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Test Report

Prepared for: Deviceroy

EUT Name: ARIA1

Model: ARIA1

FCC ID: 2A3KPARIA1
IC: 29172-ARIA1

To

FCC Part 15.247
And
ISED RSS-247

Date of Issue: 11/16/2022

On the behalf of the applicant:	**Viceroy Devices Corporation dba Deviceroy** **Salt Lake City, Utah, USA**
Attention of:	**Steve Ellis** **Ph: 801-440-4480** **Email: sellis@deviceroy.com**

Prepared By
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Project No: p22a0015
Test Result-Pass

Authorized By

Alex Macon
Sr Compliance Engineer

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All results contained herein relate only to the sample tested.

Test Summary

FCC 15.247 Specification	RSS-247 Specification	Test Name	Pass, Fail, N/A	Comments
15.247(b)(1)	Section 5.4	Output Power	Pass	
15.247(e)	Section 5.2	Power Spectral Density	Pass	
15.247(d)	Section 5.5	Conducted Spurious Emissions	Pass	
15.247(d), 15.209(a), 15.205	Section 5.5	Radiated Spurious Emissions	Pass	
15.247(d), 15.209(a), 15.205	Section 5.5	Emissions At Band Edges	Pass	
15.247(a)(1)	Sections 5.1(a)	Occupied Bandwidth	Pass	RSS-Gen Section 6.7 99% BW Also Reported
15.247(a)	Section 5.1 (c)	Dwell Time	Pass	
15.247(a)	Section 5.1 (d)	Number of Hopping Channels	Pass	
15.247(a)	Section 5.1 (b)	Channel Separation	Pass	
15.207	RSS-GEN Section 8.8	A/C Powerline Conducted Emissions	N/A	No Connection to AC Mains

Statements of conformity are reported as:

- Pass - the measured value is below the acceptance limit, *acceptance limit = test limit*.
- Fail - the measured value is above the acceptance limit, *acceptance limit = test limit*.

References	Description
CFR47, Part 15, Subpart B	Unintentional Radiators
CFR47, Part 15, Subpart C	Intentional Radiators
RSS-247 Issue 2	Digital Transmission Systems (DTSs), Frequency Hoping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices
RSS-GEN Issue 5	General Requirements for Compliance of Radio Apparatus
ANSI C63.10-2013	American National standard for testing Unlicensed Wireless Devices
ANSI C63.4-2014	Method and Measurements of Radio-Noise Emissions from low-Voltage Electrical and Electronic Equipment in the range 9kHz to 40GHz.
ISO/IEC 17025:2005	General requirements for the Competence of Testing and Calibrations Laboratories
KDB 558074 D01 v05r02	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating under §15.247

Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	November 16, 2022	Alex Macon	Original Document
2.0	December 8, 2022	Alex Macon	Updated Simultaneous Emissions section

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ANAB

Compliance Testing, LLC, has been accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to the joint ISO-ILAC-IAF Communiqué dated January 2009).

The tests results contained within this test report all fall within our scope of accreditation.

Please refer to http://www.compliancetesting.com/labscope.html for current scope of accreditation.

FCC Site Reg. #349717

IC Site Reg. #2044A-2

The applicant has been cautioned as to the following

15.21 - Information to User

The user's manual or instruction manual for an intentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

15.27(a) - Special Accessories

Equipment marked to a consumer must be capable of complying with the necessary regulations in the configuration in which the equipment is marketed. Where special accessories, such as shielded cables and/or special connectors are required to enable an unintentional or intentional radiator to comply with the emission limits in this part, the equipment must be marketed with, i.e. shipped and sold with, those special accessories. However, in lieu of shipping or packaging the special accessories with the unintentional or intentional radiator, the responsible party may employ other methods of ensuring that the special accessories are provided to the consumer without an additional charge.

Information detailing any alternative method used to supply the special accessories for a grant of equipment authorization or retained in the verification records, as appropriate. The party responsible for the equipment, as detailed in § 2.909 of this chapter, shall ensure that these special accessories are provided with the equipment. The instruction manual for such devices shall include appropriate instructions on the first page of text concerned with the installation of the device that these special accessories must be used with the device. It is the responsibility of the user to use the needed special accessories supplied with the equipment.

Standard Test Conditions Engineering Practices

Except as noted herein, the following conditions and procedures were observed during the testing:

In accordance with ANSI C63.10-2013 and unless otherwise indicated in the specific measurement results, the ambient temperature of the actual EUT was maintained within the range of 10° to 40°C (50° to 104°F) unless the particular equipment requirements specified testing over a different temperature range. Also, unless otherwise indicated, the humidity levels were in the range of 10% to 90% relative humidity.

Measurement results, unless otherwise noted, are worst-case measurements.

Environmental Conditions		
Temperature (ºC)	**Humidity (%)**	**Pressure (mbar)**
19.3 – 23.5	27.6 – 34.5	970.8 – 981.1

EUT Description ARIA Modem

Product Marketing Name (PMN)	ARIA
Model:	ARIA1
Hardware Version Identification Number (HVIN)	1.0.1
Firmware Version Identification Number (FVIN)	1.0.fcc
Serial Number (SN)	5309
Frequency Range	902-928 MHz
Number of Channels	64 and 129
Modulation(s)	LoRaWAN 1.0.4, 1.1.1 LoRa FSK Sidewalk
Data Rate(s)	SF7 – SF12
Antenna	Type: Omni Part Number: 2J0B24-C995G Pk Gain: 1.5 dBi

General Description of EUT and its intended use:
The DUT is a POE powered transceiver for digital transmission with 900 MHz and 2.4 GHz BLE capabilities

EUT operation during test:
A test mode sample with omni antenna attached was used for the Radiated Spurious Emissions (RSE) demonstration. All combinations of BLE and LoRa simultaneous transmission were investigated in 3 orthogonal axis and the worst case data has been reported. The built in SMA port was used to perform all other tests using Antenna Port Conducted measurements.

Test mode samples were operated via TeraTerm commands.

Modes of Operation Tested:

Data Rate [Name]	Data Rate [SF]
LoRa DTS	7 – 12
Sidewalk DTS	11
LoRa FHSS	7 – 10
Sidewalk FSK	FSK

Support Equipment

Qty	Description	Manufacturer	Model	S/N
1	Laptop	NA	NA	NA

Support Cables:

Qty	Description	Length (M)	Shielding Y/N	Shielded Hood Y/N	Termination
1	USB 2.0	<3m	Y	Y	Communication Board
1	Ethernet	<3m	Y	N	POE

Modifications:

none

15.203: Antenna Requirement:

X	The antenna is permanently attached to the EUT
	The antenna uses a unique coupling
	The EUT must be professionally installed
	The antenna requirement does not apply

Occupied Bandwidth [DTS & DSS]

Engineer: Aaron S. Froehlich
Test Date: 10/31/2022

Test Procedure

The method of ANSI C63.10 Clause 7.8.7, which references Clause 6.9.2 were utilized to measure the 20 dB Occupied Bandwidth. The "n dB down" function of the spectrum analyzer, with n = 20, was used as long as the marker did not settle in a null region. When that was the case the markers were manually configured from the edge of the emission until a value equal to or less than n dB below the peak was used.

The same n dB down function was used in accordance with Clause 11.8.1 to measure the 6 dB "DTS" bandwidth.

The method of clause 6.9.3 was utilized to measure the 99% Occupied Bandwidth.

Limit 6 dB

47 CFR 15.247(b)(3) & RSS-247 Clause 5.4 d. - The maximum conducted output power of the intentional radiator shall not exceed 1 Watt.

Limit 20 dB

47 CFR 15.247(a)(1)(i) & RSS 247 Clause 5.1 c.– The maximum 20 dB bandwidth of the hopping channel is 500 kHz.

Limit 99%

RSS-Gen Section 6.7 requires the 99% Occupied Bandwidth be reported in addition to all other required bandwidths.

The Spectrum Analyzer was set to the following:

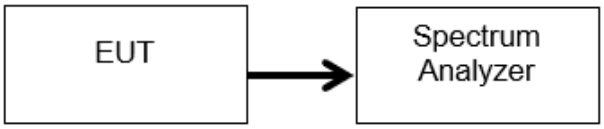
20 dB Occupied Bandwidth

Span	Between two times and five times the OBW
RBW	1% to 5% of the OBW
VBW	~3 time RBW

99% Occupied Bandwidth

Span	Between 1.5 times and 5.0 times the OBW
RBW	1% to 5% of the OBW
VBW	~3 time RBW

Test Setup



Test Data

Tabular Data

FHSS Operation

Mode	SF	Frequency	99% OBW	20 dB BW
	#	MHz	MHz	MHz
LoRa FHSS	7	902.3	0.128	0.149
LoRa FHSS	7	908.5	0.128	0.145
LoRa FHSS	7	914.9	0.127	0.147
LoRa FHSS	8	902.3	0.127	0.151
LoRa FHSS	8	908.5	0.127	0.143
LoRa FHSS	8	914.9	0.127	0.147
LoRa FHSS	9	902.3	0.129	0.146
LoRa FHSS	9	908.5	0.128	0.144
LoRa FHSS	9	914.9	0.129	0.144
LoRa FHSS	10	902.3	0.129	0.144
LoRa FHSS	10	908.5	0.129	0.144
LoRa FHSS	10	914.9	0.130	0.144
Sidewalk FSK	NA	902.2	0.102	0.111
Sidewalk FSK	NA	915	0.104	0.112
Sidewalk FSK	NA	927.8	0.104	0.111

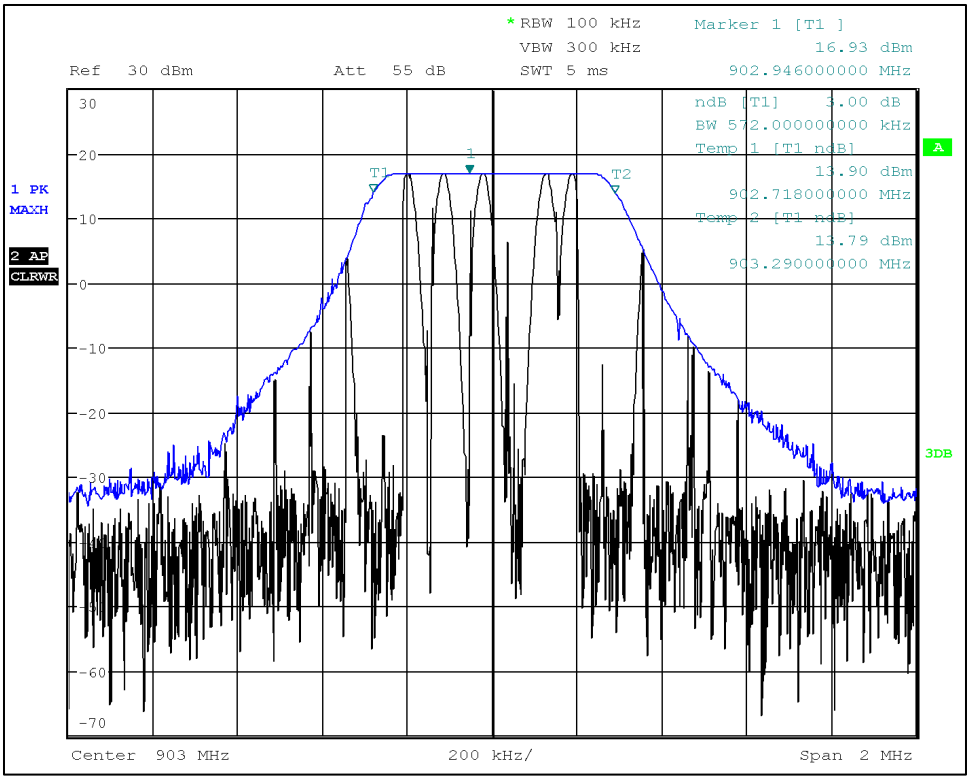
DTS Operation

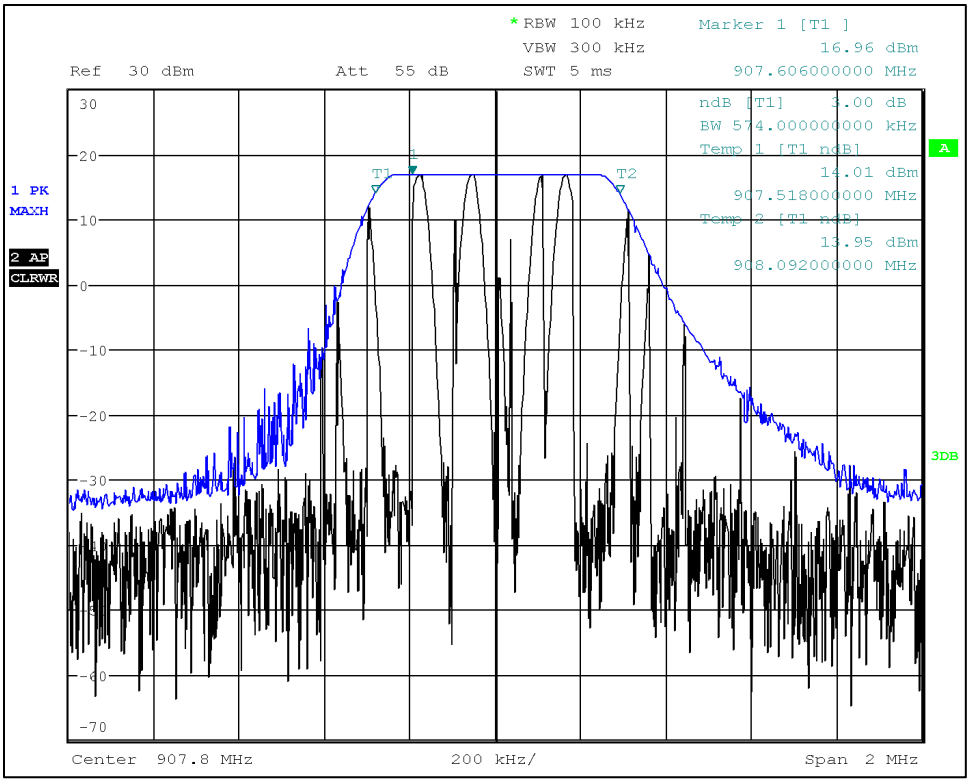
Mode	SF	Frequency	99% OBW	DTS	Limit	Margin	Result
	#	MHz	MHz	MHz	MHz	MHz	
LoRa DTS	7	903	0.529	0.572	0.500	-0.072	Compliant
LoRa DTS	7	907.8	0.516	0.574	0.500	-0.074	Compliant
LoRa DTS	7	914.2	0.522	0.570	0.500	-0.070	Compliant
LoRa DTS	8	903	0.519	0.631	0.500	-0.131	Compliant
LoRa DTS	8	907.8	0.519	0.631	0.500	-0.131	Compliant
LoRa DTS	8	914.2	0.522	0.635	0.500	-0.135	Compliant
LoRa DTS	9	903	0.522	0.588	0.500	-0.088	Compliant
LoRa DTS	9	907.8	0.519	0.592	0.500	-0.092	Compliant
LoRa DTS	9	914.2	0.522	0.592	0.500	-0.092	Compliant
LoRa DTS	10	903	0.522	0.596	0.500	-0.096	Compliant
LoRa DTS	10	907.8	0.522	0.598	0.500	-0.098	Compliant
LoRa DTS	10	914.2	0.522	0.598	0.500	-0.098	Compliant
LoRa DTS	11	903	0.526	0.594	0.500	-0.094	Compliant
LoRa DTS	11	907.8	0.526	0.600	0.500	-0.100	Compliant
LoRa DTS	11	914.2	0.529	0.600	0.500	-0.100	Compliant
LoRa DTS	12	903	0.522	0.598	0.500	-0.098	Compliant
LoRa DTS	12	907.8	0.522	0.592	0.500	-0.092	Compliant
LoRa DTS	12	914.2	0.522	0.642	0.500	-0.142	Compliant
Sidewalk LoRa DTS	11	902.5	0.526	0.628	0.500	-0.128	Compliant
Sidewalk LoRa DTS	11	914.5	0.526	0.644	0.500	-0.144	Compliant
Sidewalk LoRa DTS	11	926.5	0.526	0.641	0.500	-0.141	Compliant

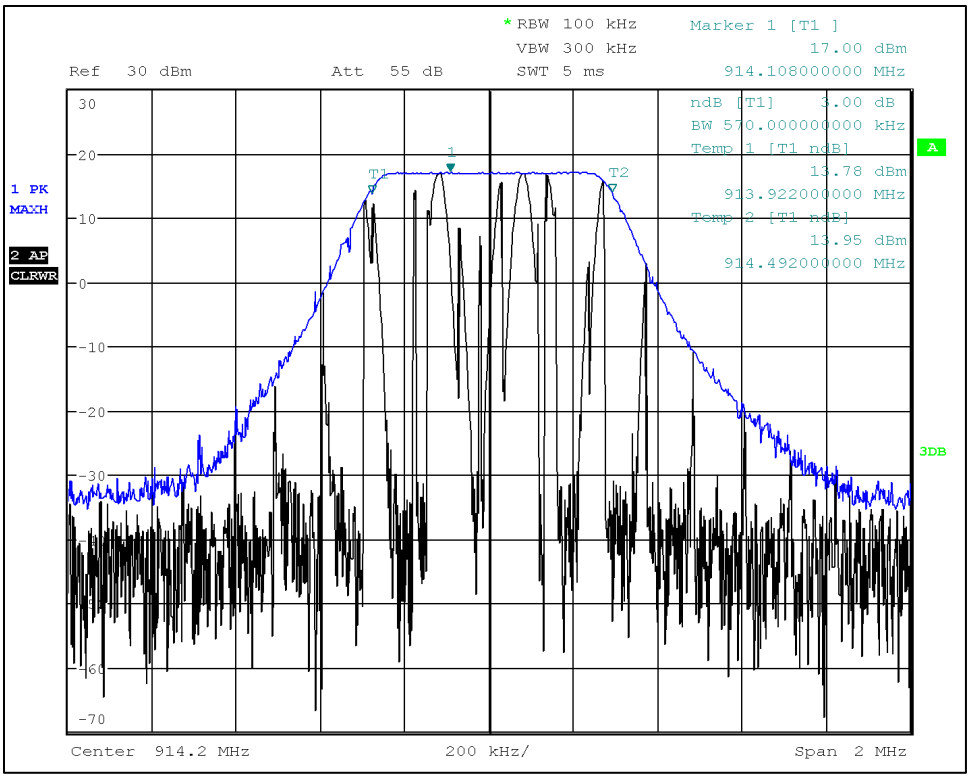
Margin = Limit – DTS

LoRa DTS

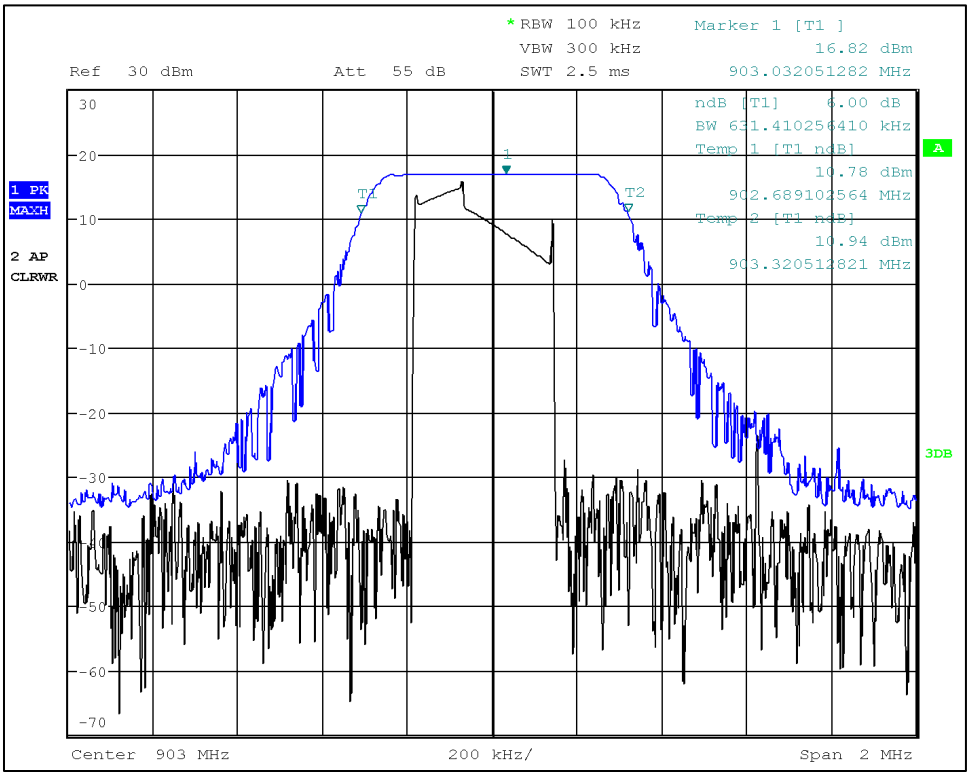
6 dB Spread Factor 7

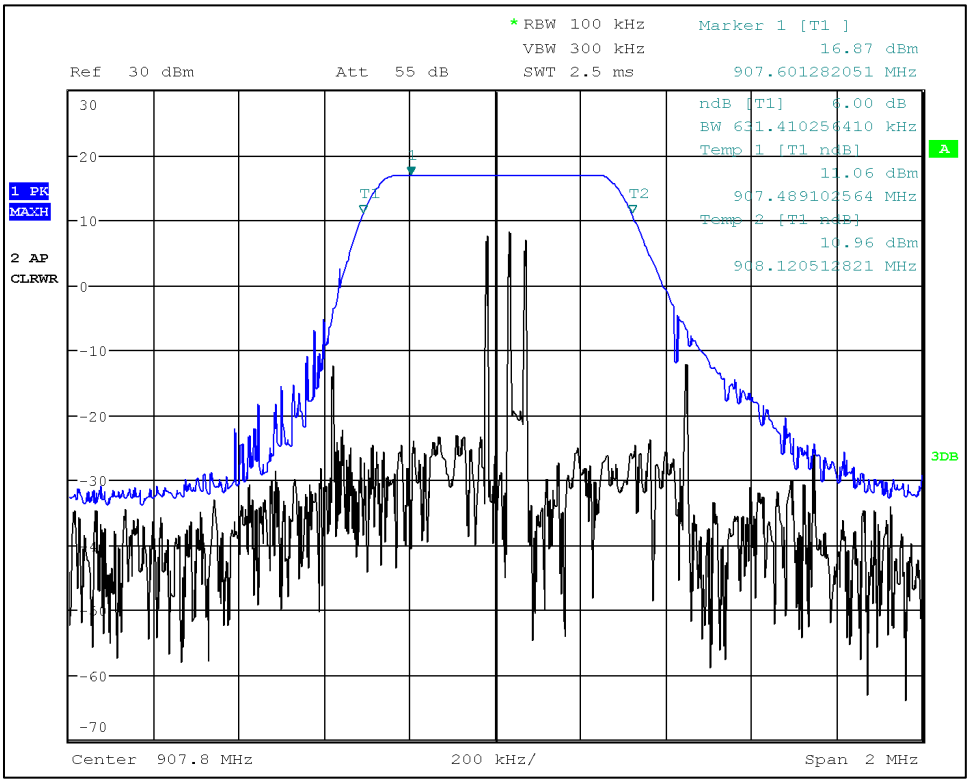


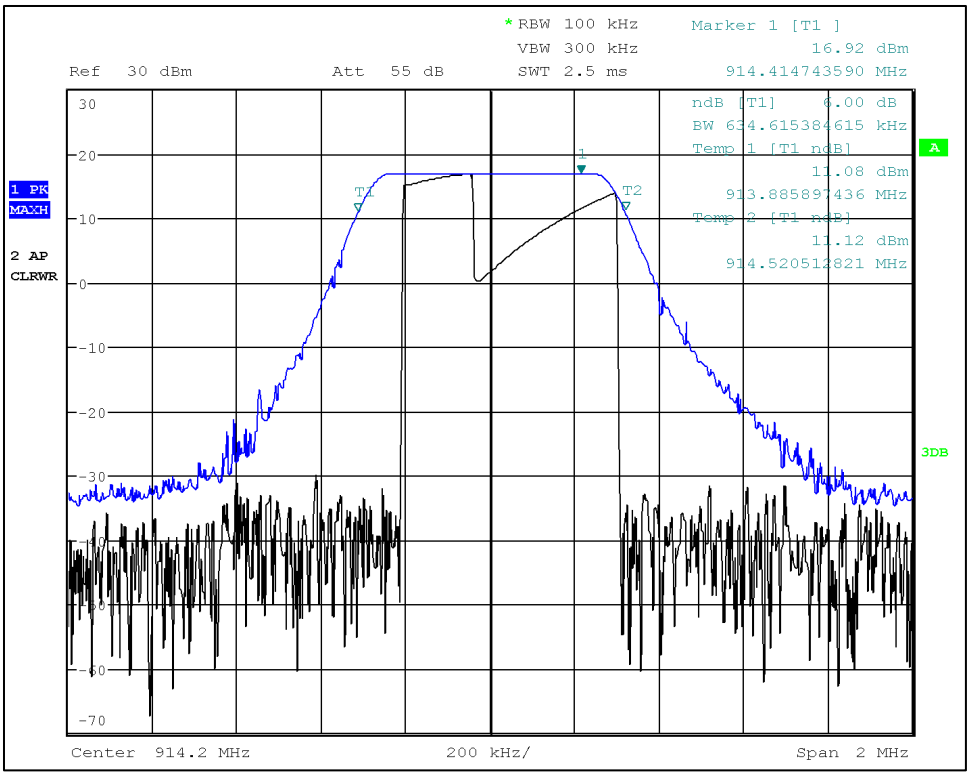



* RBW 100 kHz
VBW 300 kHz
SWT 5 ms
Marker 1 [T1]
17.00 dBm
914.108000000 MHz
Ref 30 dBm
Att 55 dB
ndB [T1] 3.00 dB
BW 570.000000000 kHz
Temp 1 [T1 ndB]
13.78 dBm
913.922000000 MHz
Temp 2 [T1 ndB]
13.95 dBm
914.492000000 MHz
1 PK
MAXH
2 AP
CLRWR
A
3DB
T1
T2
1
30
-20
-10
0
-10
-20
-30
-60
-70
Center 914.2 MHz
200 kHz/
Span 2 MHz

