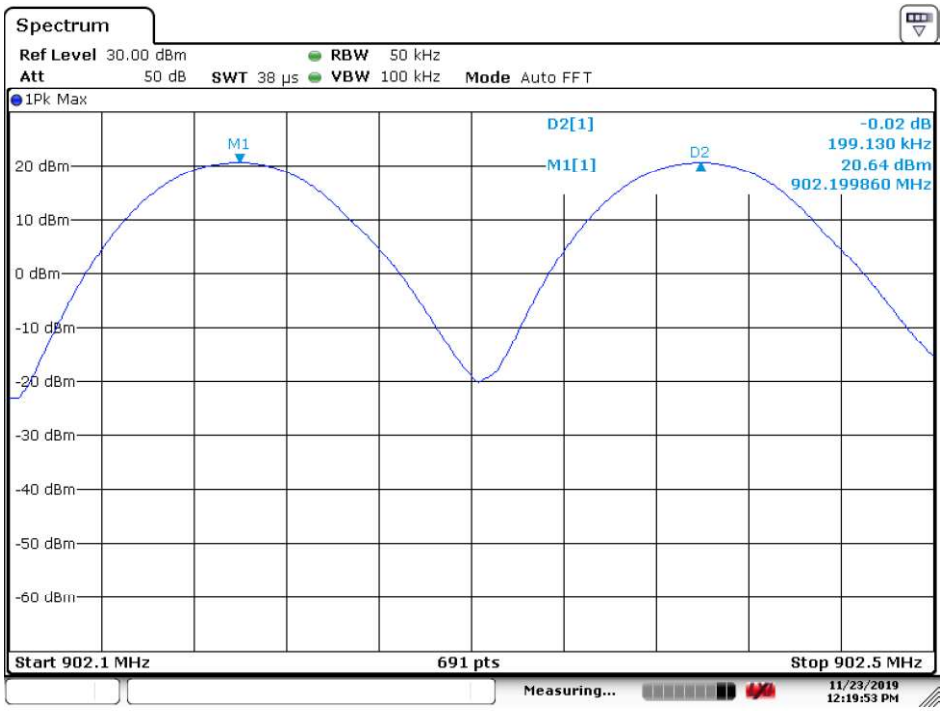
   Carrier Separation: 200.290KHz > 20 dB bandwidth



Date: 23.NOV.2019 11:13:18

6. FSK 5Kbps FHSS, Carrier Separation, 902.2MHz~927.8MHz

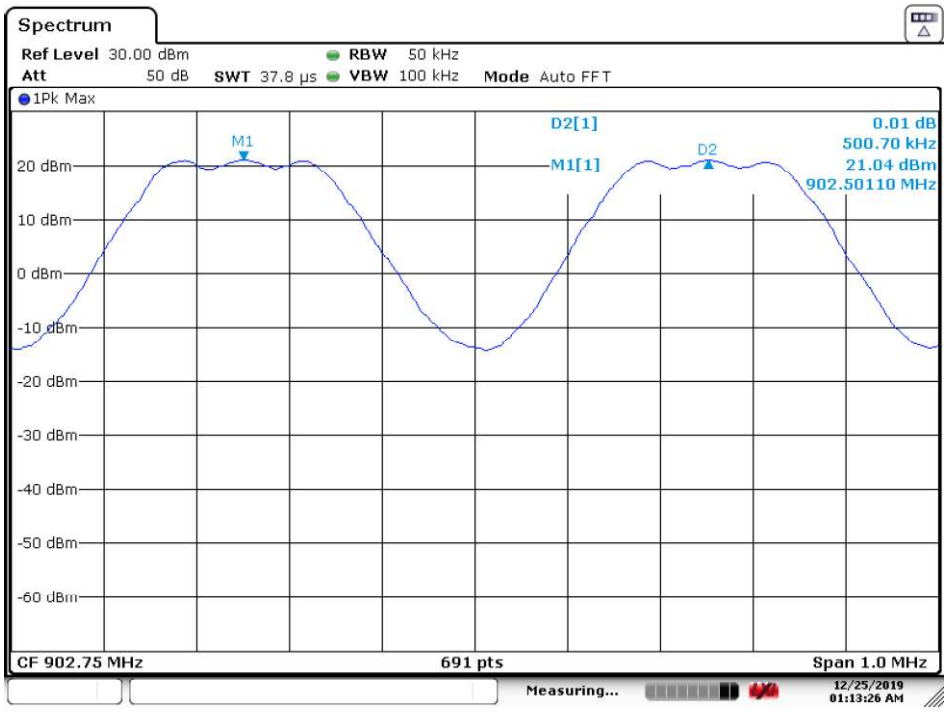
   Carrier Separation: 199.130KHz > 20 dB bandwidth