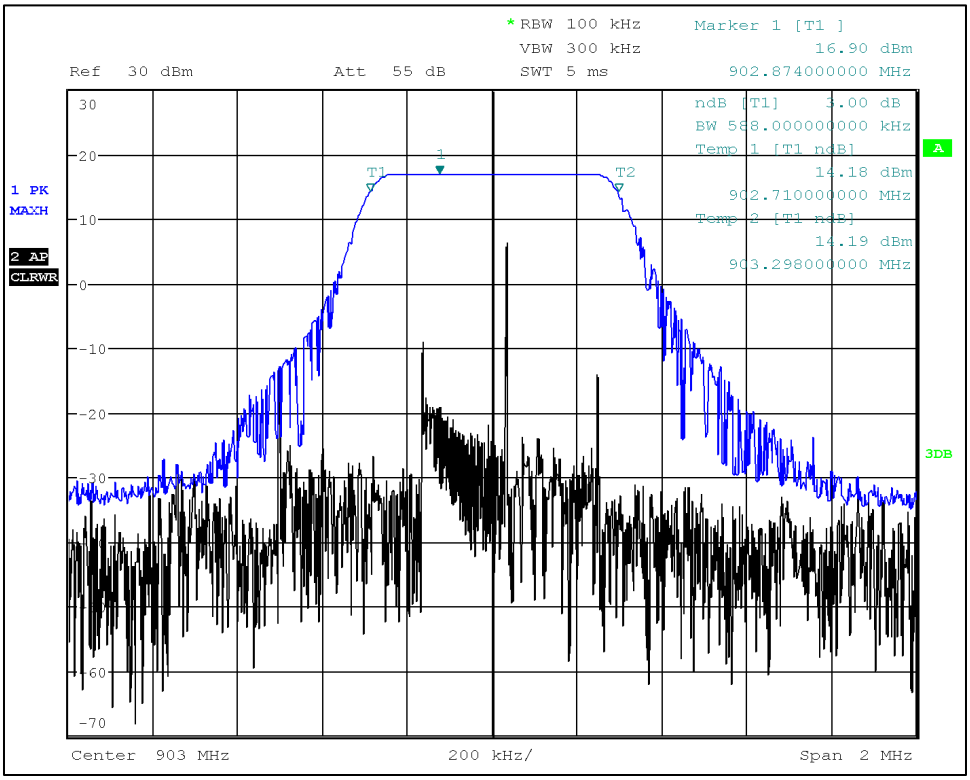
6 dB Spread Factor 8

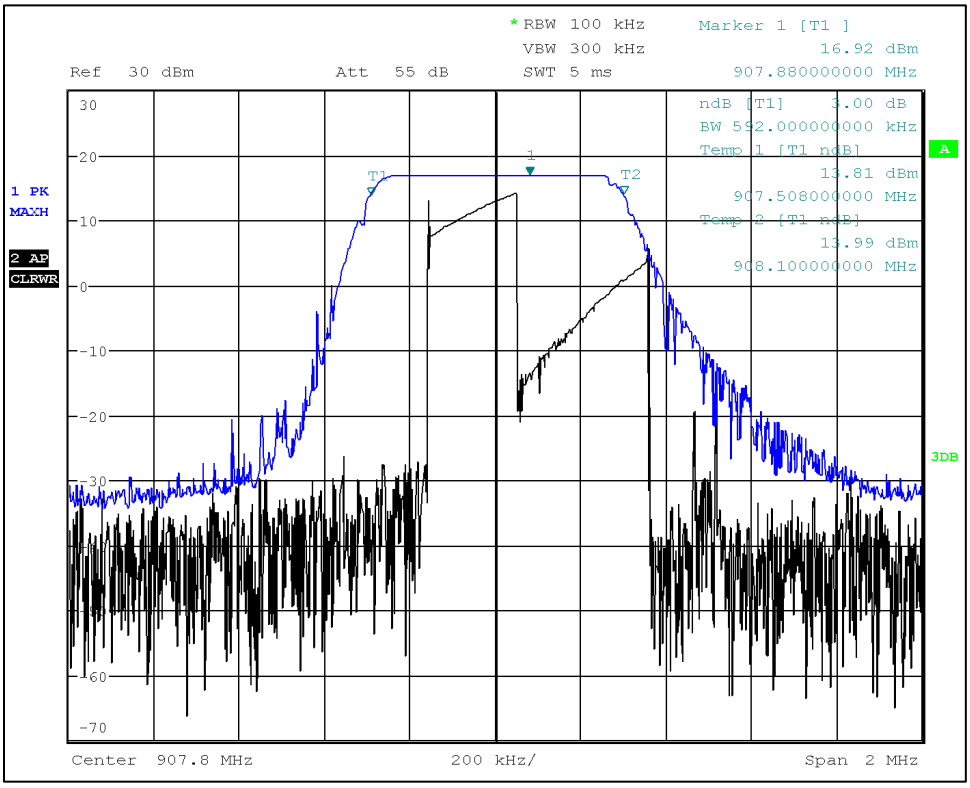


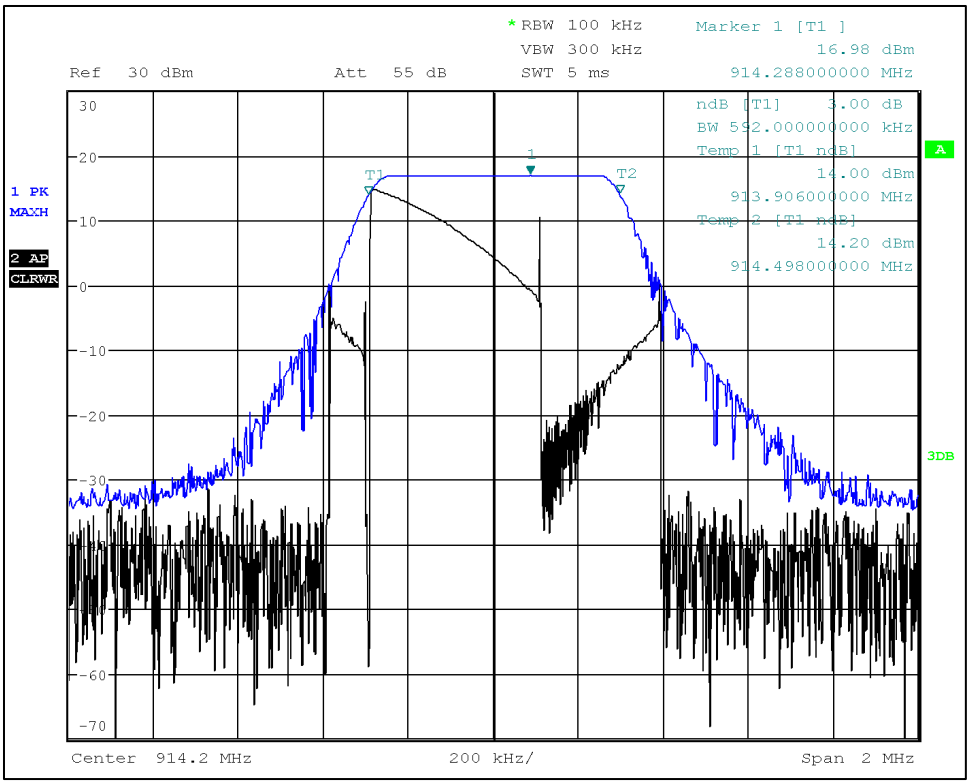



* RBW 100 kHz
VBW 300 kHz
SWT 2.5 ms
Marker 1 [T1]
16.92 dBm
914.414743590 MHz
Ref 30 dBm
Att 55 dB
ndB [T1] 6.00 dB
BW 634.615384615 kHz
Temp 1 [T1 ndB]
11.08 dBm
913.885897436 MHz
Temp 2 [T1 ndB]
11.12 dBm
914.520512821 MHz
1 PK
MAXH
2 AP
CLRWR
A
3DB
T1
T2
1
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
Center 914.2 MHz
200 kHz/
Span 2 MHz

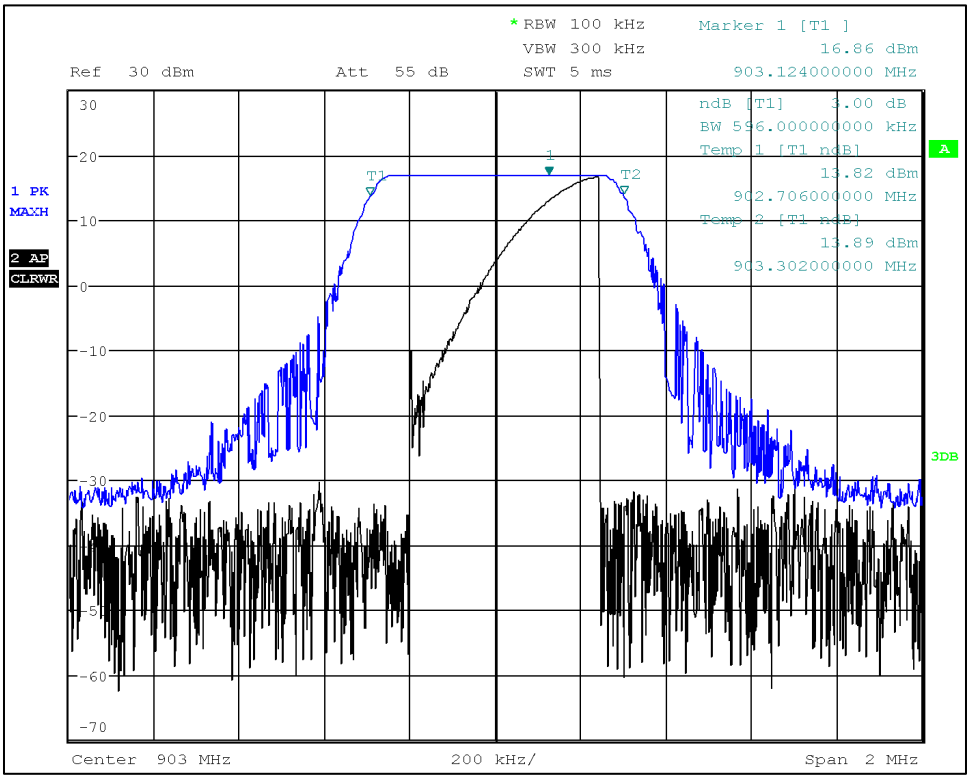
6 dB Spread Factor 9

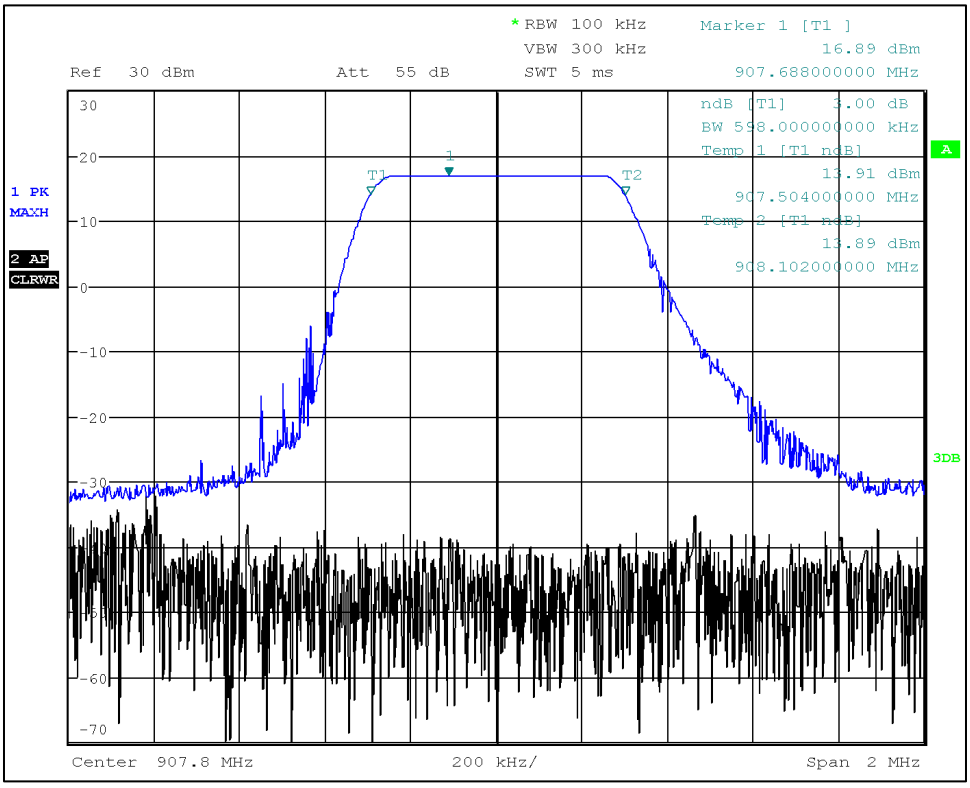


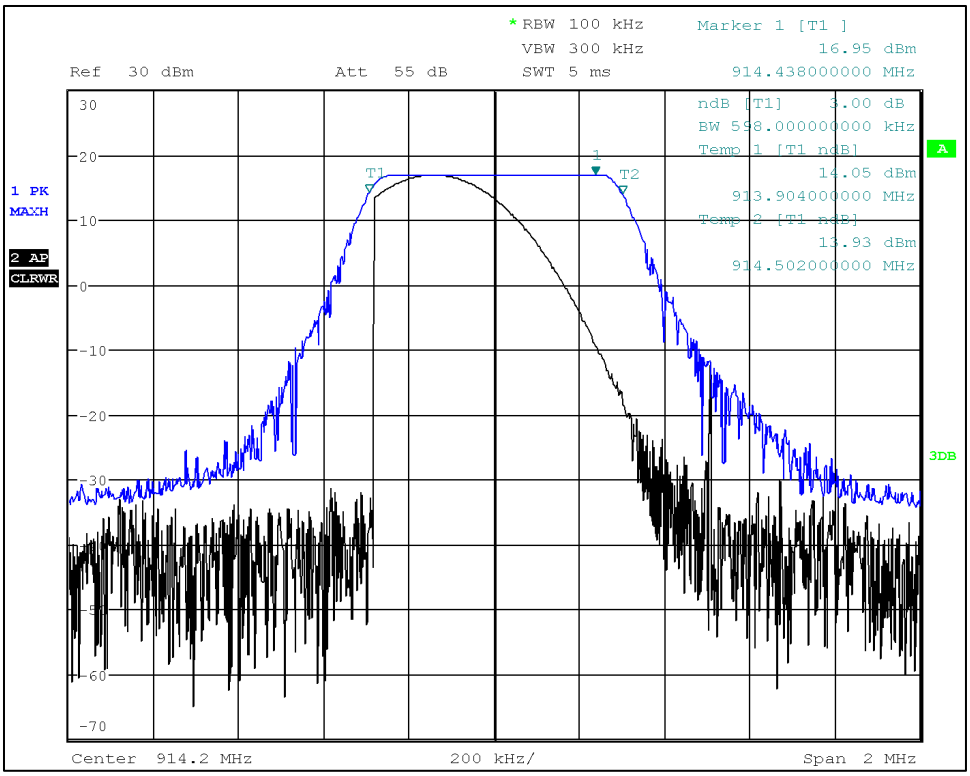



* RBW 100 kHz
VBW 300 kHz
SWT 5 ms
Marker 1 [T1]
16.98 dBm
914.288000000 MHz
Ref 30 dBm
Att 55 dB
ndB [T1] 3.00 dB
BW 592.000000000 kHz
Temp 1 [T1 ndB]
14.00 dBm
913.906000000 MHz
Temp 2 [T1 ndB]
14.20 dBm
914.498000000 MHz
1 PK
MAXH
2 AP
CLRWR
A
3DB
T1
T2
1
30
20
10
0
-10
-20
-30
-60
-70
Center 914.2 MHz
200 kHz/
Span 2 MHz

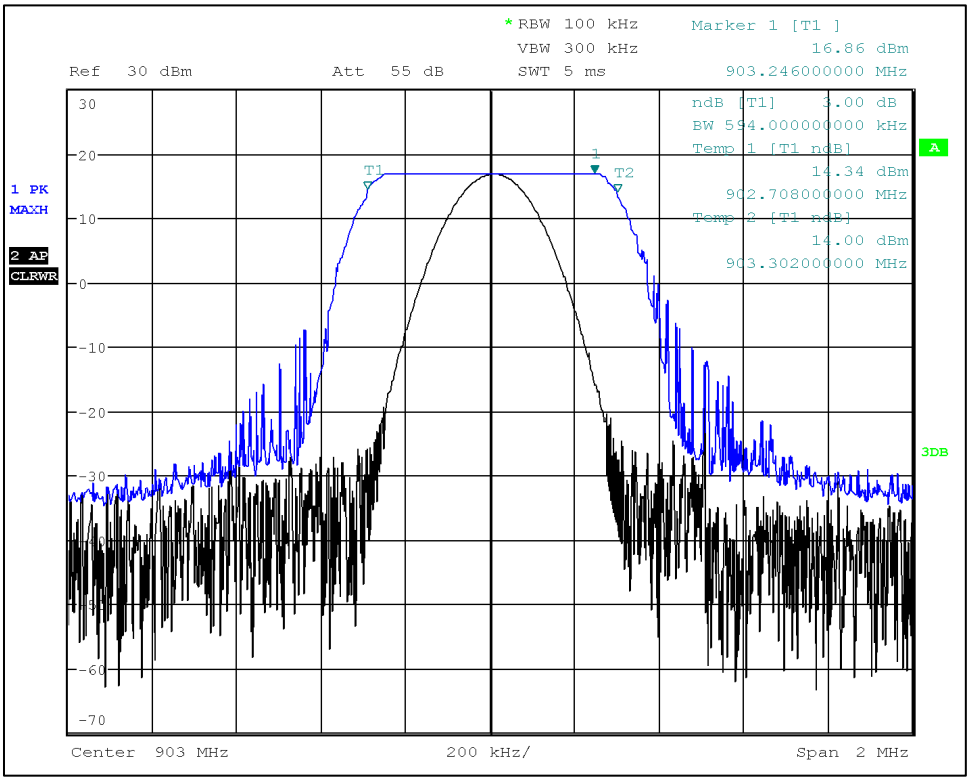
6 dB Spread Factor 10

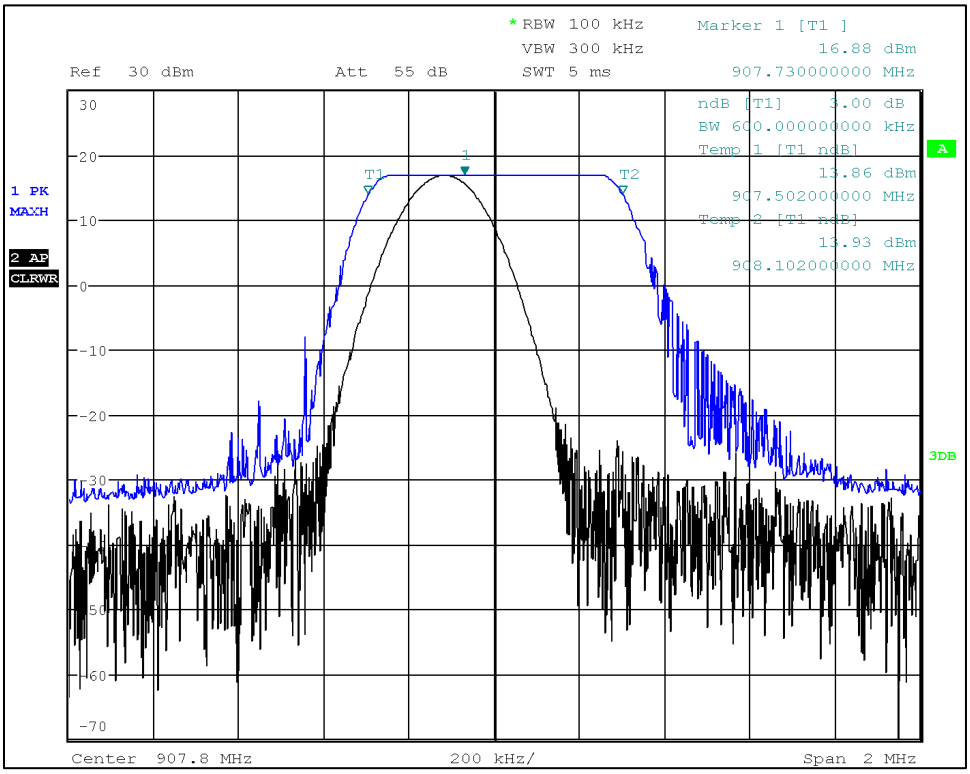


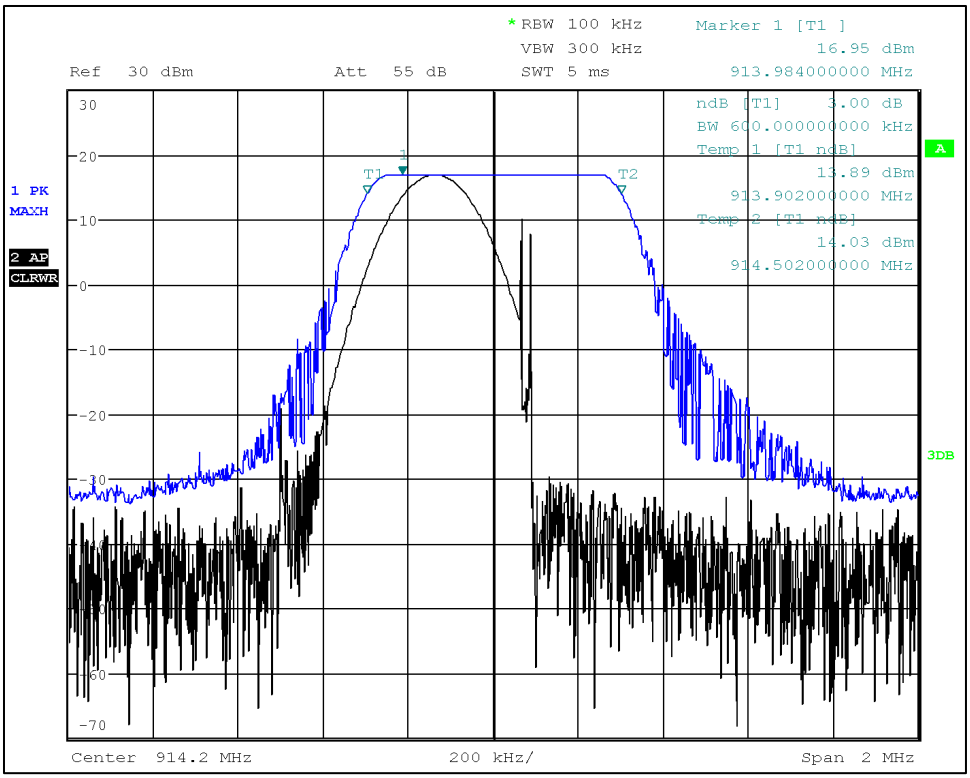



* RBW 100 kHz
VBW 300 kHz
SWT 5 ms
Marker 1 [T1]
16.95 dBm
914.438000000 MHz
Ref 30 dBm
Att 55 dB
ndB [T1] 3.00 dB
BW 598.000000000 kHz
Temp 1 [T1 ndB]
14.05 dBm
913.904000000 MHz
Temp 2 [T1 ndB]
13.93 dBm
914.502000000 MHz
1 PK
MAXH
2 AP
CLRWR
A
3DB
T1
T2
Center 914.2 MHz
200 kHz/
Span 2 MHz

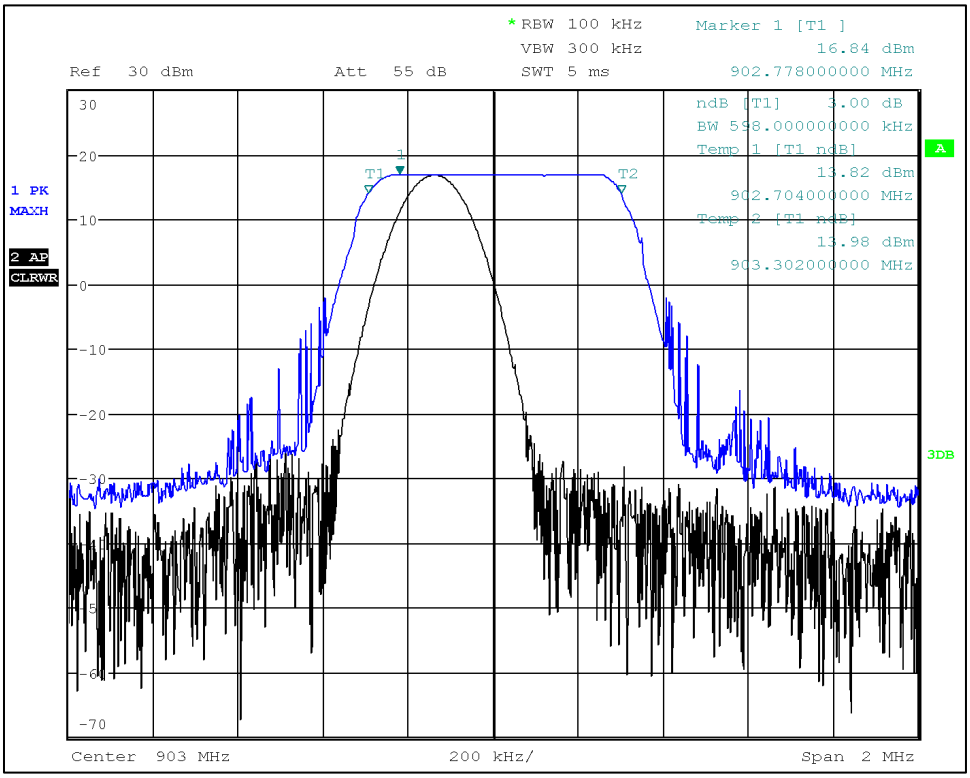
6 dB Spread Factor 11

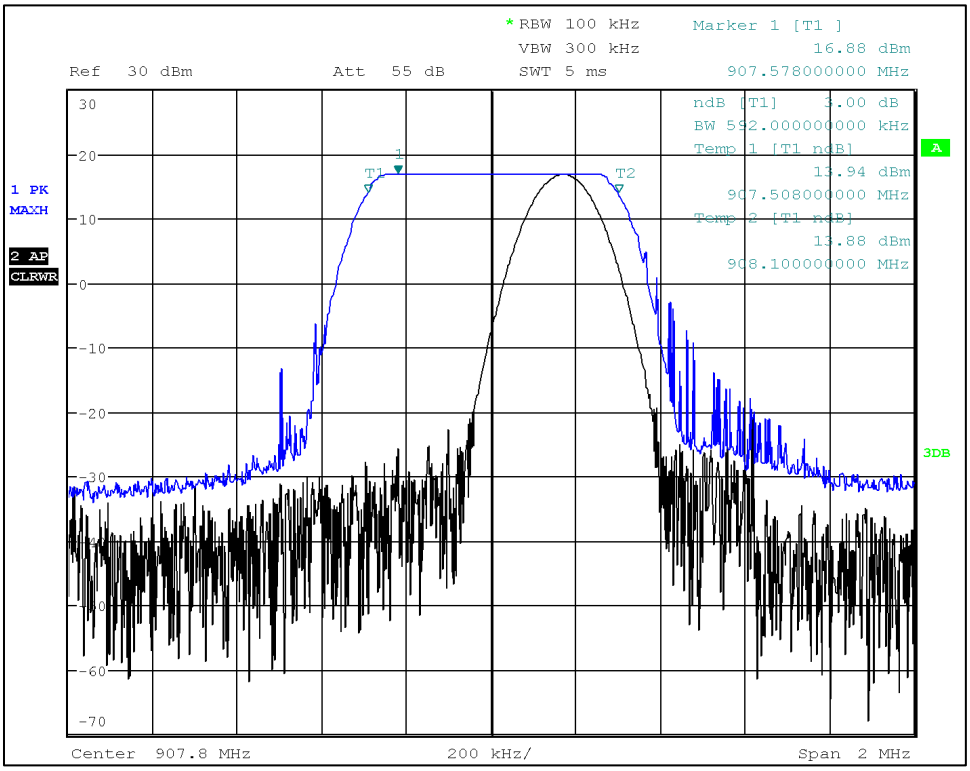


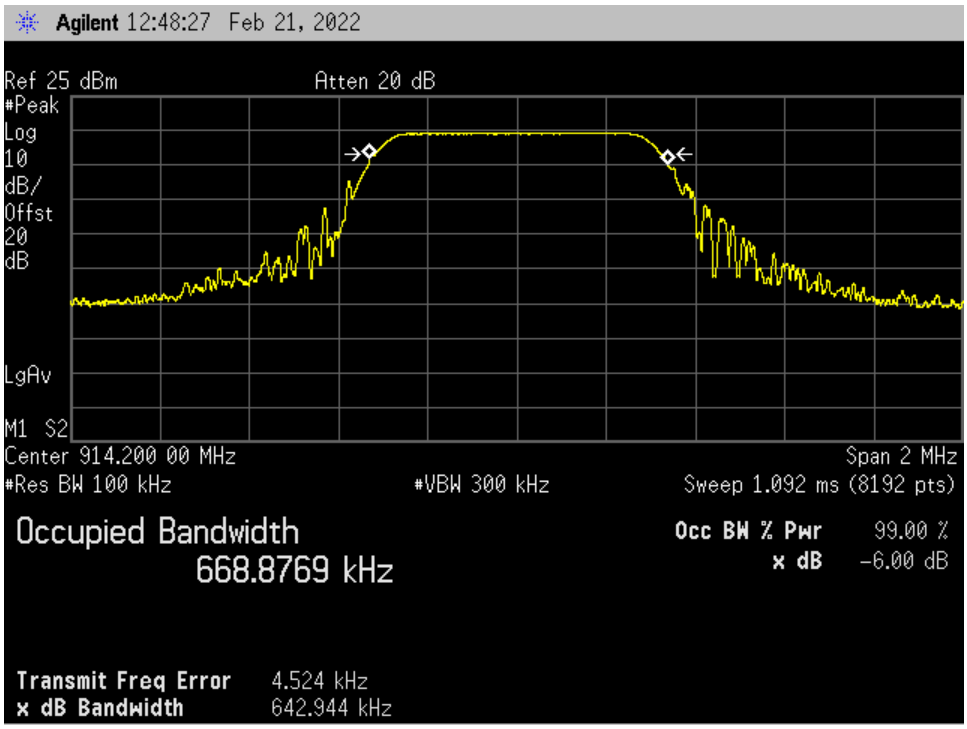



* RBW 100 kHz
VBW 300 kHz
SWT 5 ms
Marker 1 [T1]
16.95 dBm
913.984000000 MHz
Ref 30 dBm
Att 55 dB
ndB [T1] 3.00 dB
BW 600.000000000 kHz
Temp 1 [T1 ndB]
13.89 dBm
913.902000000 MHz
Temp 2 [T1 ndB]
14.03 dBm
914.502000000 MHz
1 PK
MAXH
2 AP
CLRWR
A
3DB
T1
T2
30
20
10
0
-10
-20
-30
-60
-70
Center 914.2 MHz
200 kHz/
Span 2 MHz