Date: 23.NOV.2019 12:19:53

7. FSK 250Kbps FHSS, Carrier Separation, 902.5MHz~927.5MHz

   Carrier Separation: 500.7KHz > 20 dB bandwidth



Date: 25.DEC.2019 01:13:26

4.1.9 The number of hopping channels

Result: **Pass**

Test Specification

Test standard	:	FCC Part 15.247(g) RSS-247 Issue 2 February 2017 Clause 5.1(c)
Basic standard	:	ANSI C63.10: 2013
Limits	:	At least 25 (for LoRa 250KHz) At least 50 (for LoRa 125KHz, FSK FHSS)
Kind of test site	:	Shielded Room

Test Setup

Date of testing	:	27.11.2019~25.12.2019
Input voltage	:	AC 120V, 60Hz
Operational mode	:	Test mode of LoRa FHSS, FSK FHSS
Temperature	:	20.1°C
Relative humidity	:	57%
Atmospheric pressure	:	101 kPa

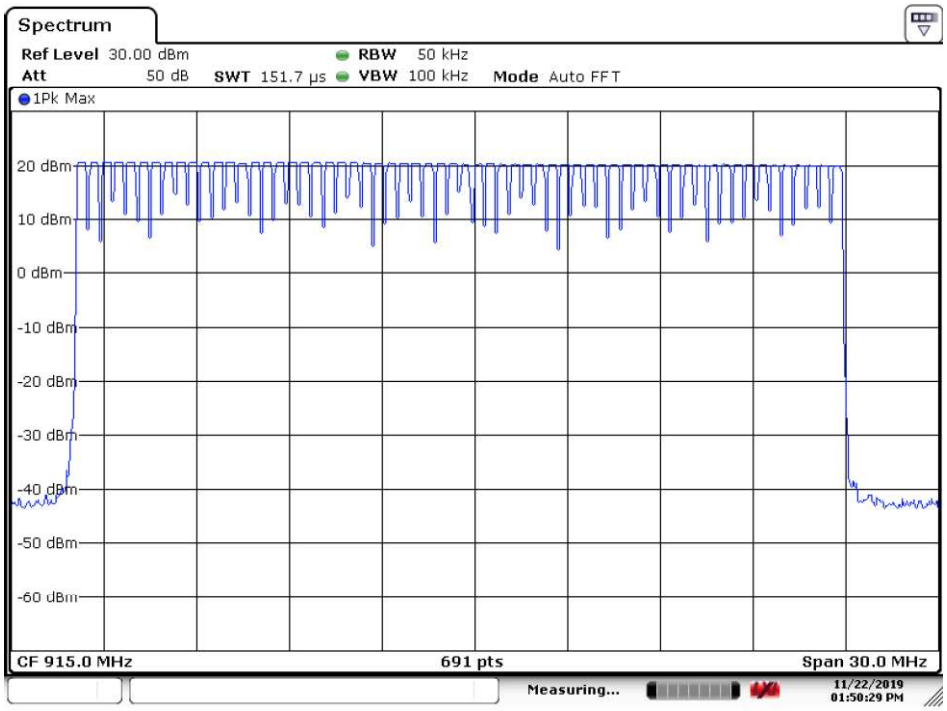
Table 7: Test result of hopping channel number for LoRa FHSS and FSK FHSS

Modulation Type and Operation band	20dB Bandwidth(KHz)	Channel Number	Limit	Result
LoRa 250KHz FHSS 902.3MHz~926.7MHz	250 ⩽ 20dB Bandwidth⩽ 500	62	25	Pass
LoRa 125KHz FHSS 902.3MHz~914.9MHz	20dB Bandwidth⩽ 250	64	50	Pass
LoRa 125KHz FHSS 902.2MHz~927.8MHz	20dB Bandwidth⩽ 250	129	50	Pass
FSK 150Kbps FHSS 902.4MHz~927.6MHz	20dB Bandwidth⩽ 250	64	50	Pass
FSK 50Kbps FHSS 902.2MHz~927.8MHz	20dB Bandwidth⩽ 250	129	50	Pass
FSK 5Kbps FHSS 902.2MHz~927.8MHz	20dB Bandwidth⩽ 250	129	50	Pass
FSK 250Kbps FHSS 902.5MHz~927.5MHz	250 ⩽ 20dB Bandwidth⩽ 500	51	25	Pass