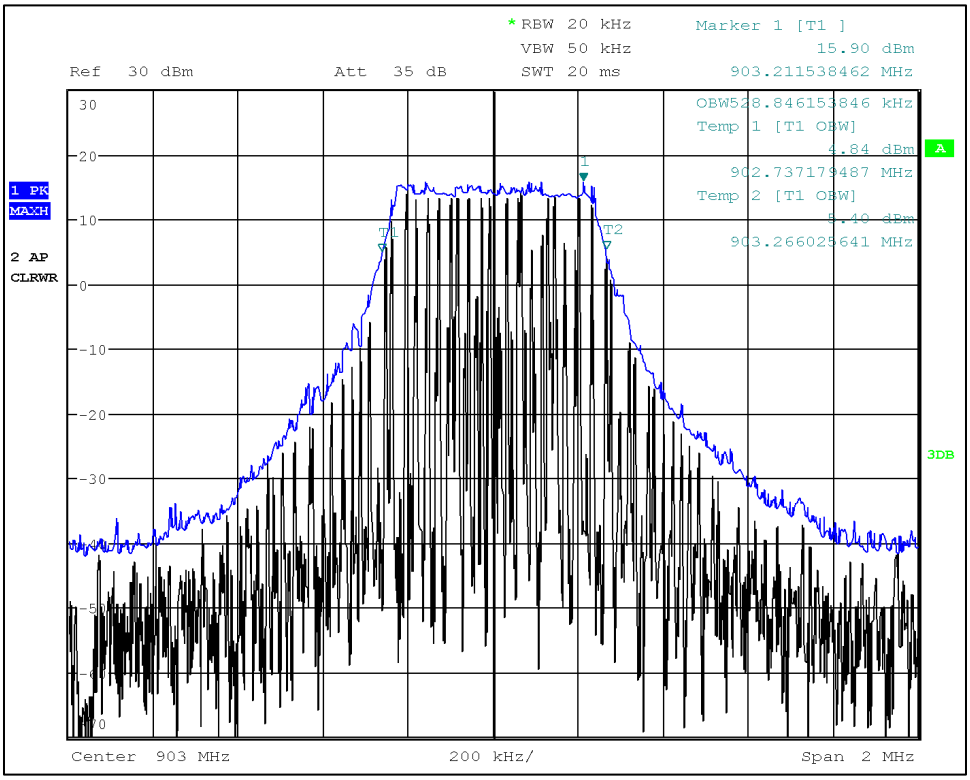
6 dB Spread Factor 12

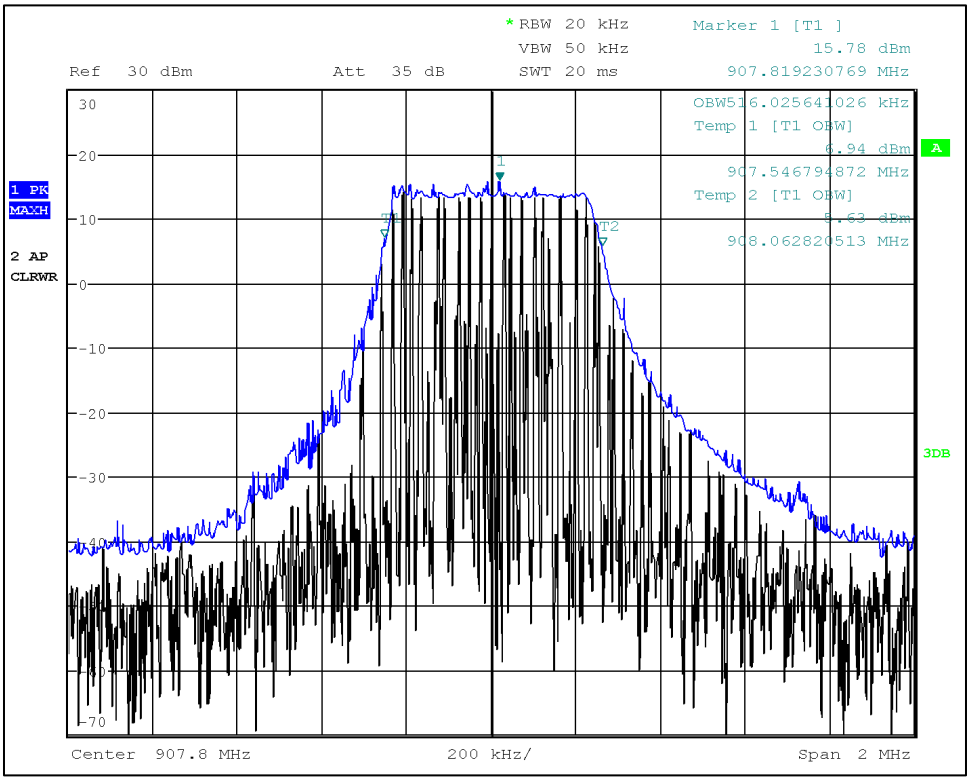


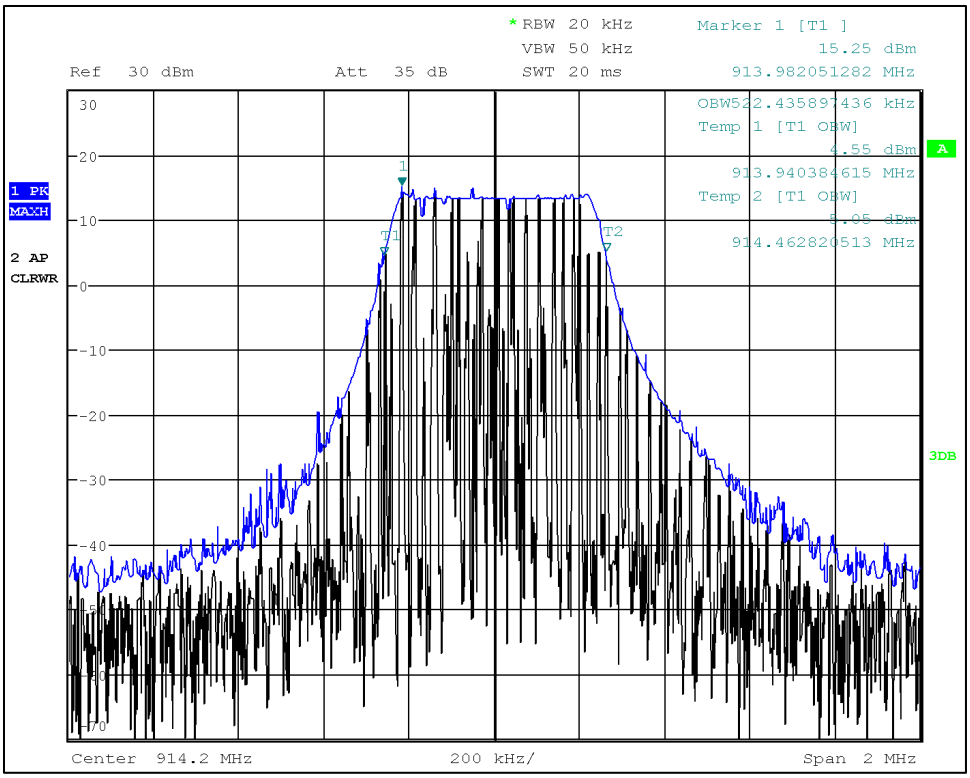



Agilent 12:48:27 Feb 21, 2022
Ref 25 dBm
Atten 20 dB
#Peak
Log
10
dB/
Offst
20
dB
LgAv
M1 S2
Center 914.200 00 MHz
Span 2 MHz
#Res BW 100 kHz
#VBW 300 kHz
Sweep 1.092 ms (8192 pts)
Occupied Bandwidth
668.8769 kHz
Occ BW % Pwr 99.00 %
x dB -6.00 dB
Transmit Freq Error 4.524 kHz
x dB Bandwidth 642.944 kHz

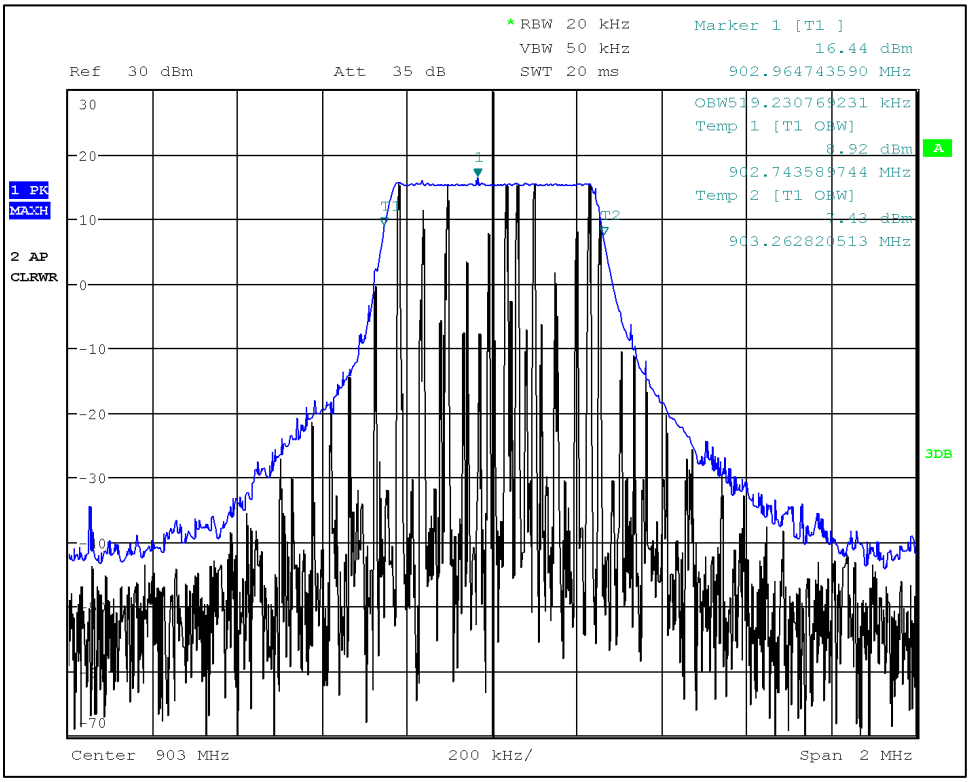
99% Spread Factor 7

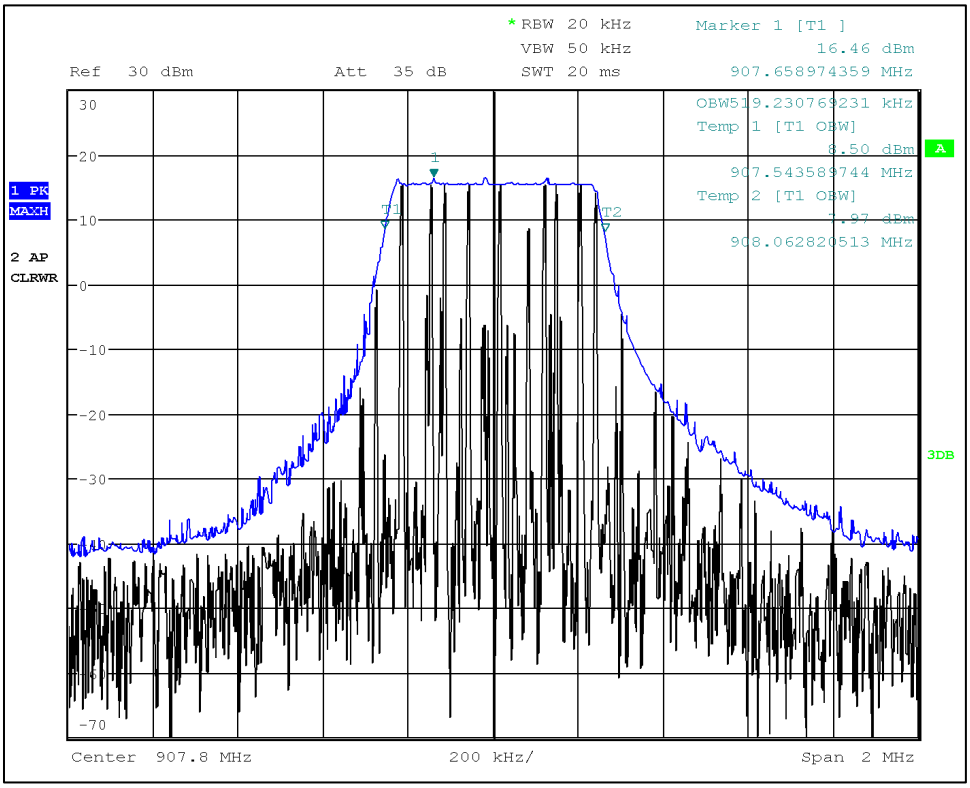


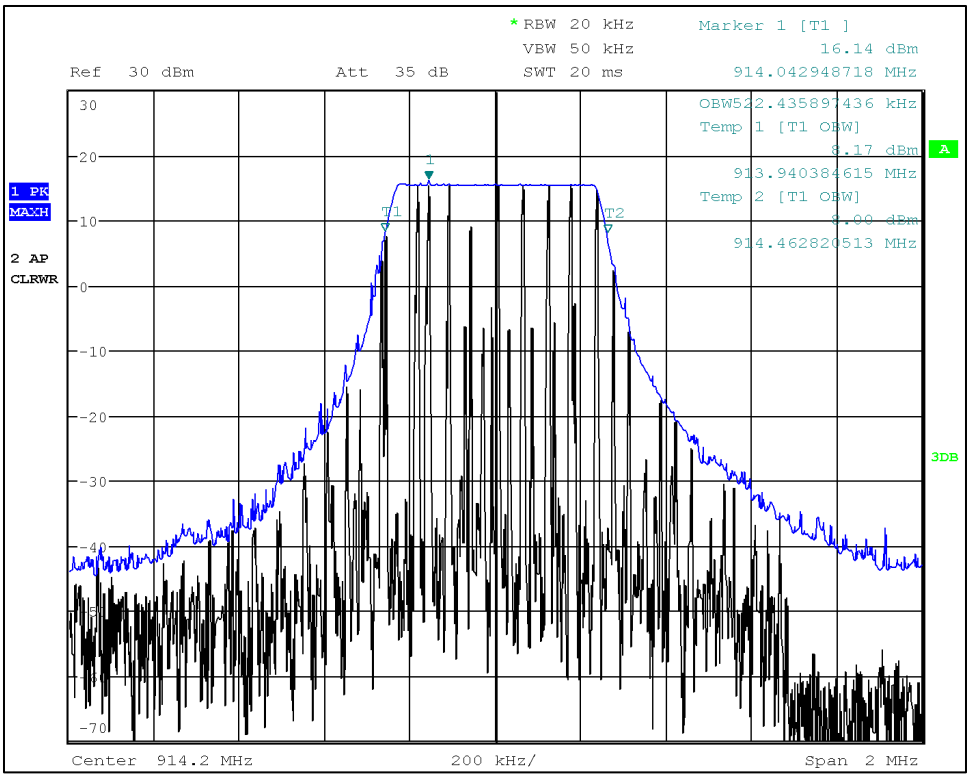



* RBW 20 kHz
VBW 50 kHz
SWT 20 ms
Marker 1 [T1]
15.25 dBm
913.982051282 MHz
Ref 30 dBm
Att 35 dB
OBW522.435897436 kHz
Temp 1 [T1 OBW]
4.55 dBm
913.940384615 MHz
Temp 2 [T1 OBW]
5.05 dBm
914.462820513 MHz
1 PK
MAXH
2 AP
CLRWR
A
3DB
T1
T2
Center 914.2 MHz
200 kHz/
Span 2 MHz

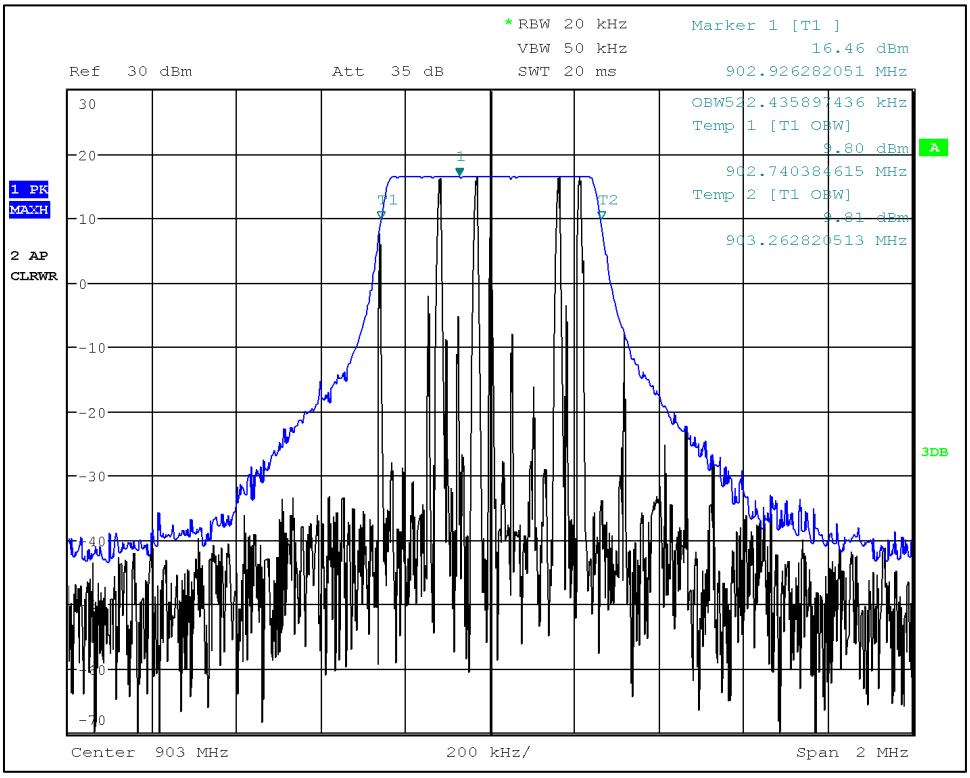
99% Spread Factor 8

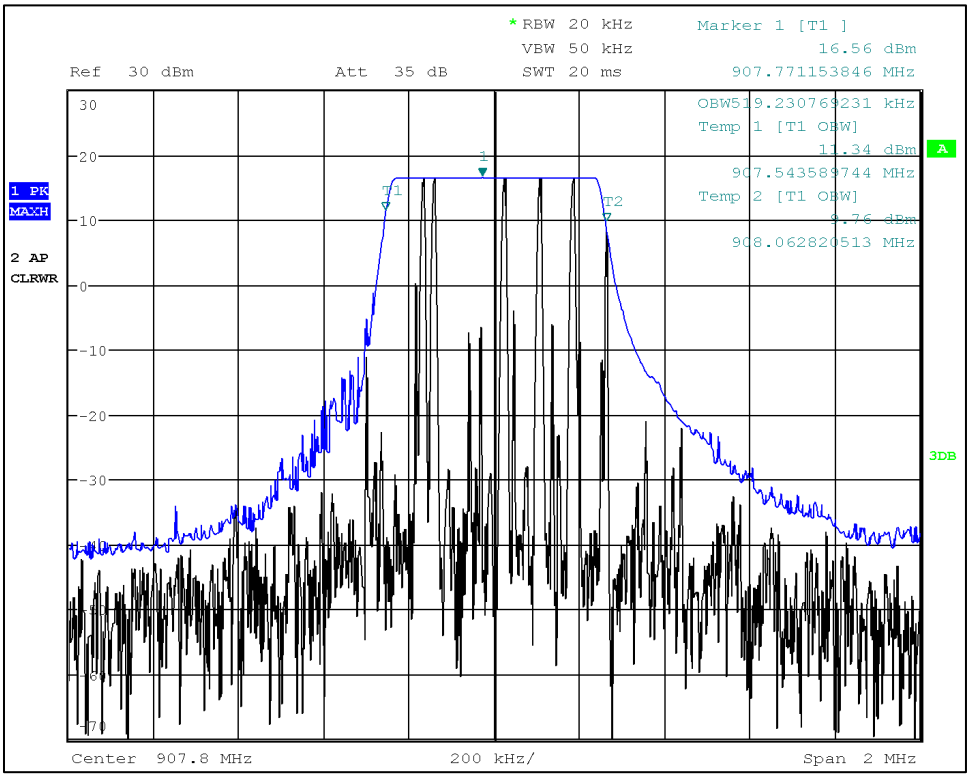


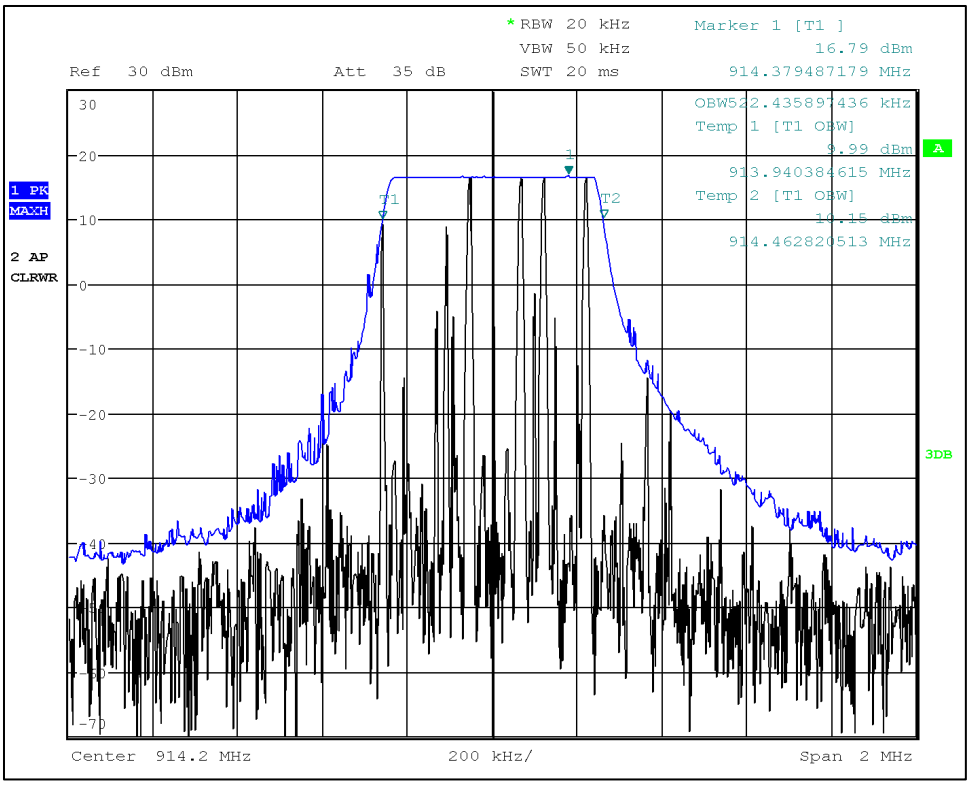



* RBW 20 kHz
VBW 50 kHz
SWT 20 ms
Marker 1 [T1]
16.14 dBm
914.042948718 MHz
Ref 30 dBm
Att 35 dB
OBW522.435897436 kHz
Temp 1 [T1 OBW]
9.17 dBm
913.940384615 MHz
Temp 2 [T1 OBW]
9.00 dBm
914.462820513 MHz
1 PK
MAXH
2 AP
CLRWR
A
3DB
T1
T2
Center 914.2 MHz
200 kHz/
Span 2 MHz

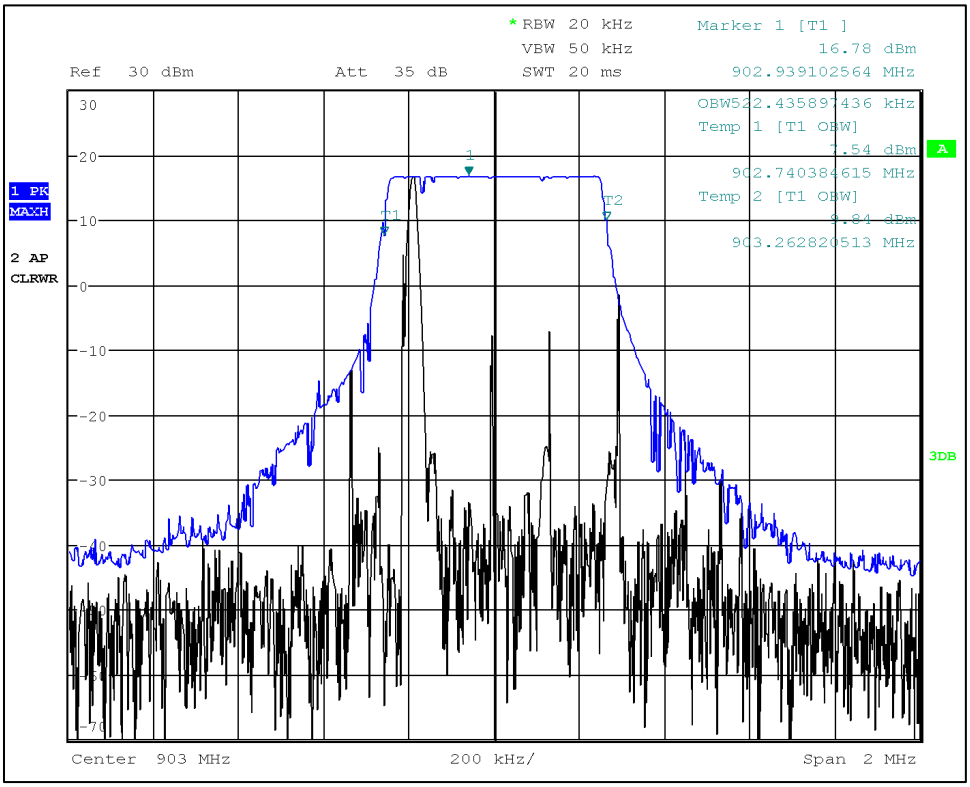
99% Spread Factor 9

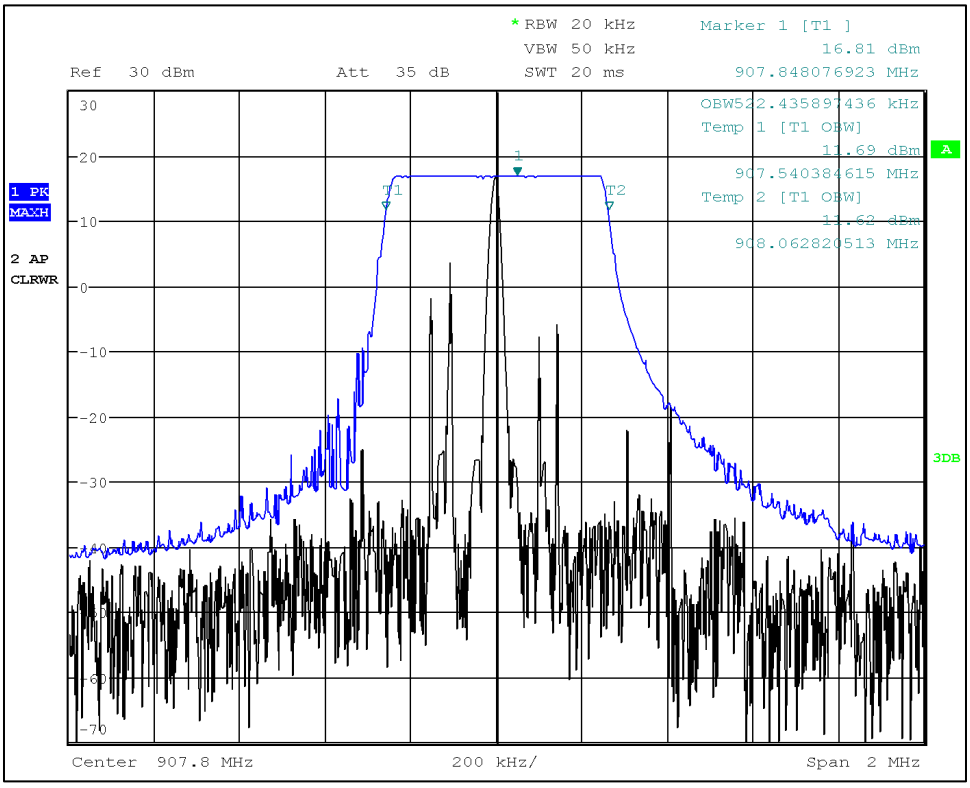


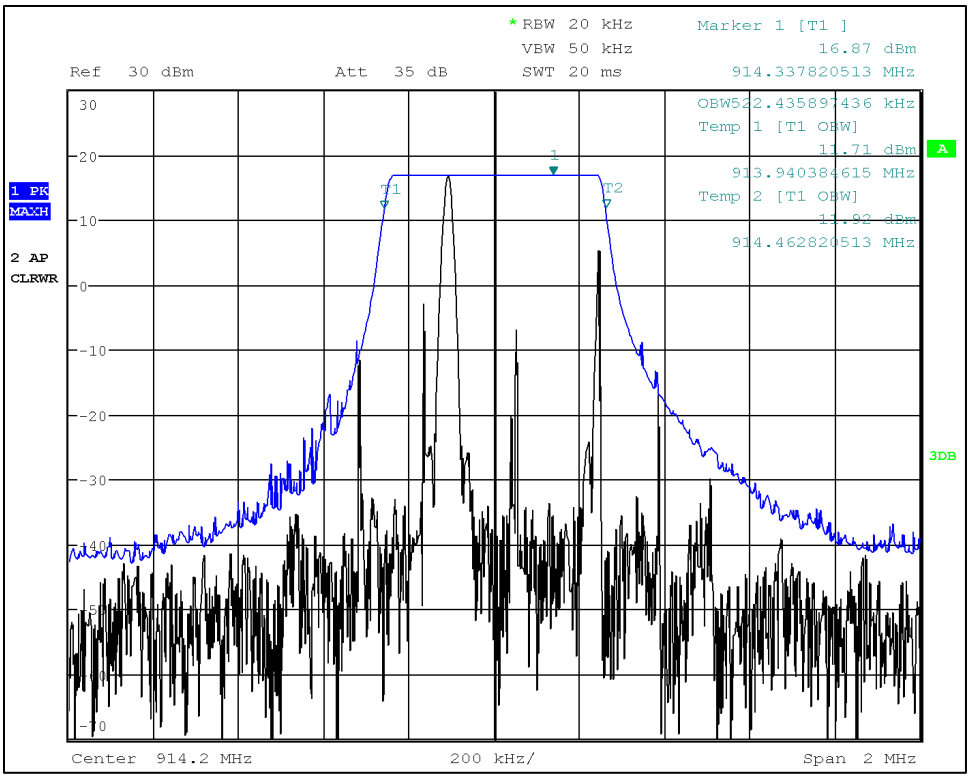



* RBW 20 kHz
VBW 50 kHz
SWT 20 ms
Marker 1 [T1]
16.79 dBm
914.379487179 MHz
Ref 30 dBm
Att 35 dB
OBW522.435897436 kHz
Temp 1 [T1 OBW]
9.99 dBm
913.940384615 MHz
Temp 2 [T1 OBW]
10.15 dBm
914.462820513 MHz
1 PK
MAXH
2 AP
CLRWR
A
3DB
T1
T2
30
20
10
0
-10
-20
-30
-40
-50
-70
Center 914.2 MHz
200 kHz/
Span 2 MHz

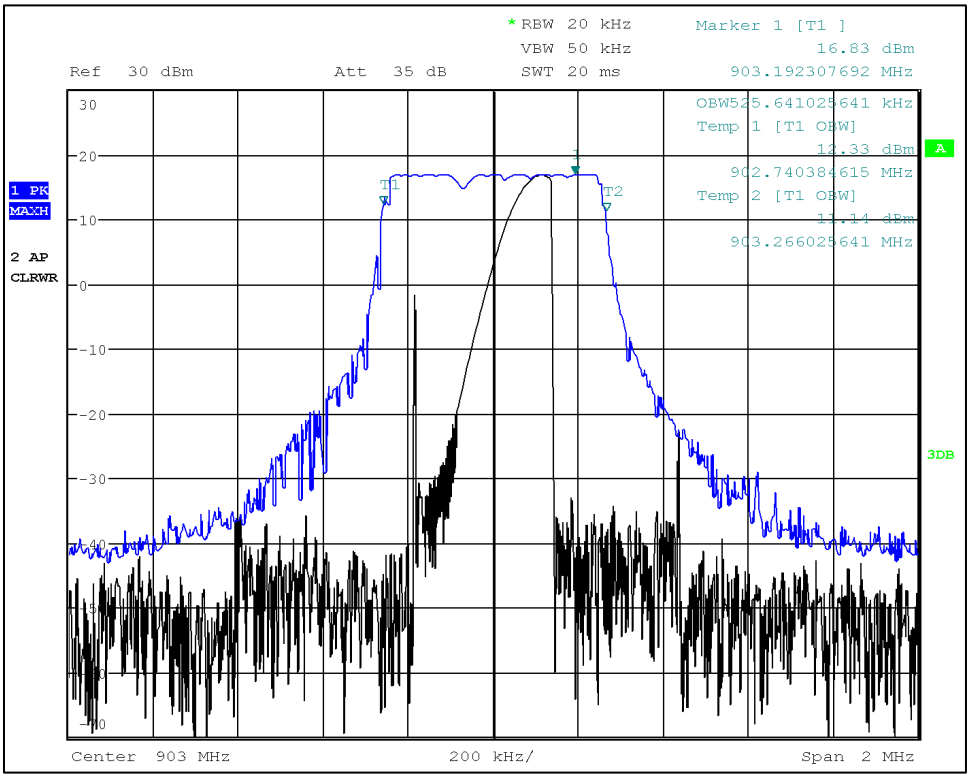
99% Spread Factor 10

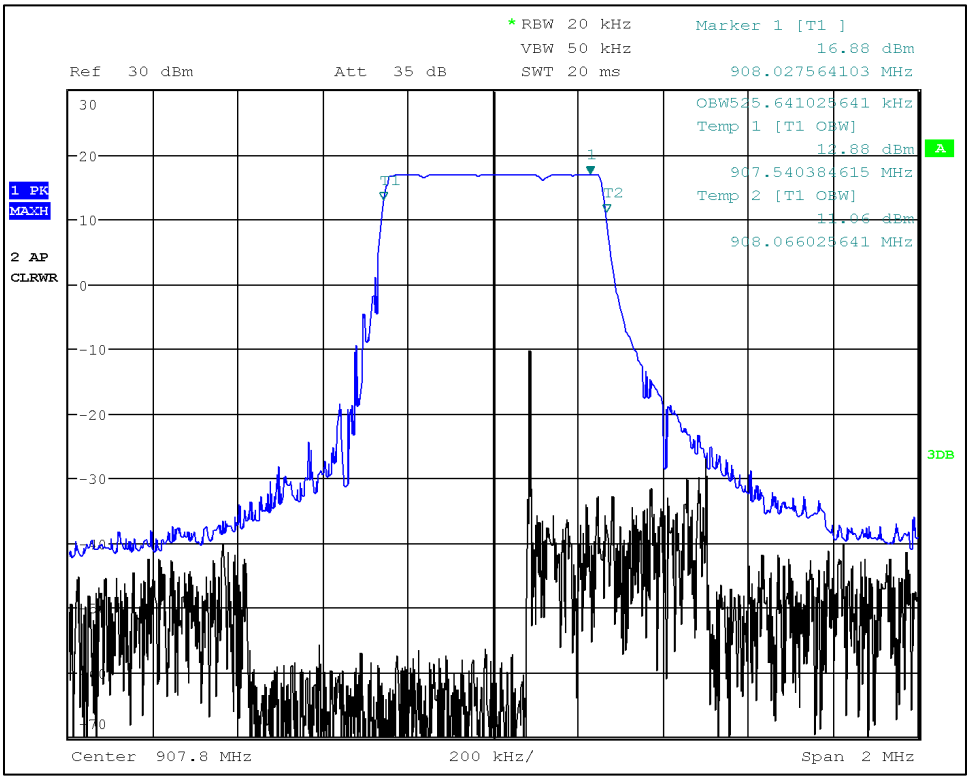


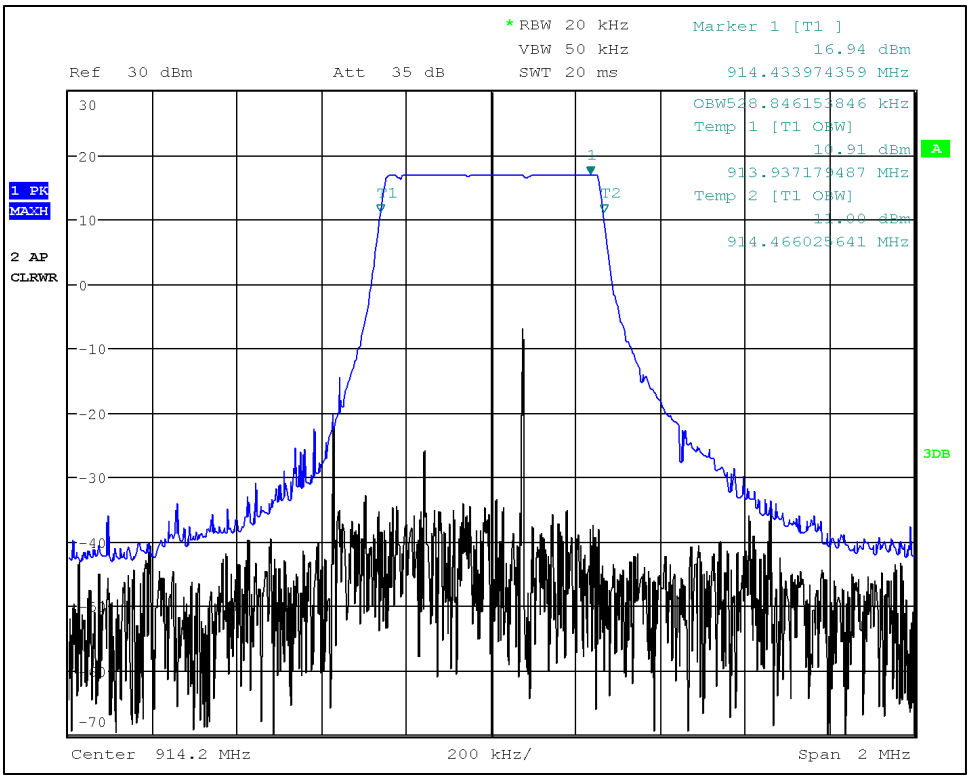



* RBW 20 kHz
VBW 50 kHz
SWT 20 ms
Marker 1 [T1]
16.87 dBm
914.337820513 MHz
Ref 30 dBm
Att 35 dB
OBW522.435897436 kHz
Temp 1 [T1 OBW]
11.71 dBm
913.940384615 MHz
Temp 2 [T1 OBW]
11.92 dBm
914.462820513 MHz
1 PK
MAXH
2 AP
CLRWR
A
3DB
T1
T2
1
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
Center 914.2 MHz
200 kHz/
Span 2 MHz

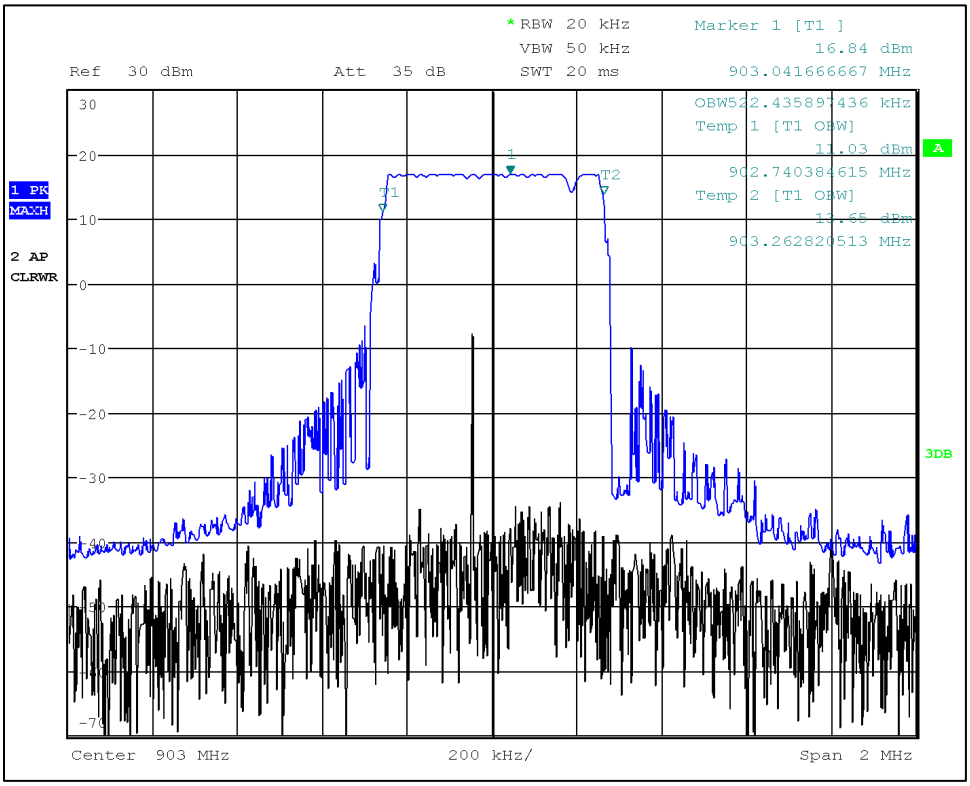
99% Spread Factor 11

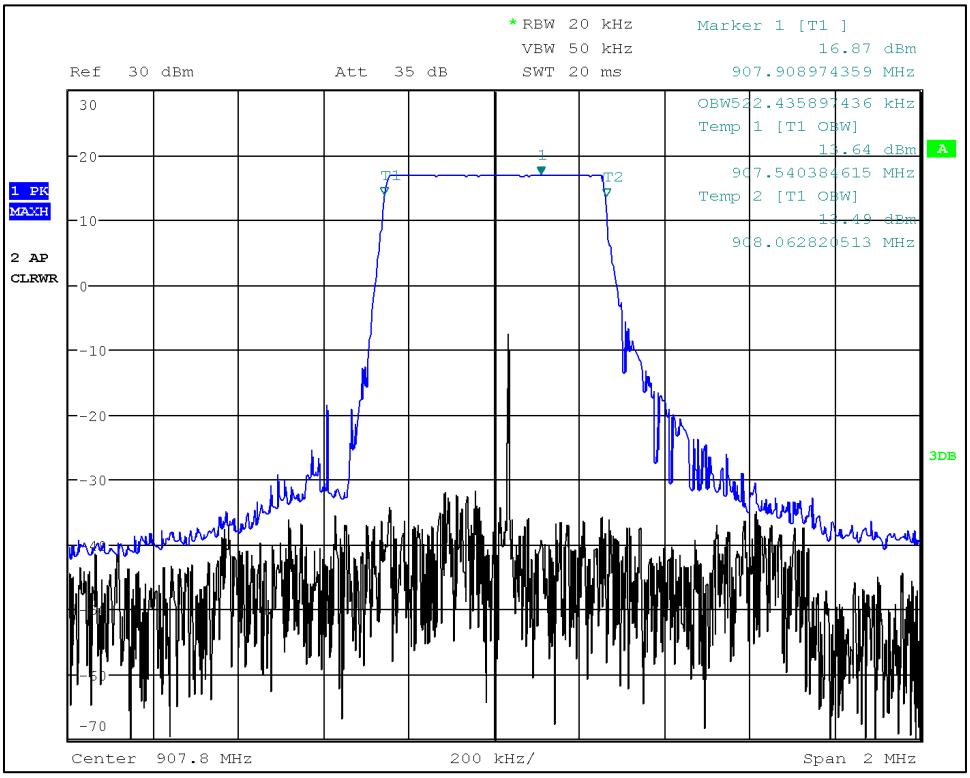


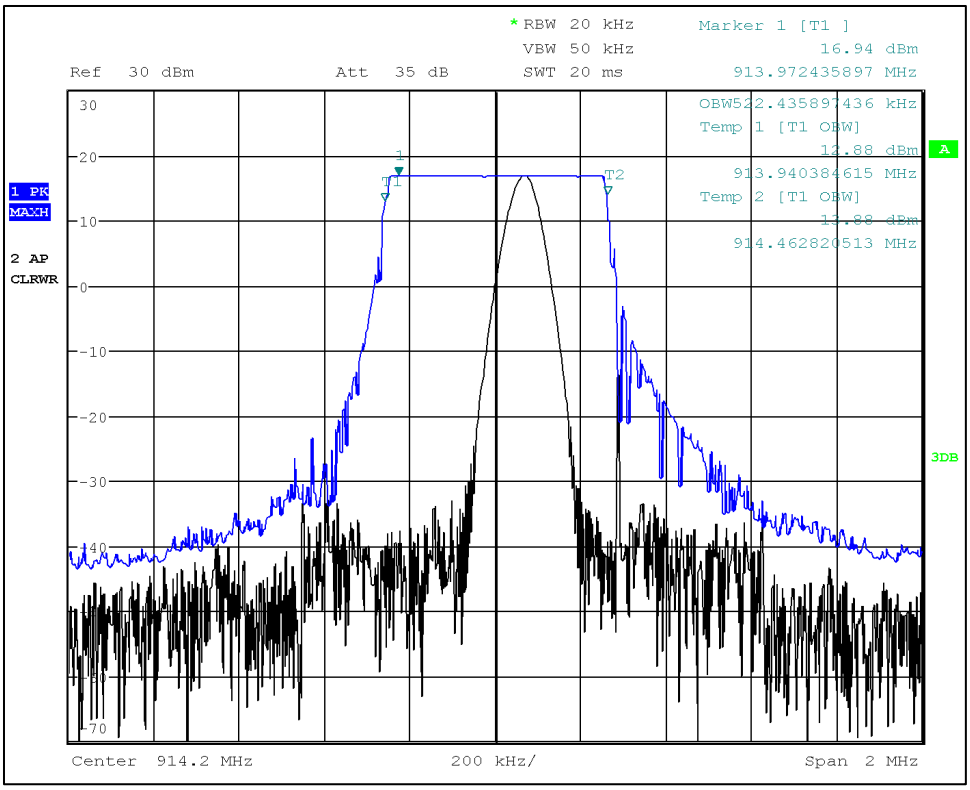



* RBW 20 kHz
VBW 50 kHz
SWT 20 ms
Marker 1 [T1]
16.94 dBm
914.433974359 MHz
Ref 30 dBm
Att 35 dB
OBW528.846153846 kHz
Temp 1 [T1 OBW]
10.91 dBm
913.937179487 MHz
Temp 2 [T1 OBW]
11.00 dBm
914.466025641 MHz
1 PK
MAXH
2 AP
CLRWR
A
3DB
T1
T2
Center 914.2 MHz
200 kHz/
Span 2 MHz

99% Spread Factor 12

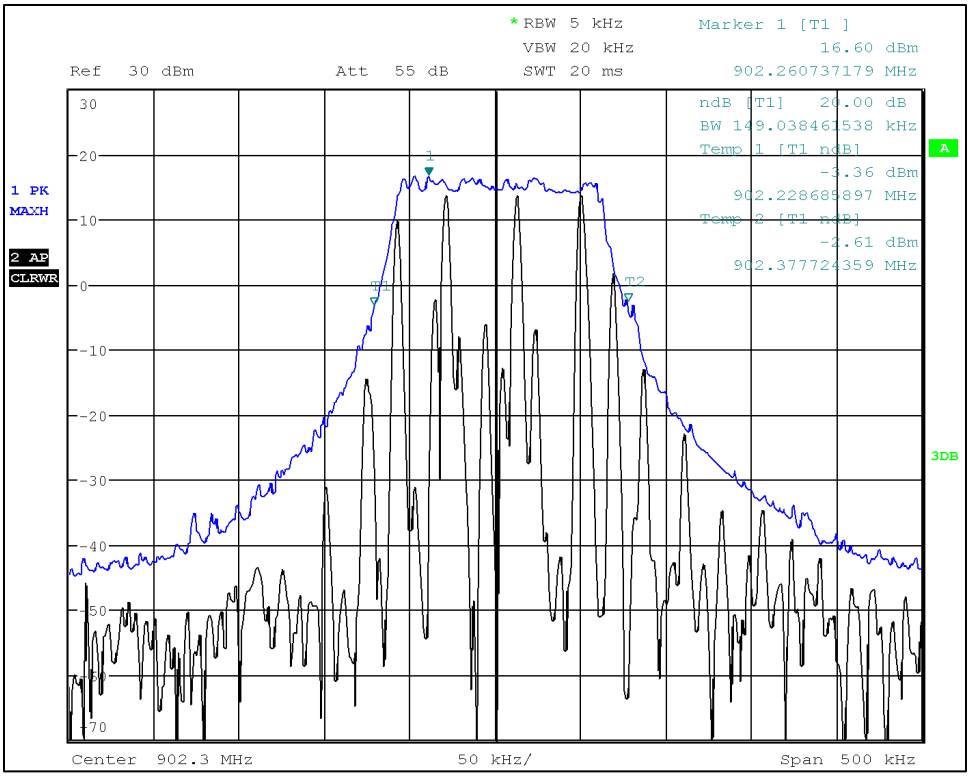


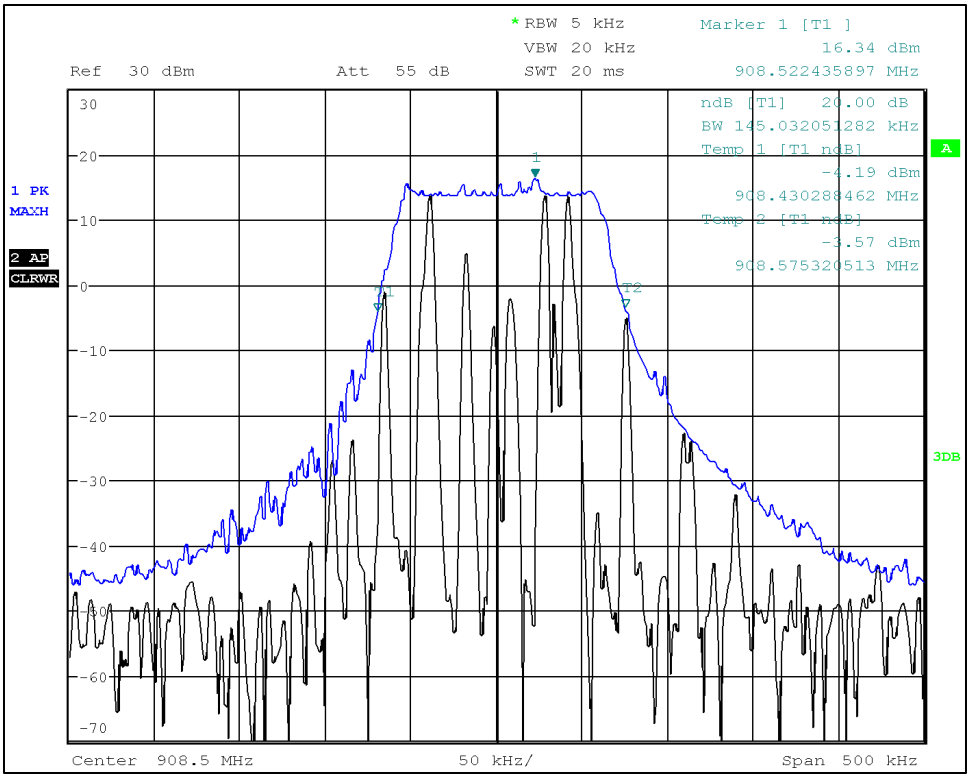


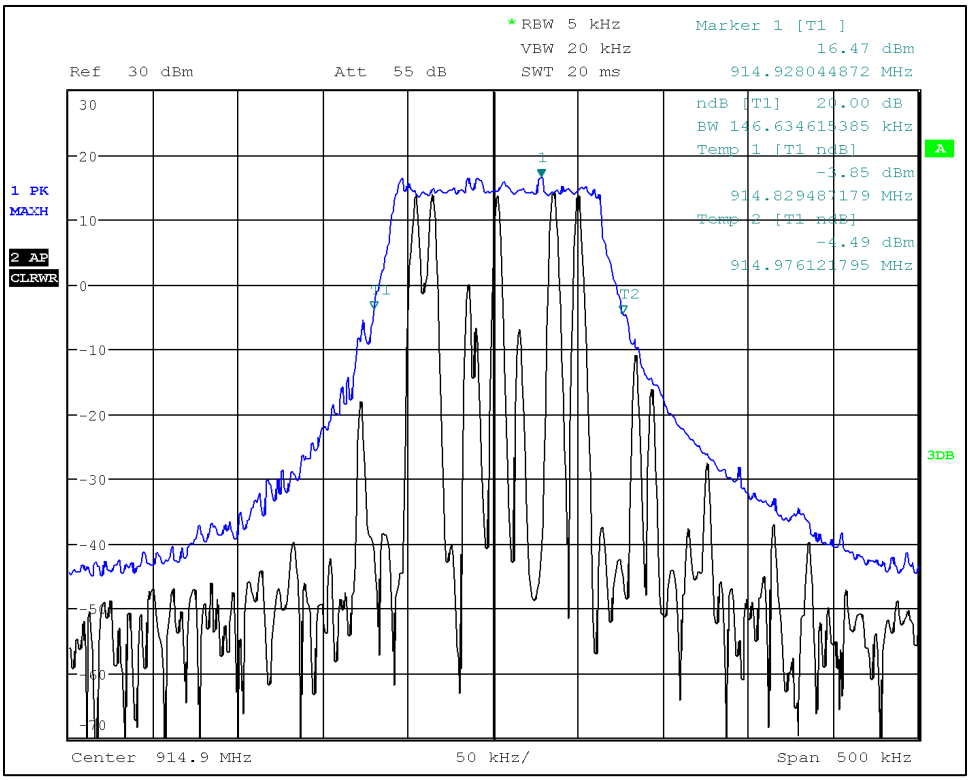

* RBW 20 kHz
VBW 50 kHz
SWT 20 ms
Marker 1 [T1]
16.94 dBm
913.972435897 MHz
Ref 30 dBm
Att 35 dB
OBW522.435897436 kHz
Temp 1 [T1 OBW]
12.88 dBm
913.940384615 MHz
Temp 2 [T1 OBW]
12.88 dBm
914.462820513 MHz
1 PK
MAXH
2 AP
CLRWR
A
3DB
T1
T2
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
Center 914.2 MHz
200 kHz/
Span 2 MHz