Figure 7: The number of hopping channels

1. LoRa 250KHz FHSS, 902.3MHz~926.7MHz

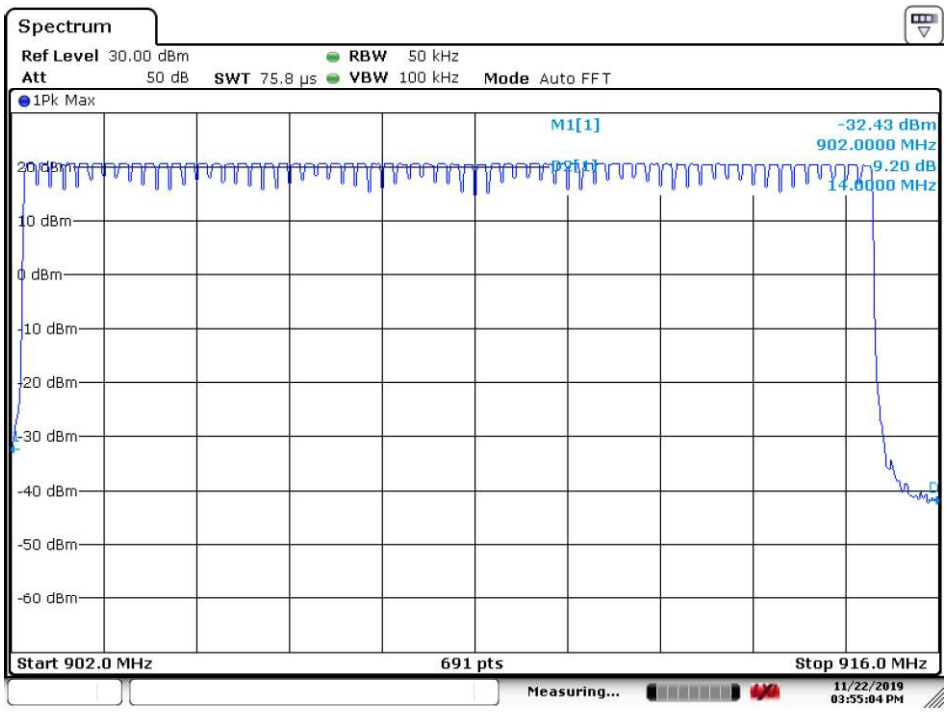
   Channel number: 62



Date: 22.NOV.2019 13:50:29

2. LoRa 125KHz FHSS, 902.3MHz~914.9MHz

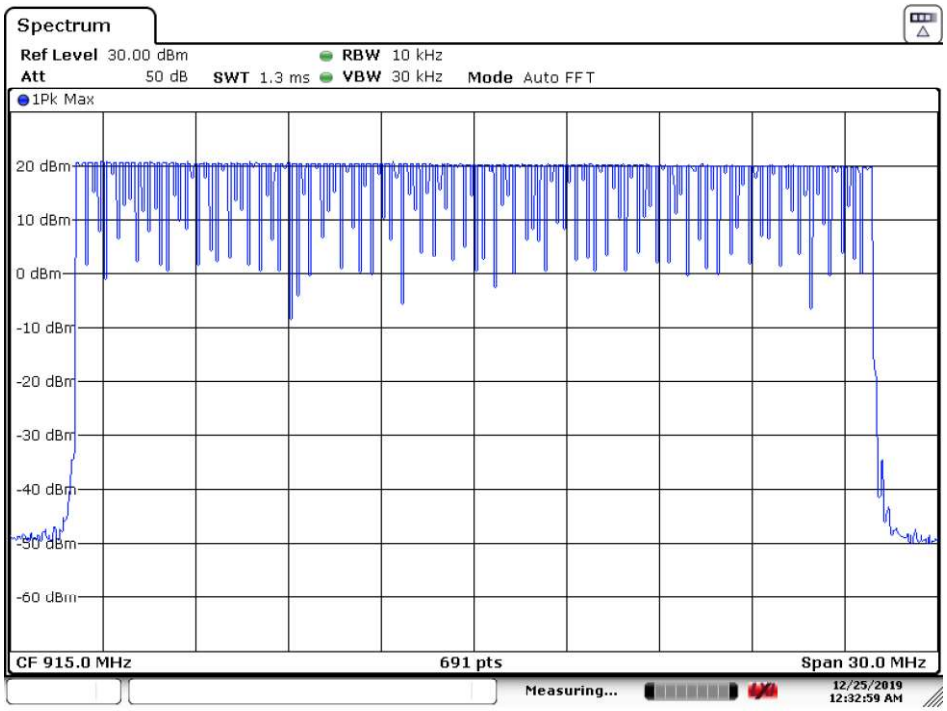
   Channel Number: 64



Date: 22.NOV.2019 15:55:05

3. LoRa 125KHz FHSS, 902.2MHz~927.8MHz

   Channel Number: 129



4. FSK 150Kbps FHSS, 902.4MHz~927.6MHz

   Channel Number: 64