LoRa FHSS

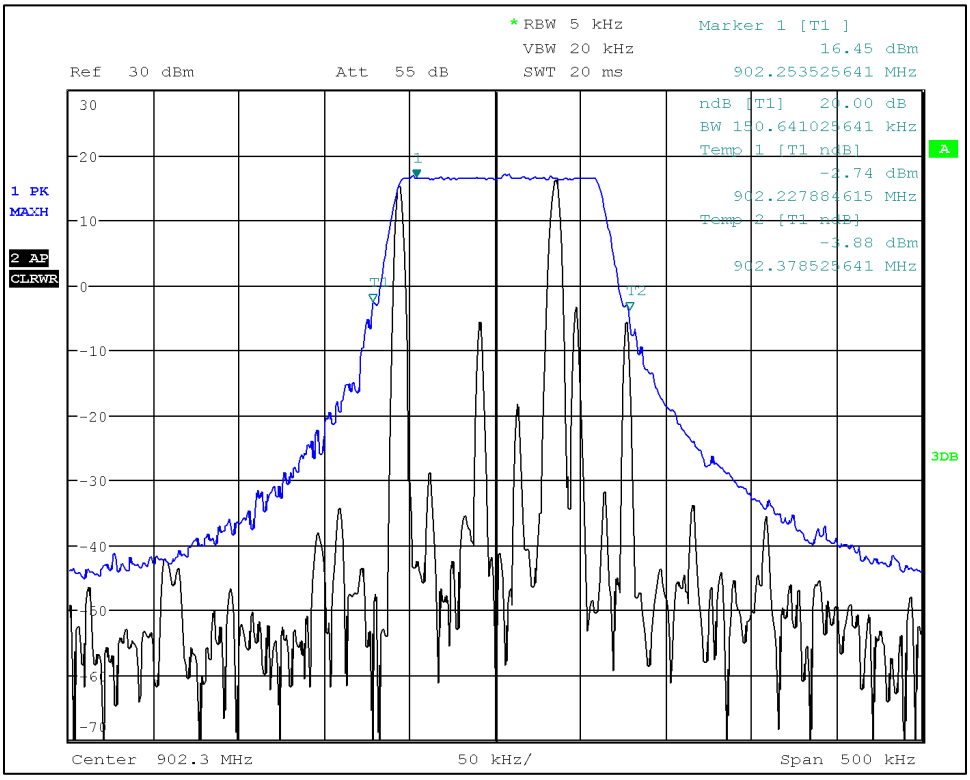
20 dB Spread Factor 7

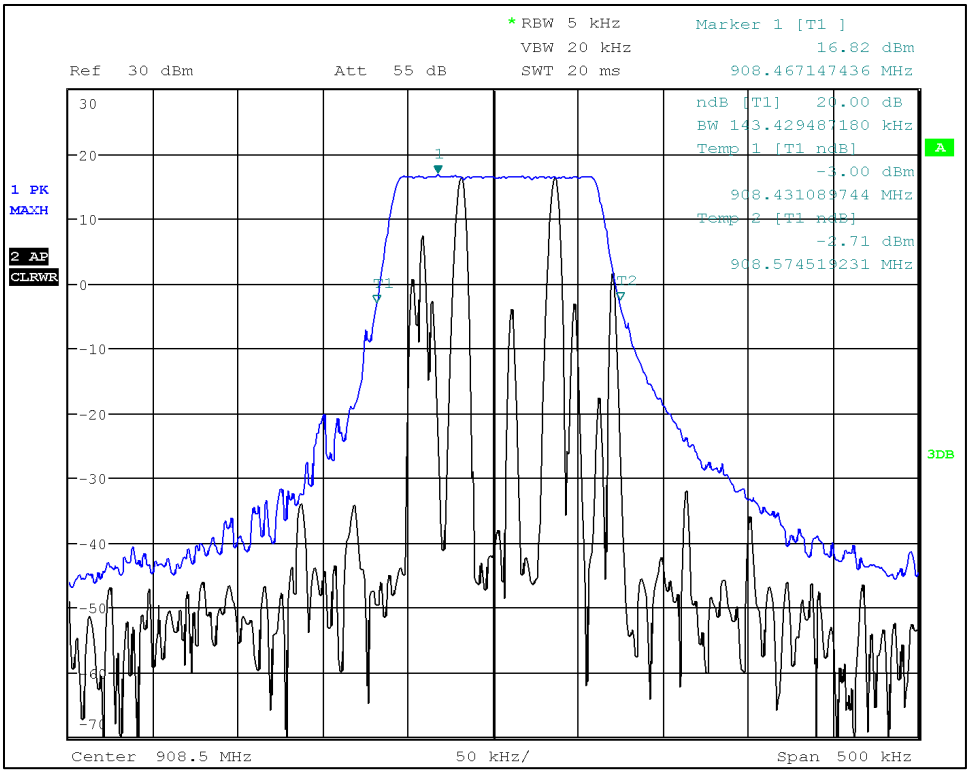


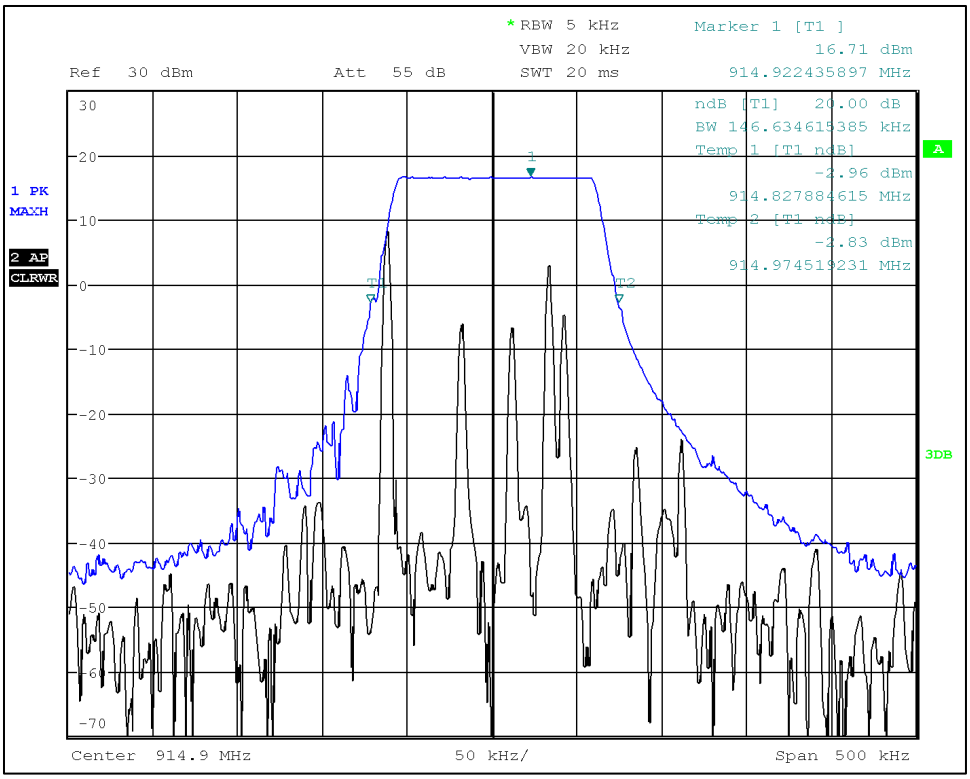




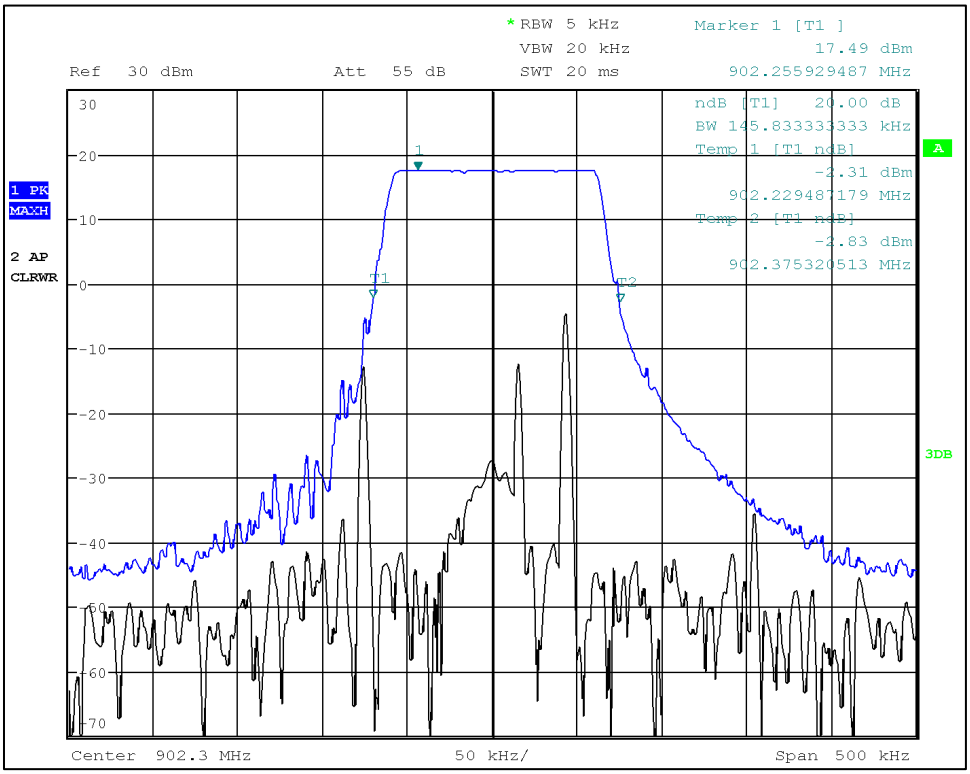
20 dB Spread Factor 8

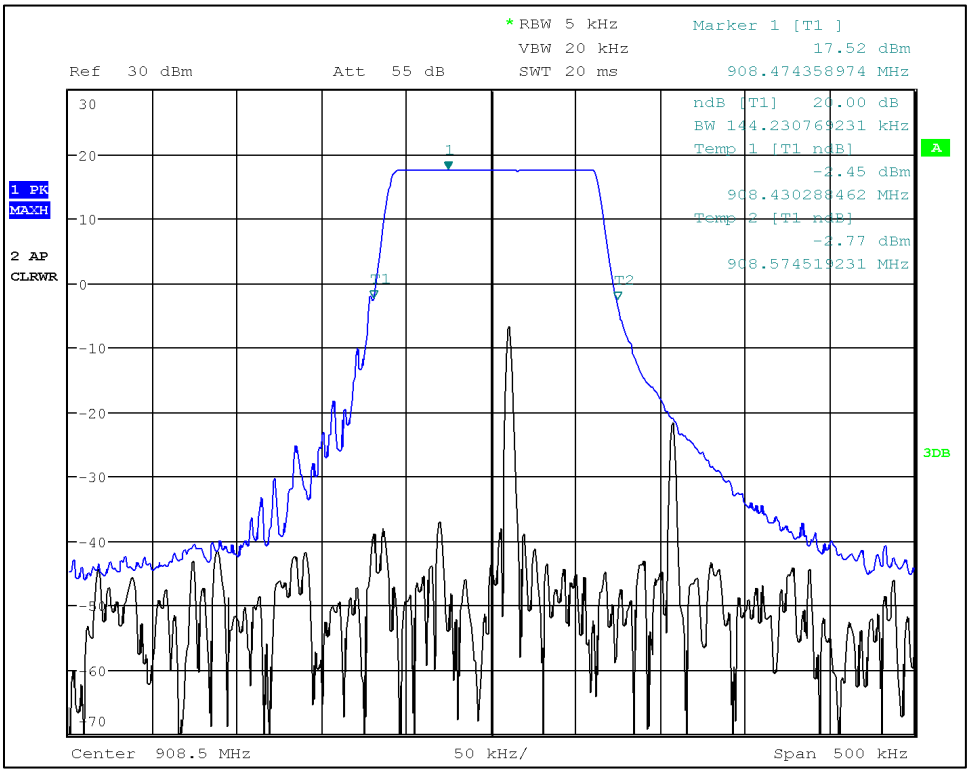


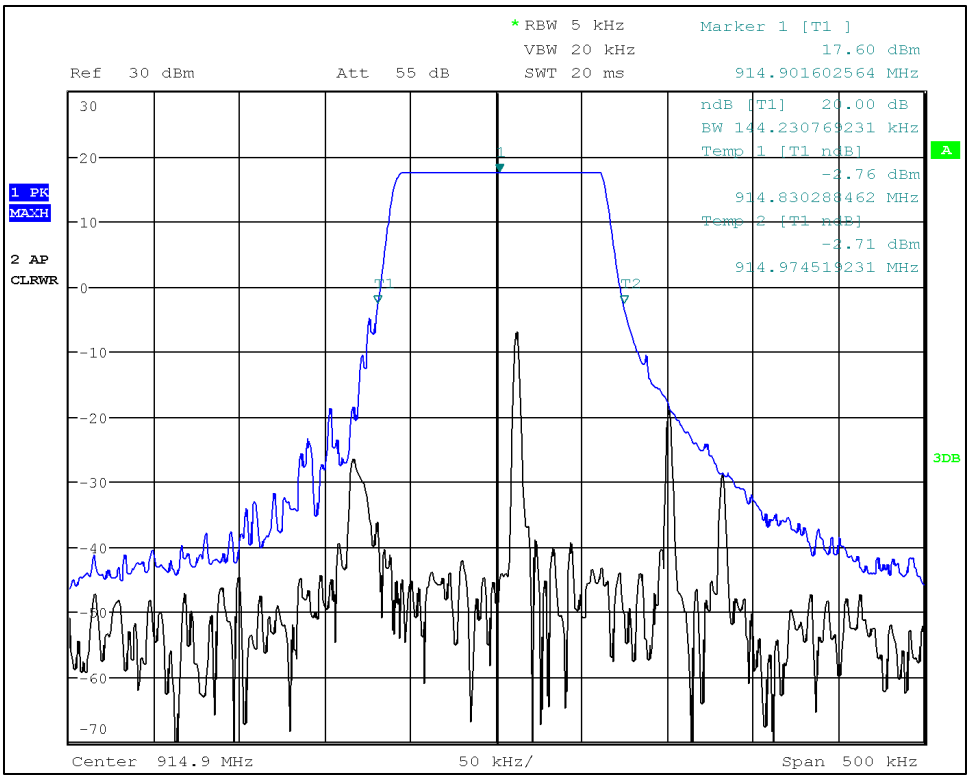

* RBW 5 kHz
VBW 20 kHz
SWT 20 ms
Marker 1 [T1]
16.82 dBm
908.467147436 MHz
Ref 30 dBm
Att 55 dB
ndB [T1] 20.00 dB
BW 143.429487180 kHz
Temp 1 [T1 ndB]
-3.00 dBm
908.431089744 MHz
Temp 2 [T1 ndB]
-2.71 dBm
908.574519231 MHz
1 PK
MAXH
2 AP
CLRWR
A
3DB
Center 908.5 MHz
50 kHz/
Span 500 kHz


* RBW 5 kHz
VBW 20 kHz
SWT 20 ms
Marker 1 [T1]
16.71 dBm
914.922435897 MHz
Ref 30 dBm
Att 55 dB
ndB [T1] 20.00 dB
BW 146.634615385 kHz
Temp 1 [T1 ndB]
-2.96 dBm
914.827884615 MHz
Temp 2 [T1 ndB]
-2.83 dBm
914.974519231 MHz
1 PK
MAXH
2 AP
CLRWR
A
3DB
Center 914.9 MHz
50 kHz/
Span 500 kHz

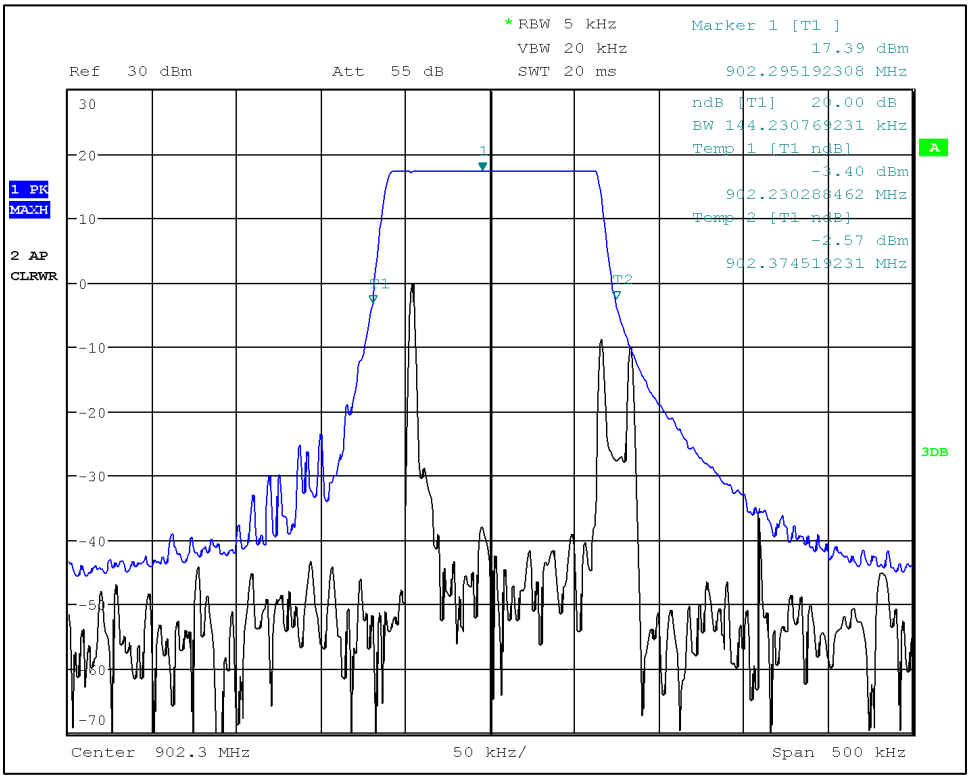
20 dB Spread Factor 9

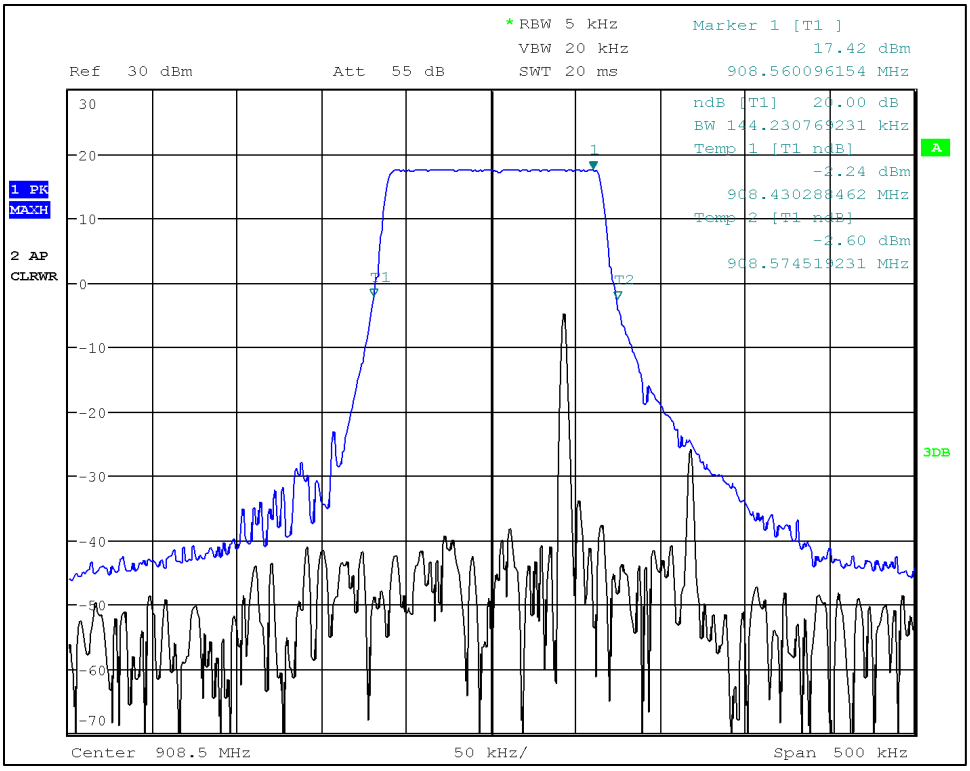


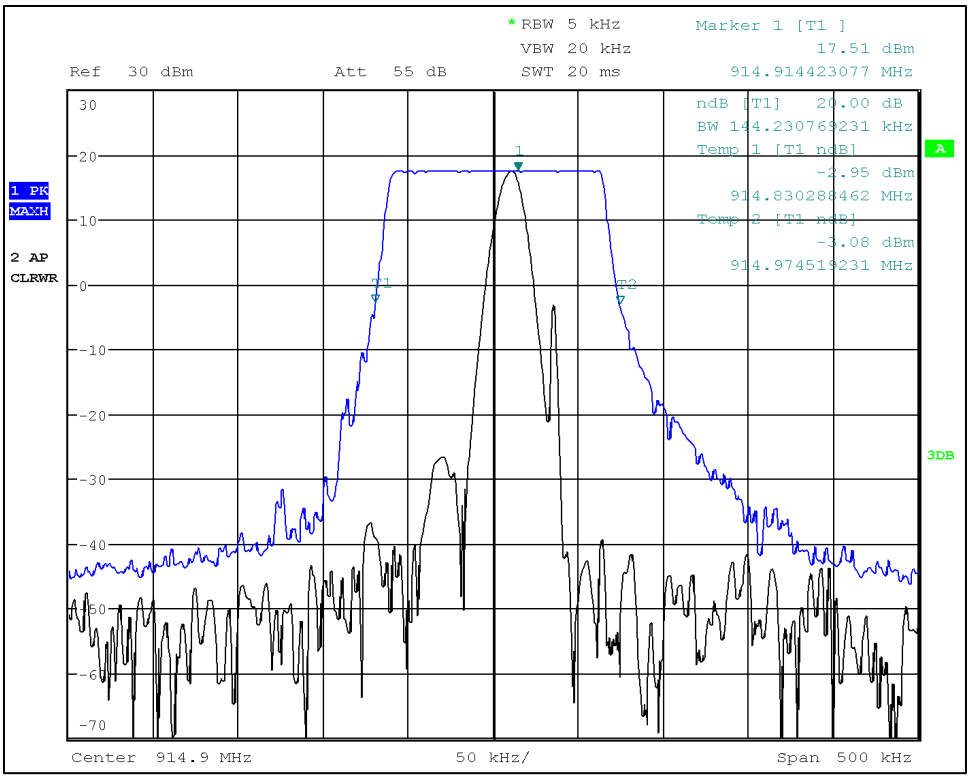




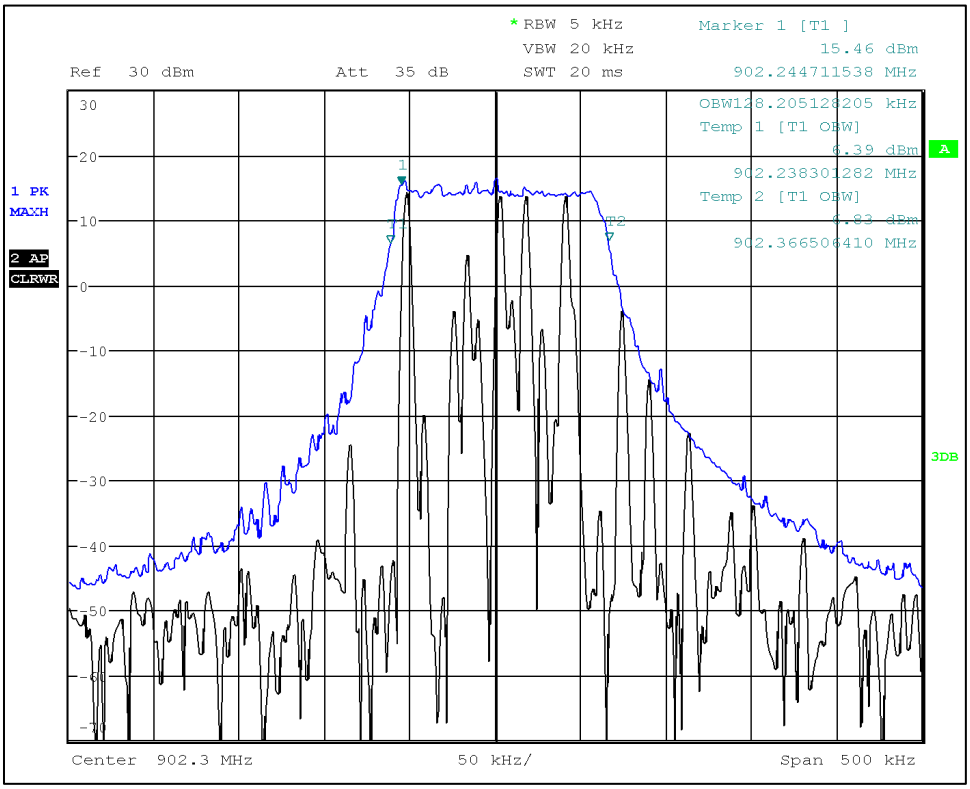
20 dB Spread Factor 10

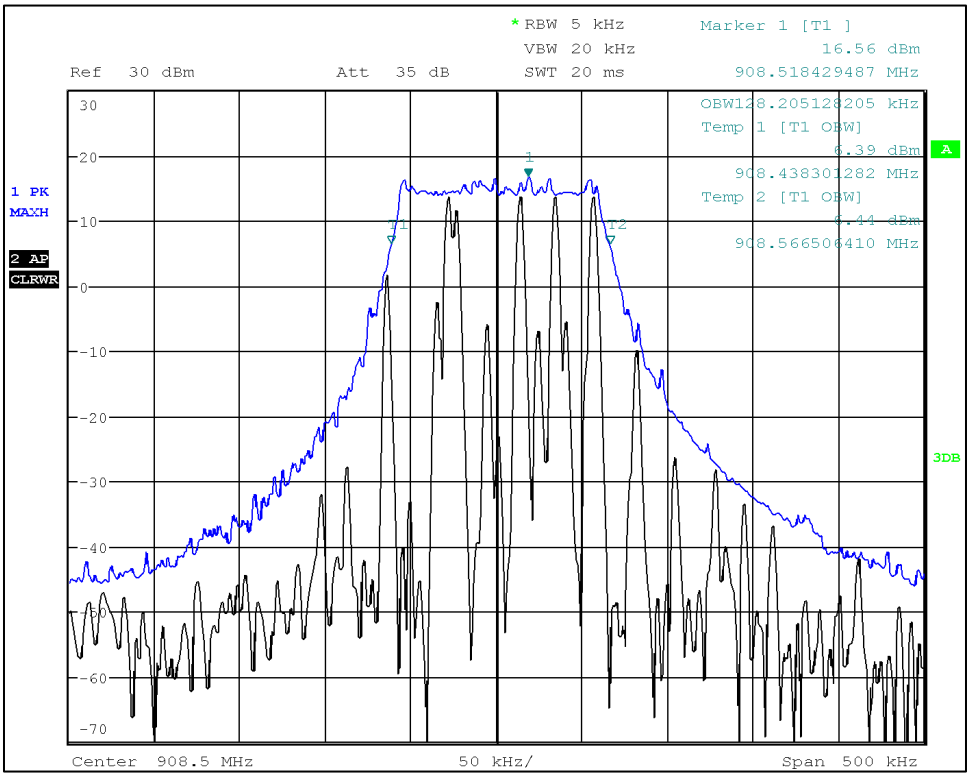


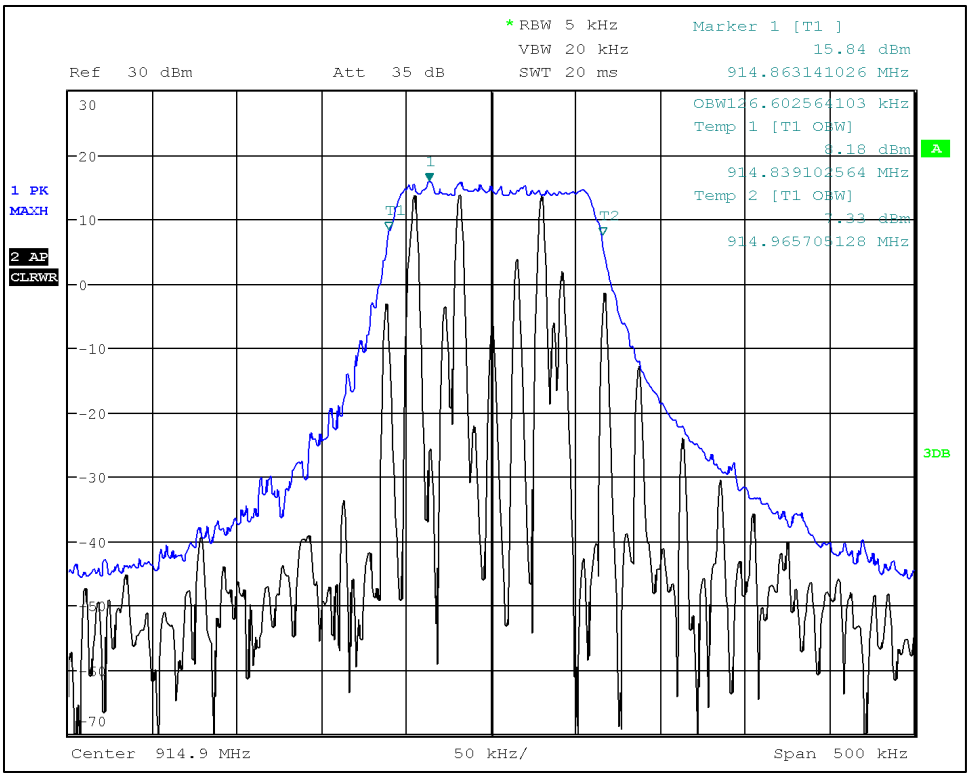

* RBW 5 kHz
VBW 20 kHz
SWT 20 ms
Marker 1 [T1]
17.42 dBm
908.560096154 MHz
Ref 30 dBm
Att 55 dB
ndB [T1] 20.00 dB
BW 144.230769231 kHz
Temp 1 [T1 ndB]
-2.24 dBm
908.430288462 MHz
Temp 2 [T1 ndB]
-2.60 dBm
908.574519231 MHz
1 PK
MAXH
2 AP
CLRWR
A
3DB
T1
T2
Center 908.5 MHz
50 kHz/
Span 500 kHz


* RBW 5 kHz
VBW 20 kHz
SWT 20 ms
Marker 1 [T1]
17.51 dBm
914.914423077 MHz
Ref 30 dBm
Att 55 dB
ndB [T1] 20.00 dB
BW 144.230769231 kHz
Temp 1 [T1 ndB]
-2.95 dBm
914.830288462 MHz
Temp 2 [T1 ndB]
-3.08 dBm
914.974519231 MHz
1 PK
MAXH
2 AP
CLRWR
A
3DB
T1
T2
Center 914.9 MHz
50 kHz/
Span 500 kHz

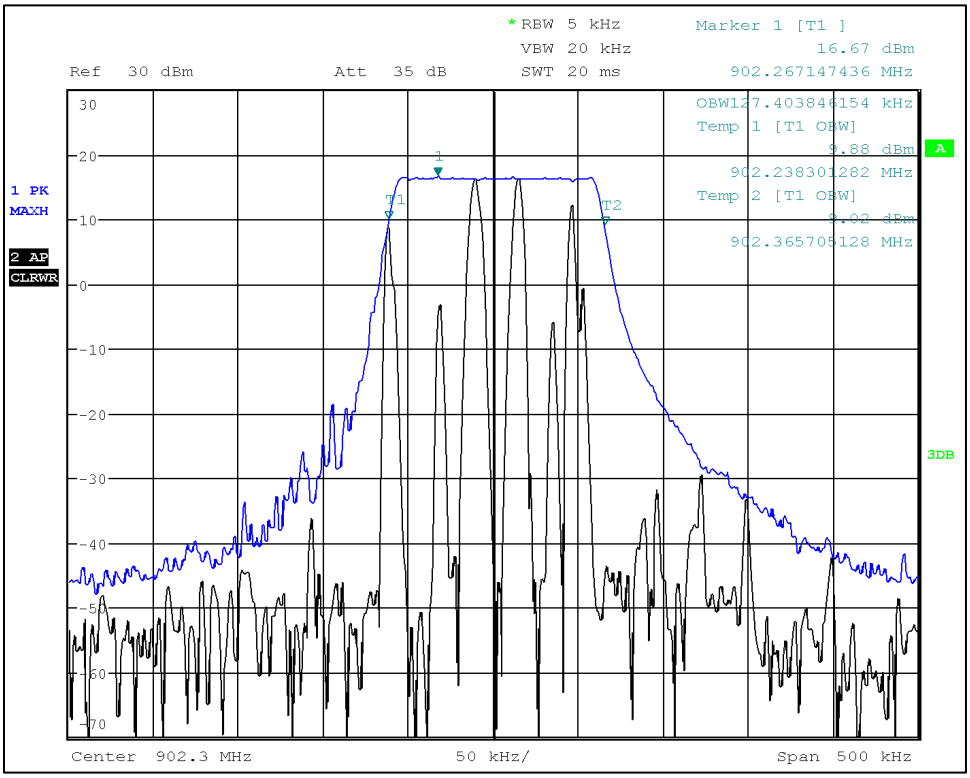
99% Spread Factor 7

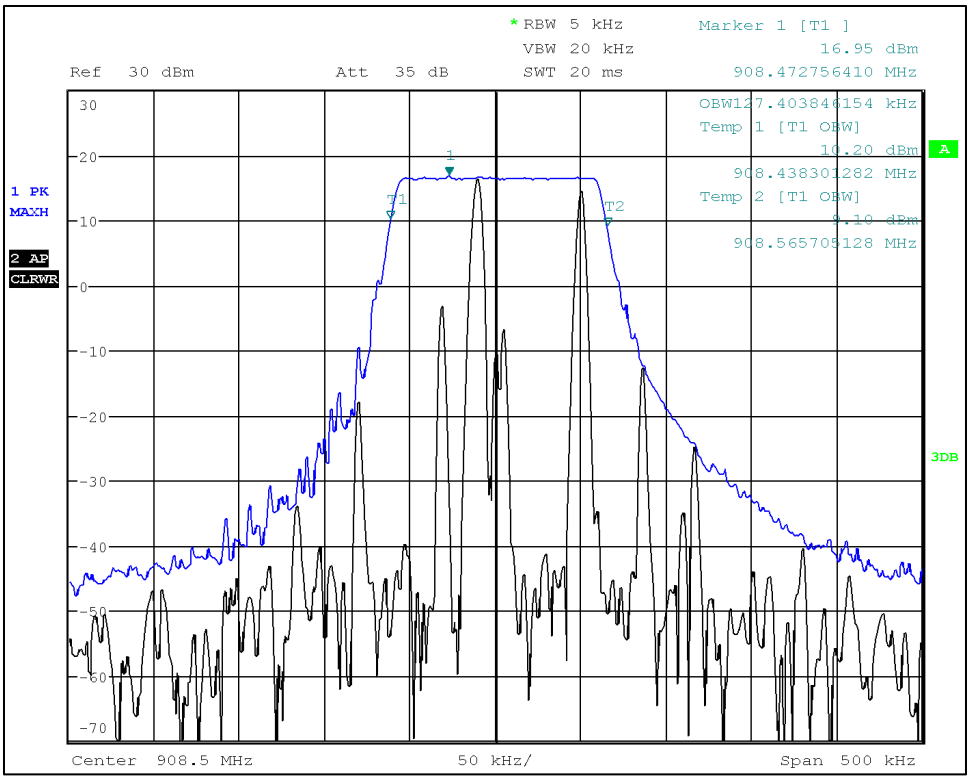


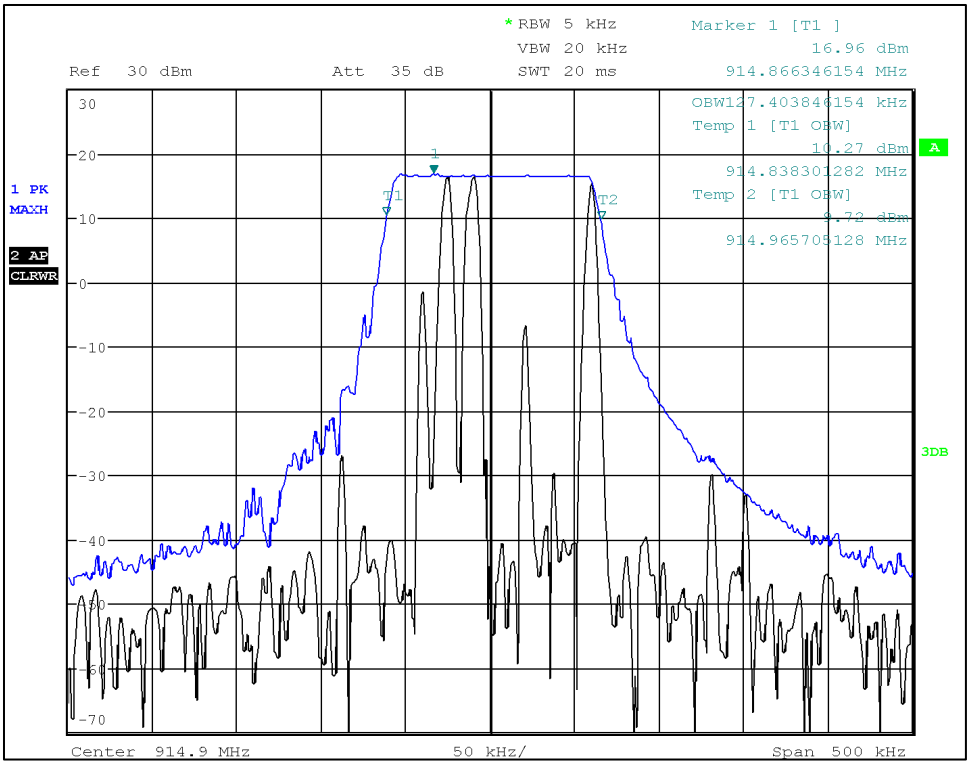




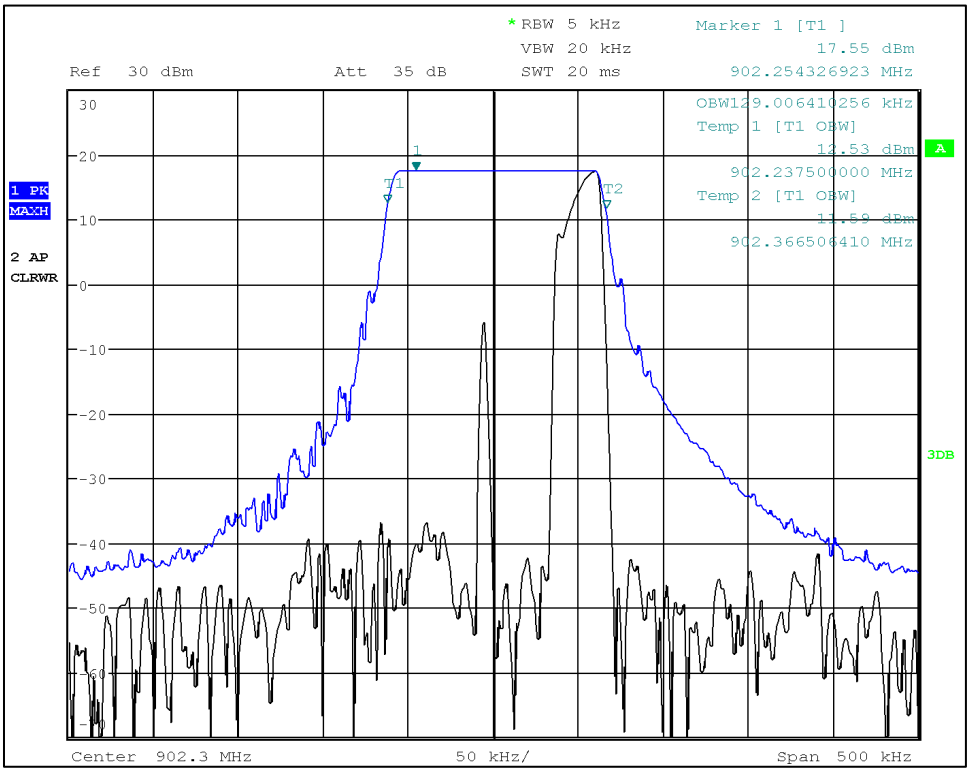
99% Spread Factor 8

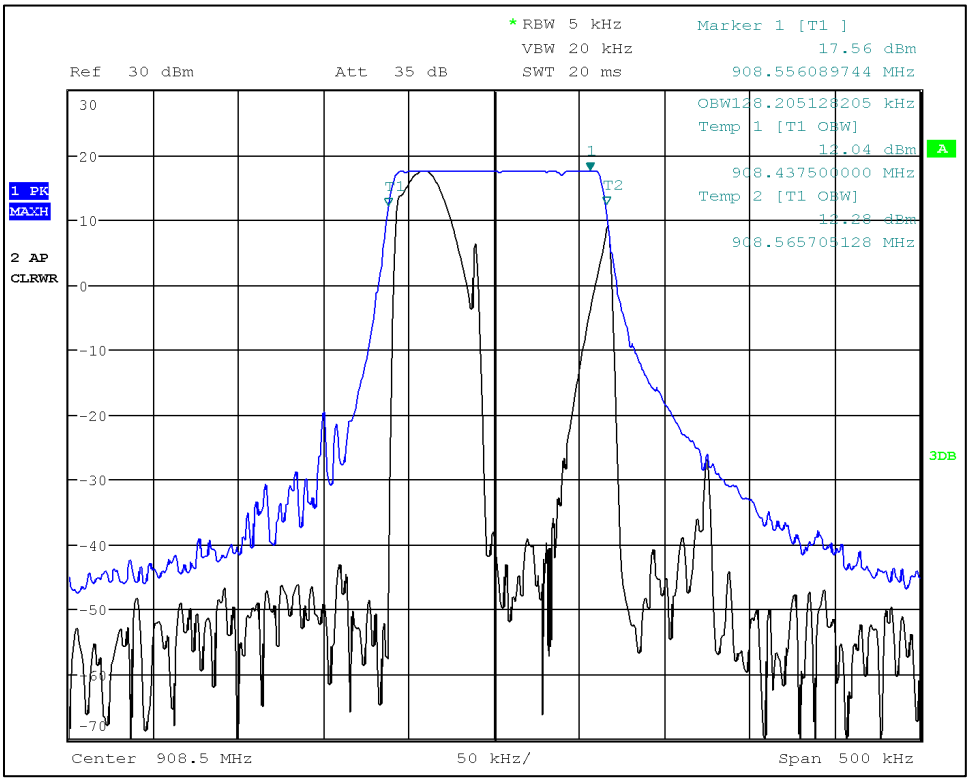


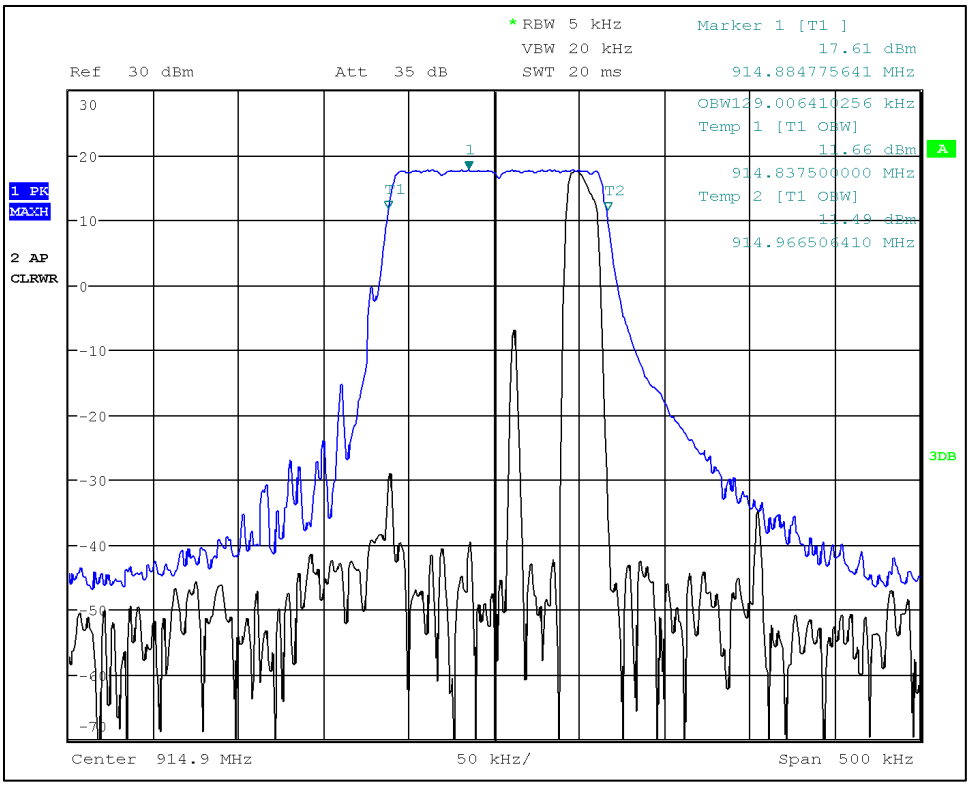

* RBW 5 kHz
VBW 20 kHz
SWT 20 ms
Marker 1 [T1]
16.95 dBm
908.472756410 MHz
Ref 30 dBm
Att 35 dB
OBW127.403846154 kHz
Temp 1 [T1 OBW]
10.20 dBm
908.438301282 MHz
Temp 2 [T1 OBW]
9.10 dBm
908.565705128 MHz
1 PK
MAXH
2 AP
CLRWR
A
3DB
Center 908.5 MHz
50 kHz/
Span 500 kHz


* RBW 5 kHz
VBW 20 kHz
SWT 20 ms
Marker 1 [T1]
16.96 dBm
914.866346154 MHz
Ref 30 dBm
Att 35 dB
OBW127.403846154 kHz
Temp 1 [T1 OBW]
10.27 dBm
914.838301282 MHz
Temp 2 [T1 OBW]
9.72 dBm
914.965705128 MHz
1 PK
MAXH
2 AP
CLRWR
A
3DB
Center 914.9 MHz
50 kHz/
Span 500 kHz

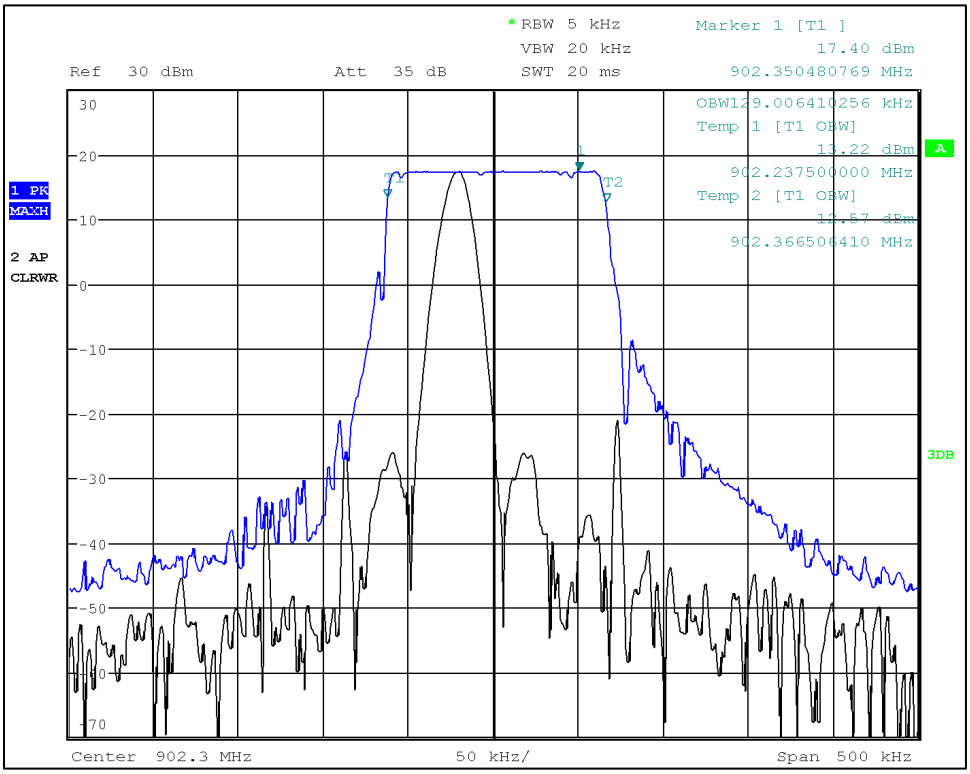
99% Spread Factor 9

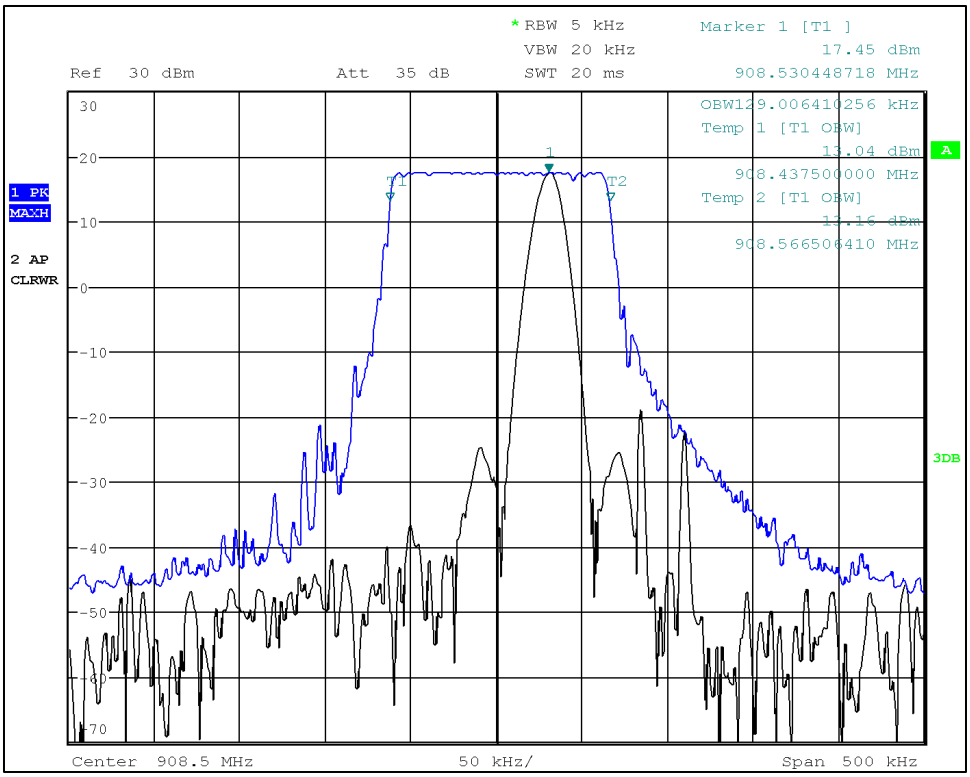


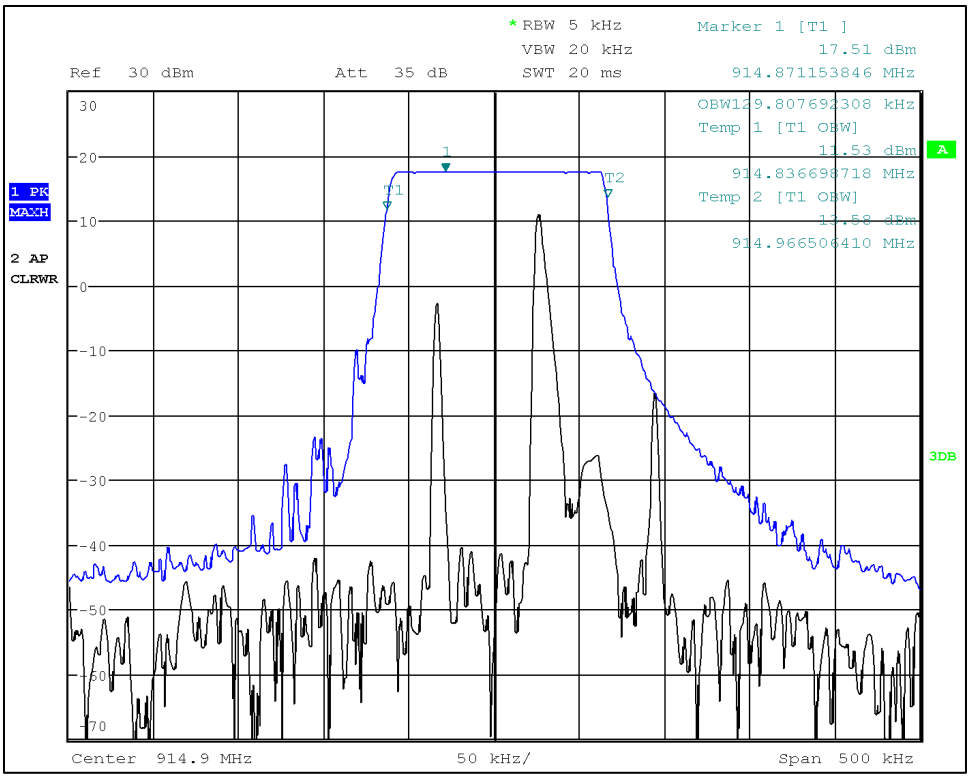




99% Spread Factor 10

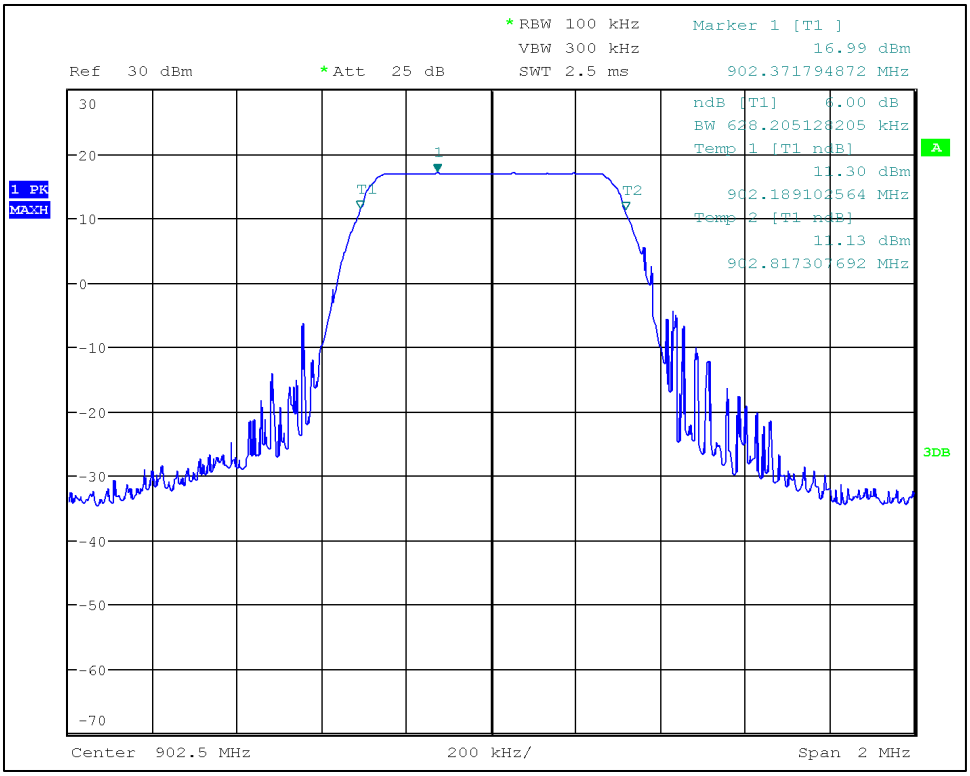


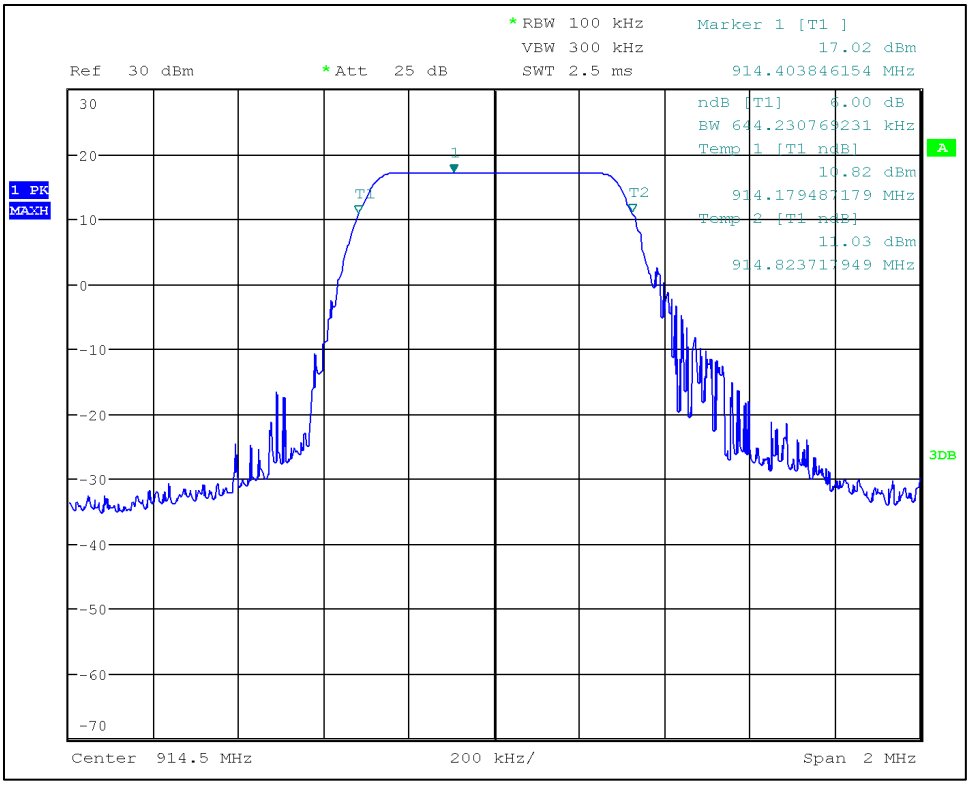

* RBW 5 kHz
VBW 20 kHz
SWT 20 ms
Marker 1 [T1]
17.45 dBm
908.530448718 MHz
Ref 30 dBm
Att 35 dB
OBW129.006410256 kHz
Temp 1 [T1 OBW]
13.04 dBm
908.437500000 MHz
Temp 2 [T1 OBW]
13.16 dBm
908.566506410 MHz
1 PK
MAXH
2 AP
CLRWR
A
3DB
Center 908.5 MHz
50 kHz/
Span 500 kHz

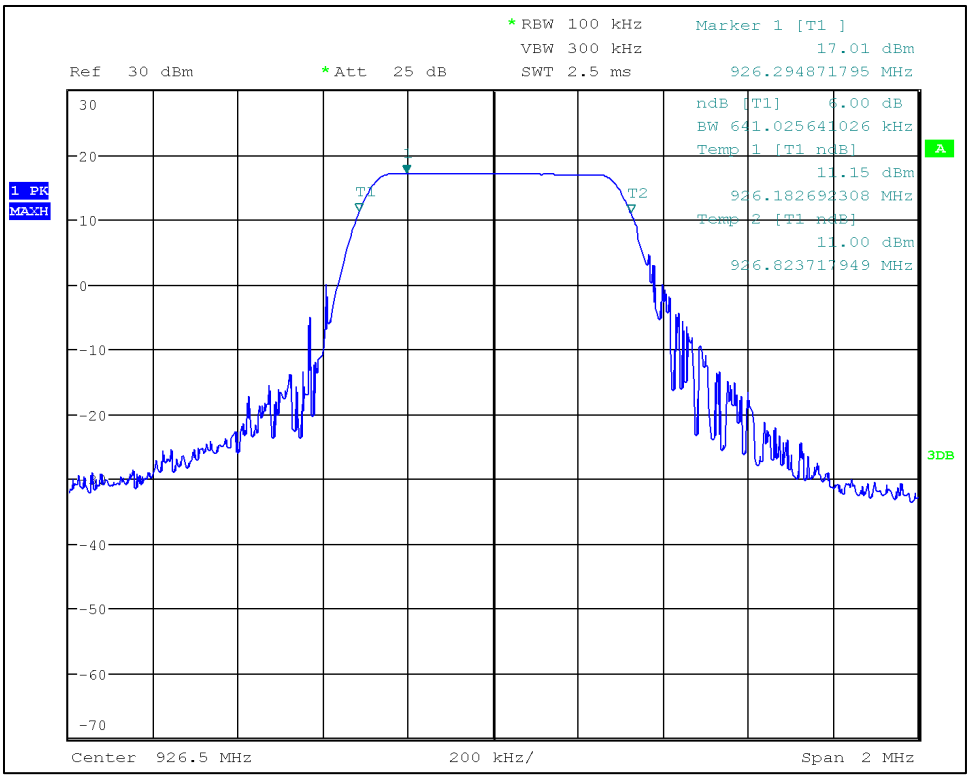

* RBW 5 kHz
VBW 20 kHz
SWT 20 ms
Marker 1 [T1]
17.51 dBm
914.871153846 MHz
Ref 30 dBm
Att 35 dB
OBW129.807692308 kHz
Temp 1 [T1 OBW]
11.53 dBm
914.836698718 MHz
Temp 2 [T1 OBW]
12.58 dBm
914.966506410 MHz
1 PK
MAXH
2 AP
CLRWR
A
3DB
Center 914.9 MHz
50 kHz/
Span 500 kHz

Sidewalk LoRa DTS

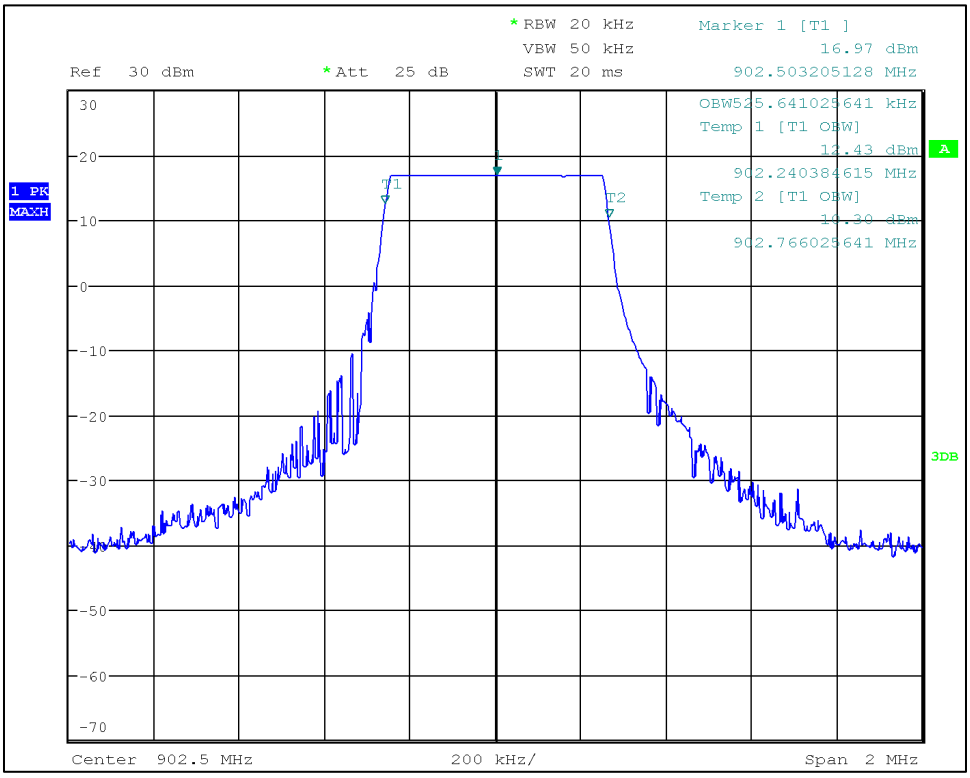
6 dB

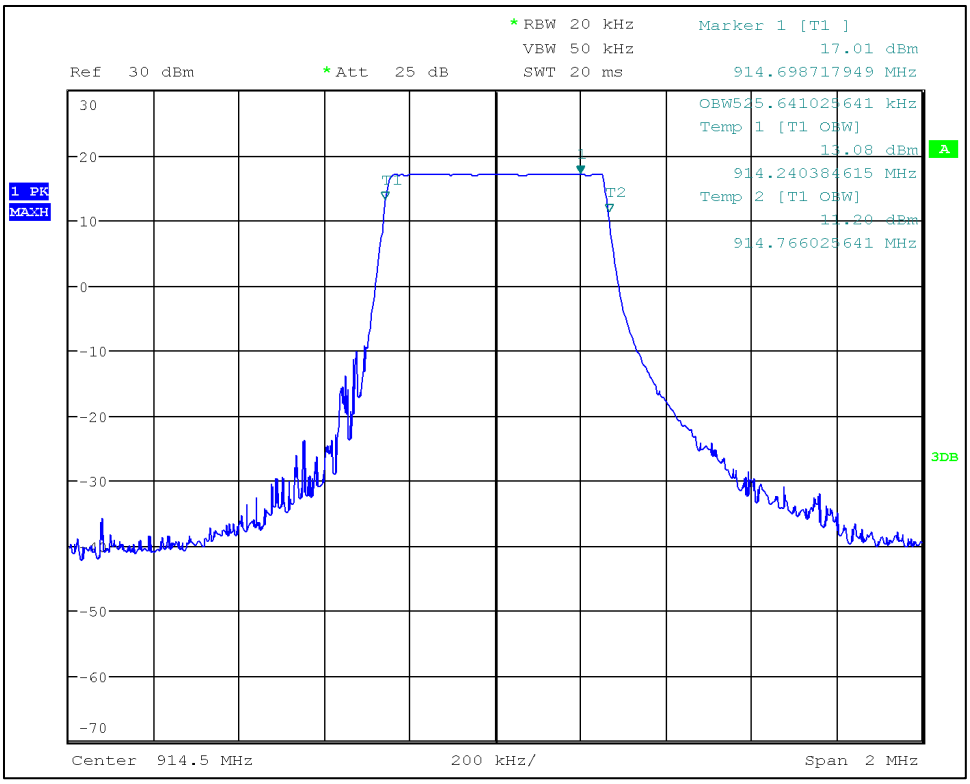


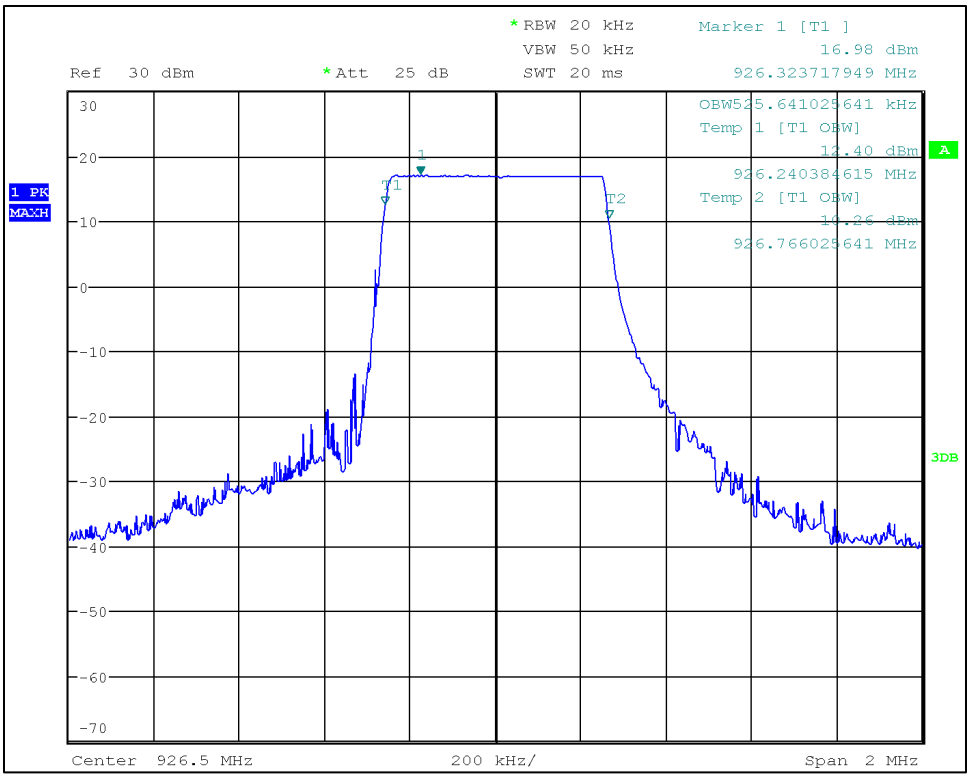



* RBW 100 kHz
VBW 300 kHz
SWT 2.5 ms
Marker 1 [T1]
17.01 dBm
926.294871795 MHz
Ref 30 dBm
* Att 25 dB
ndB [T1] 6.00 dB
BW 641.025641026 kHz
Temp 1 [T1 ndB]
11.15 dBm
926.182692308 MHz
Temp 2 [T1 ndB]
11.00 dBm
926.823717949 MHz
1 PK
MAXH
A
3DB
T1
T2
Center 926.5 MHz
200 kHz/
Span 2 MHz

99%

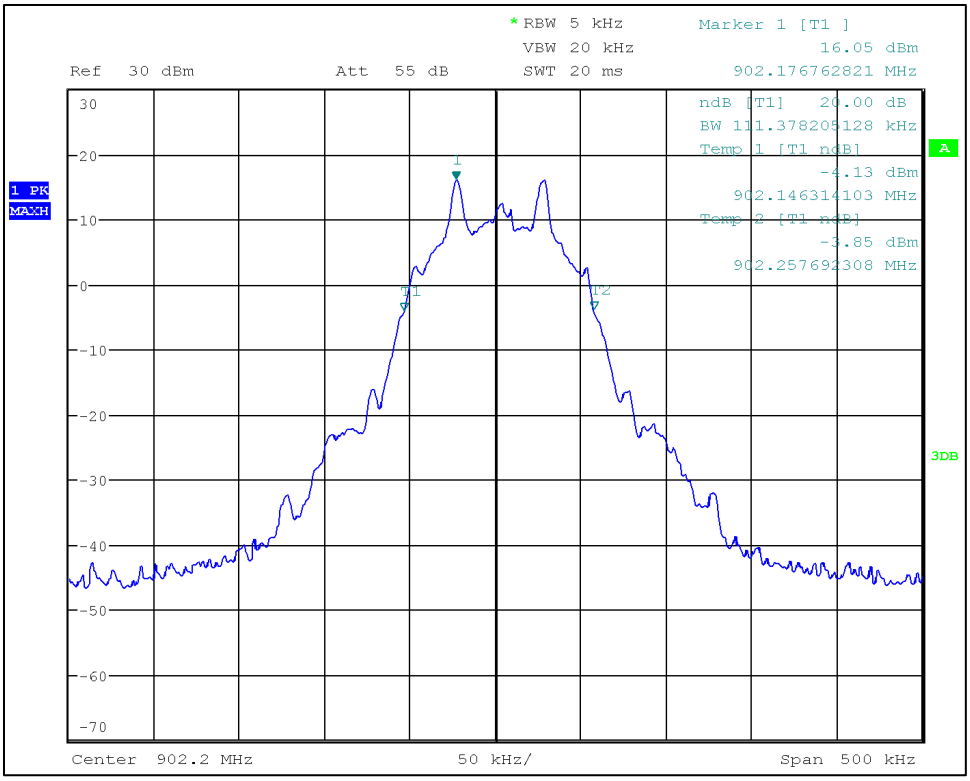

* RBW 20 kHz
VBW 50 kHz
SWT 20 ms
Marker 1 [T1]
16.97 dBm
902.503205128 MHz
Ref 30 dBm
* Att 25 dB
OBW525.641025641 kHz
Temp 1 [T1 OBW]
12.43 dBm
902.240384615 MHz
Temp 2 [T1 OBW]
14.39 dBm
902.766025641 MHz
1 PK
MAXH
A
3DB
T1
T2
Center 902.5 MHz
200 kHz/
Span 2 MHz

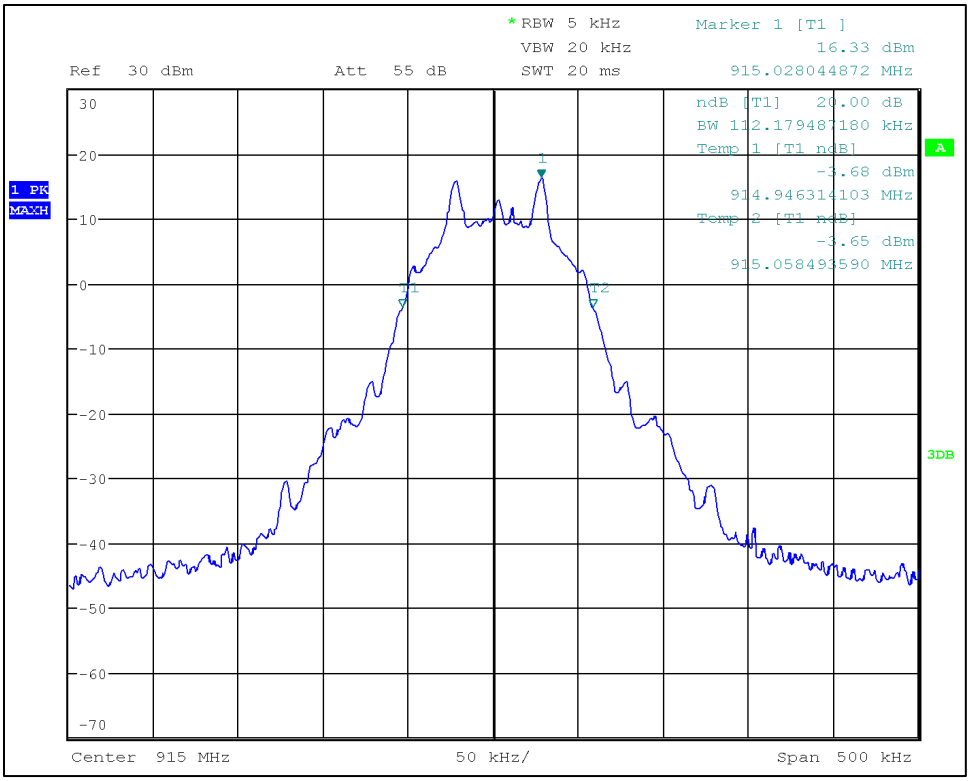

* RBW 20 kHz
VBW 50 kHz
SWT 20 ms
Marker 1 [T1]
17.01 dBm
914.698717949 MHz
Ref 30 dBm
* Att 25 dB
OBW525.641025641 kHz
Temp 1 [T1 OBW]
13.08 dBm
914.240384615 MHz
Temp 2 [T1 OBW]
11.20 dBm
914.766025641 MHz
1 PK
MAXH
A
3DB
Center 914.5 MHz
200 kHz/
Span 2 MHz

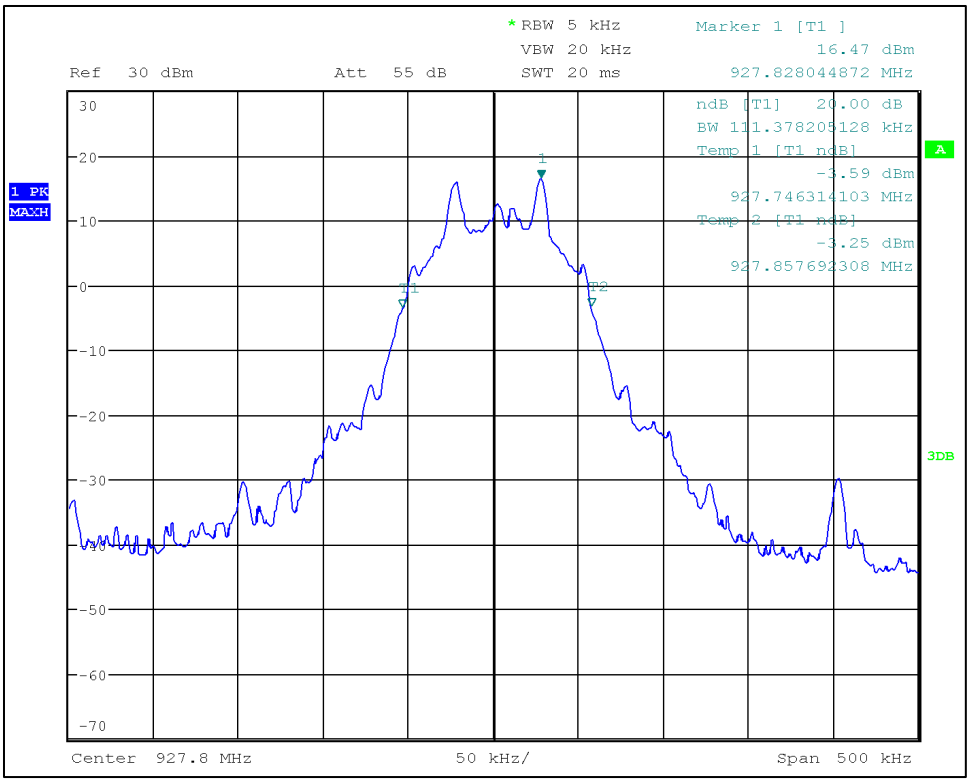

* RBW 20 kHz
VBW 50 kHz
SWT 20 ms
Marker 1 [T1]
16.98 dBm
926.323717949 MHz
Ref 30 dBm
* Att 25 dB
OBW525.641025641 kHz
Temp 1 [T1 OBW]
12.40 dBm
926.240384615 MHz
Temp 2 [T1 OBW]
14.26 dBm
926.766025641 MHz
1 PK
MAXH
A
3DB
Center 926.5 MHz
200 kHz/
Span 2 MHz

Sidewalk LoRa FSK

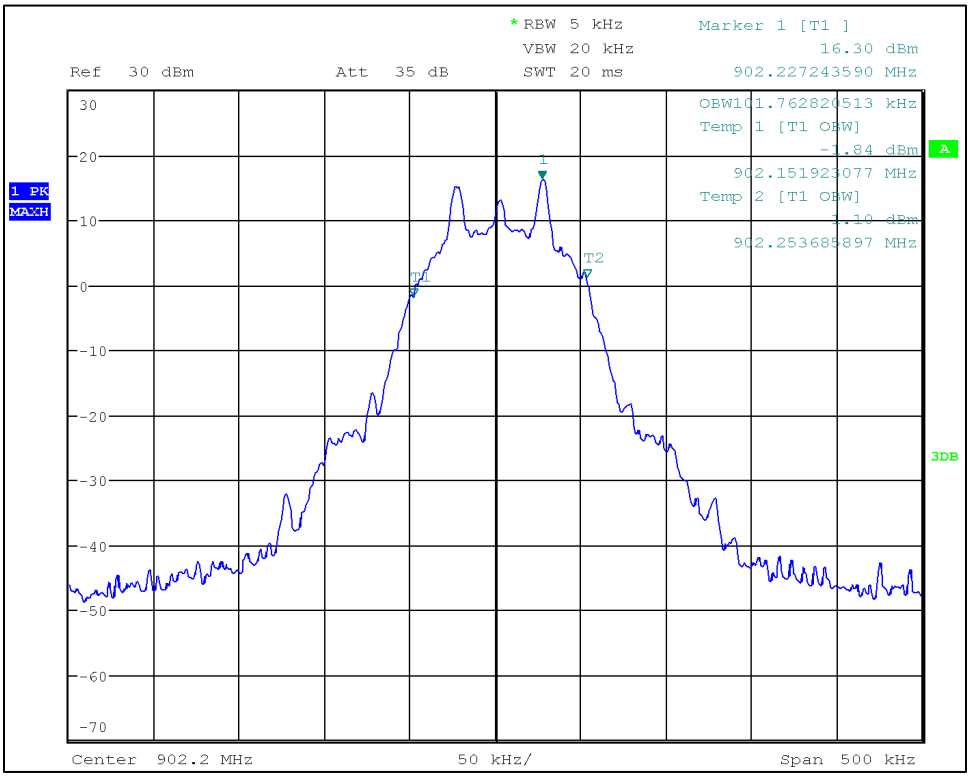
20 dB

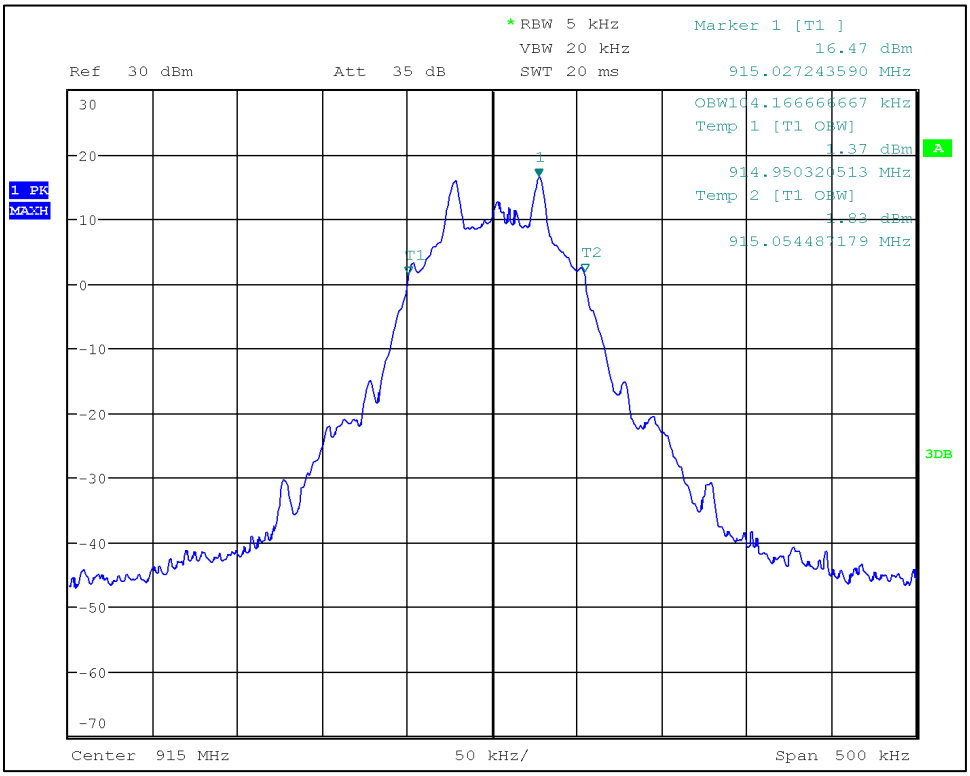


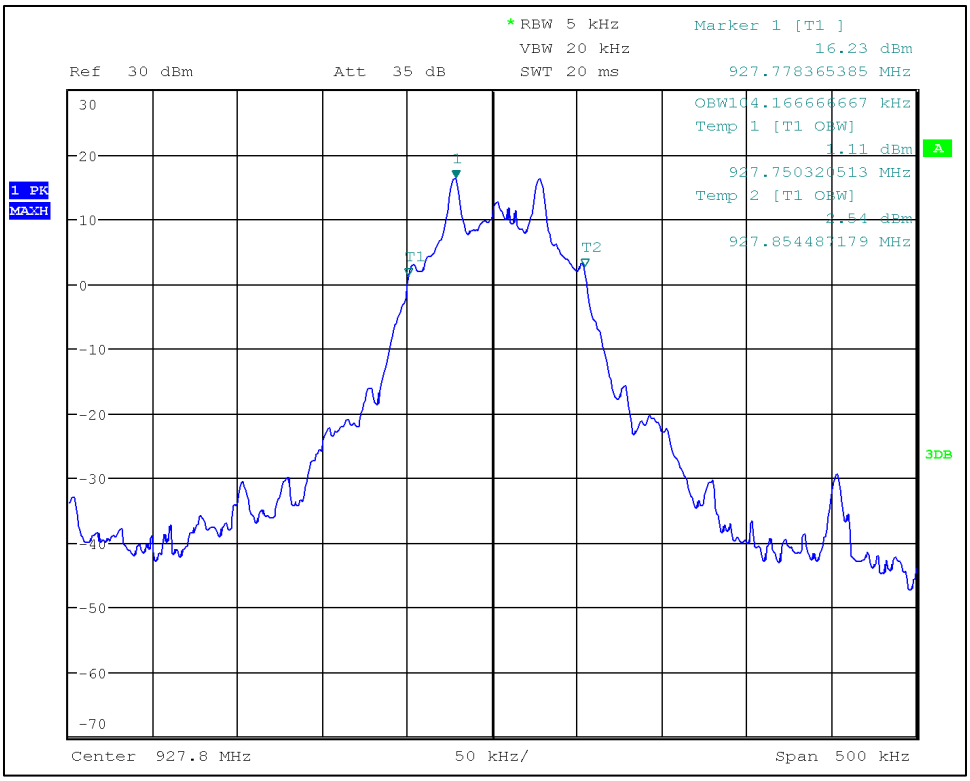



* RBW 5 kHz
VBW 20 kHz
SWT 20 ms
Marker 1 [T1]
16.47 dBm
927.828044872 MHz
Ref 30 dBm
Att 55 dB
ndB [T1] 20.00 dB
BW 111.378205128 kHz
Temp 1 [T1 ndB]
-3.59 dBm
927.746314103 MHz
Temp 2 [T1 ndB]
-3.25 dBm
927.857692308 MHz
1 PK
MAXH
A
3DB
T1
T2
Center 927.8 MHz
50 kHz/
Span 500 kHz

99%


* RBW 5 kHz
VBW 20 kHz
SWT 20 ms
Marker 1 [T1]
16.30 dBm
902.227243590 MHz
Ref 30 dBm
Att 35 dB
OBW1C1.762820513 kHz
Temp 1 [T1 OBW]
-1.84 dBm
902.151923077 MHz
Temp 2 [T1 OBW]
1.10 dBm
902.253685897 MHz
1 PK
MAXH
A
3DB
Center 902.2 MHz
50 kHz/
Span 500 kHz


* RBW 5 kHz
VBW 20 kHz
SWT 20 ms
Marker 1 [T1]
16.47 dBm
915.027243590 MHz
Ref 30 dBm
Att 35 dB
OBW1C4.166666667 kHz
Temp 1 [T1 OBW]
1.37 dBm
914.950320513 MHz
Temp 2 [T1 OBW]
1.83 dBm
915.054487179 MHz
1 PK
MAXH
A
3DB
Center 915 MHz
50 kHz/
Span 500 kHz


* RBW 5 kHz
VBW 20 kHz
SWT 20 ms
Marker 1 [T1]
16.23 dBm
927.778365385 MHz
Ref 30 dBm
Att 35 dB
OBW104.166666667 kHz
Temp 1 [T1 OBW]
1.11 dBm
927.750320513 MHz
Temp 2 [T1 OBW]
2.54 dBm
927.854487179 MHz
1 PK
MAXH
A
3DB
T1
T2
Center 927.8 MHz
50 kHz/
Span 500 kHz

Output Power [DTS & DSS]

Engineer: Alex Macon
Test Date: 11/14/2022

Test Procedure

FHSS
The methods of ANSI C63.10 Clause 7.8.5 were utilized to demonstrate compliance of the DUT. All available data rates were tested and reported. The hopping function was disabled for this test; the DUT was tested while operating on a single channel.

DTS
The methods of ANSI C63.10 Clause 11.9.2.2.2 AVGSA-1 were utilized to measure the average Maximum Conducted Output Power. All DTS modes of operation were operating at > 98% duty cycle.

FHSS Limit

47 CFR 15.247(b)(2) & RSS 247 5.4.a.

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels

DTS Limit

47 CFR 15.247(b)(3) & RSS 247 5.4 d.
For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.

FHSS - The Spectrum Analyzer was set to the following:

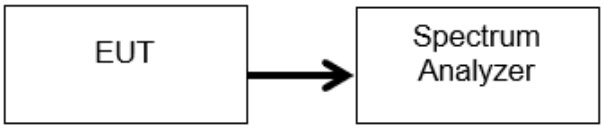
Span	Approximately five times the 20 dB Bandwidth
RBW	> 20 dB BW
VBW	≥ RBW
Sweep	Auto
Detector	Peak
Trace Mode	Max Hold

The RF output power was measured using the spectrum analyzer's marker peak function

DTS – the Spectrum Analyzer was set to the following:

Span	At least 1.5 times the OBW
RBW	100 kHz
VBW	≥ [3 x RBW]
Sweep	Auto
Detector	RMS (power averaging)
Trace Mode	Average
Trace Count	≥ 100
Integration	Via channel power measurement function

Test Setup



Test Data

Tabular Data

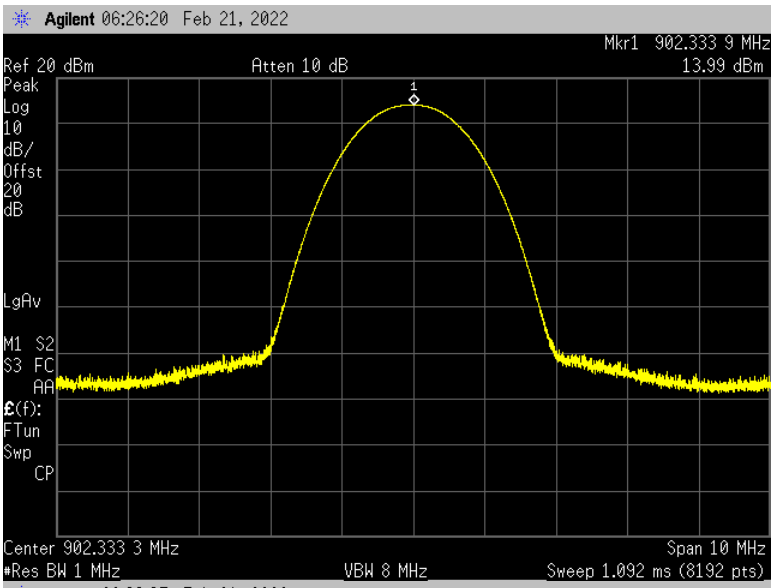
Mode	SF	Frequency	Measured	Limit	Margin	Ant Gain	ERP	Limit	Margin
		MHz	dBm	dBm	dB	dBi	dBm	dBm	dB
LoRa FHSS	7	902.3	13.99	30.00	-16.01	1.50	17.64	36.00	-18.36
LoRa FHSS	7	908.5	13.96	30.00	-16.04	1.50	17.61	36.00	-18.39
LoRa FHSS	7	914.9	13.94	30.00	-16.06	1.50	17.59	36.00	-18.41
LoRa FHSS	8	902.3	13.99	30.00	-16.01	1.50	17.64	36.00	-18.36
LoRa FHSS	8	908.5	13.95	30.00	-16.05	1.50	17.60	36.00	-18.40
LoRa FHSS	8	914.9	13.95	30.00	-16.05	1.50	17.60	36.00	-18.40
LoRa FHSS	9	902.3	13.97	30.00	-16.03	1.50	17.62	36.00	-18.38
LoRa FHSS	9	908.5	13.93	30.00	-16.07	1.50	17.58	36.00	-18.42
LoRa FHSS	9	914.9	13.94	30.00	-16.06	1.50	17.59	36.00	-18.41
LoRa FHSS	10	902.3	13.97	30.00	-16.03	1.50	17.62	36.00	-18.38
LoRa FHSS	10	908.5	13.93	30.00	-16.07	1.50	17.58	36.00	-18.42
LoRa FHSS	10	914.9	13.95	30.00	-16.05	1.50	17.60	36.00	-18.40
Sidewalk FSK	FSK	902.2	14.03	30.00	-15.97	1.50	17.68	36.00	-18.32
Sidewalk FSK	FSK	915	13.99	30.00	-16.01	1.50	17.64	36.00	-18.36
Sidewalk FSK	FSK	927.8	14.04	30.00	-15.96	1.50	17.69	36.00	-18.31

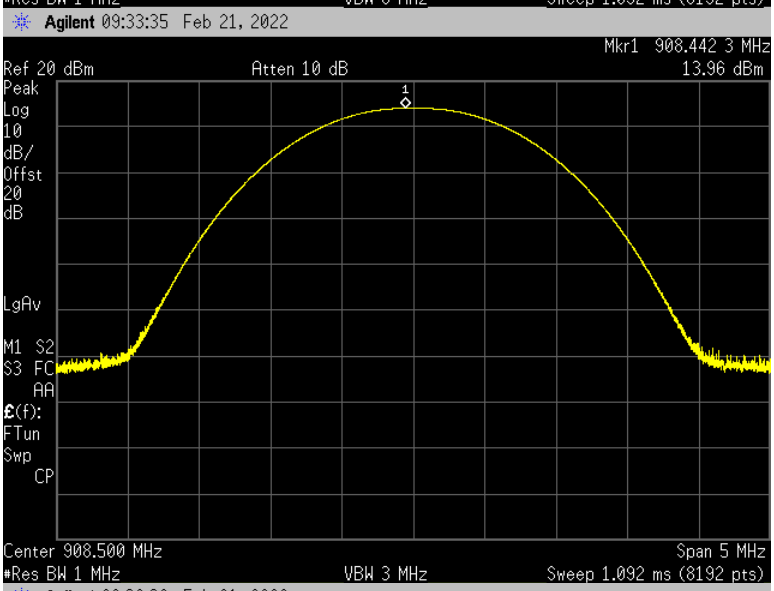
Measured = Raw + Loss
ERP = Measured + Ant Gain + 2.15

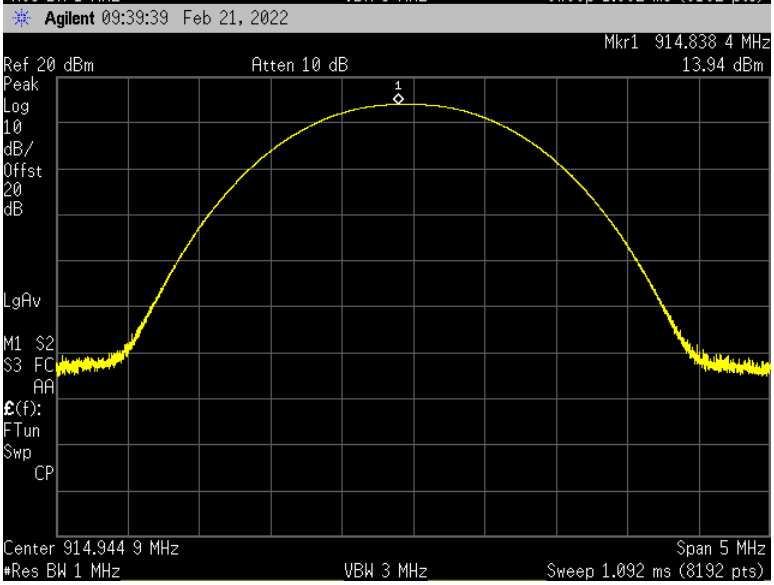
Mode	SF	Frequency	Measured	Limit	Margin	Ant Gain	ERP	Limit	Margin
		MHz	dBm	dBm	dB	dBi	dBm	dBm	dB
LoRa DTS	7	903	14.63	30.00	-15.37	1.50	18.28	36.00	-17.72
LoRa DTS	7	907.8	14.61	30.00	-15.39	1.50	18.26	36.00	-17.74
LoRa DTS	7	914.2	13.61	30.00	-16.39	1.50	17.26	36.00	-18.74
LoRa DTS	8	903	14.78	30.00	-15.22	1.50	18.43	36.00	-17.57
LoRa DTS	8	907.8	14.70	30.00	-15.30	1.50	18.35	36.00	-17.65
LoRa DTS	8	914.2	13.80	30.00	-16.20	1.50	17.45	36.00	-18.55
LoRa DTS	9	903	14.89	30.00	-15.11	1.50	18.54	36.00	-17.46
LoRa DTS	9	907.8	14.78	30.00	-15.22	1.50	18.43	36.00	-17.57
LoRa DTS	9	914.2	13.90	30.00	-16.10	1.50	17.55	36.00	-18.45
LoRa DTS	10	903	15.03	30.00	-14.97	1.50	18.68	36.00	-17.32
LoRa DTS	10	907.8	14.72	30.00	-15.28	1.50	18.37	36.00	-17.63
LoRa DTS	10	914.2	13.78	30.00	-16.22	1.50	17.43	36.00	-18.57
LoRa DTS	11	903	15.41	30.00	-14.59	1.50	19.06	36.00	-16.94
LoRa DTS	11	907.8	14.57	30.00	-15.43	1.50	18.22	36.00	-17.78
LoRa DTS	11	914.2	13.79	30.00	-16.21	1.50	17.44	36.00	-18.56
LoRa DTS	12	903	14.96	30.00	-15.04	1.50	18.61	36.00	-17.39
LoRa DTS	12	907.8	15.24	30.00	-14.76	1.50	18.89	36.00	-17.11
LoRa DTS	12	914.2	13.91	30.00	-16.09	1.50	17.56	36.00	-18.44
Sidewalk LoRa DTS	11	902.5	14.04	30.00	-15.96	1.50	17.69	36.00	-18.31
Sidewalk LoRa DTS	11	914.5	13.41	30.00	-16.59	1.50	17.06	36.00	-18.94
Sidewalk LoRa DTS	11	926.5	14.49	30.00	-15.51	1.50	18.14	36.00	-17.86

FHSS Plots (Peak) Examples

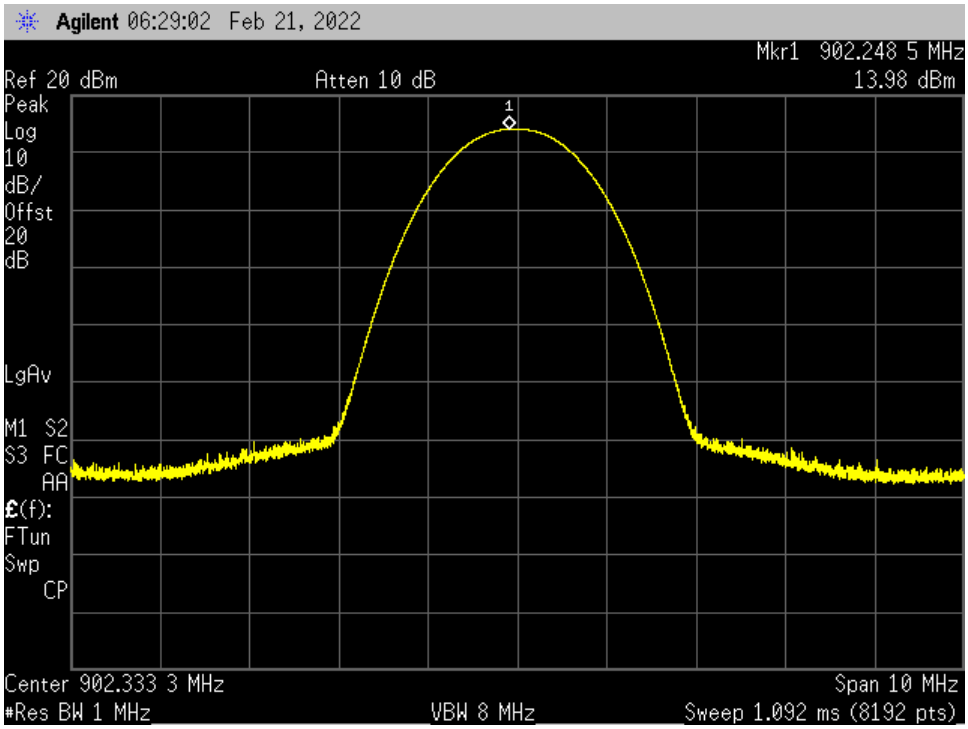
LoRa FHSS Spread Factor 7

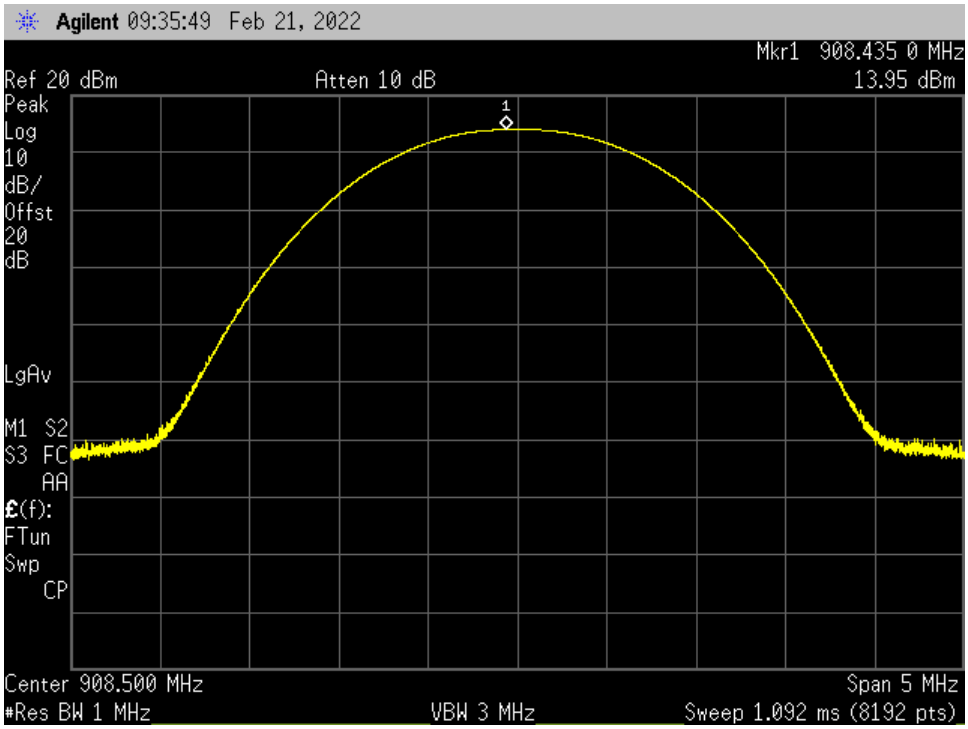


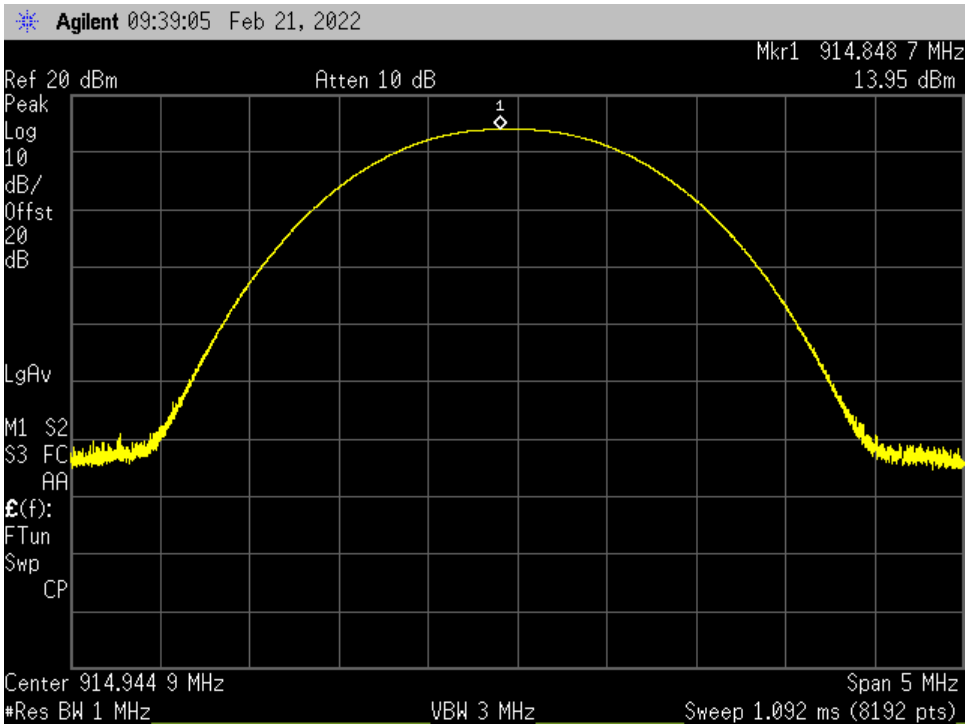




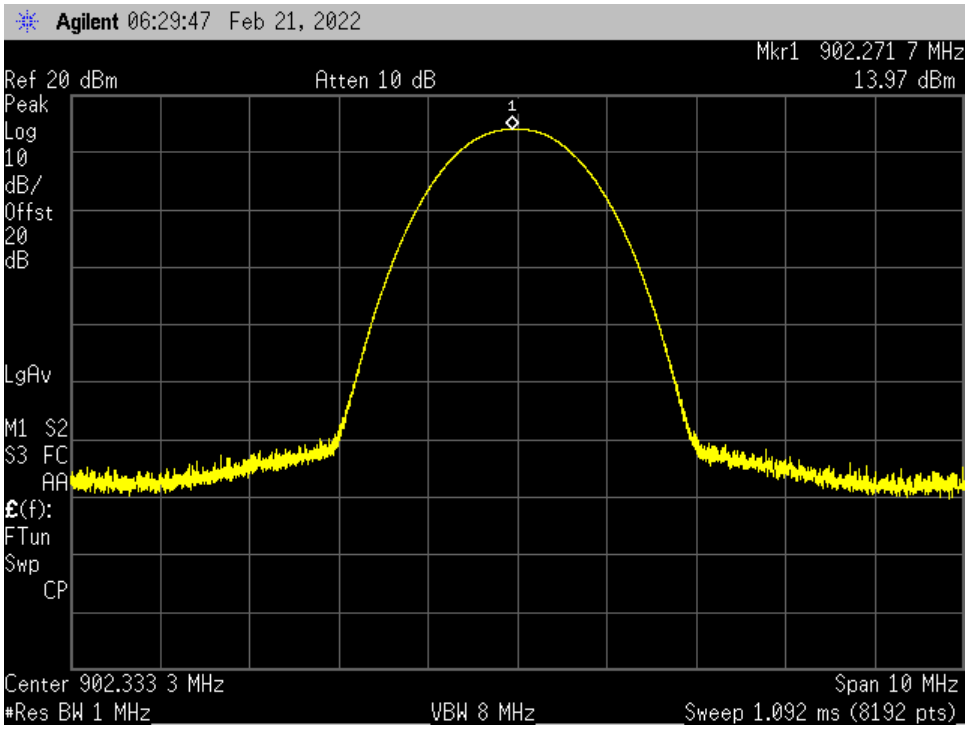
LoRa FHSS Spread Factor 8

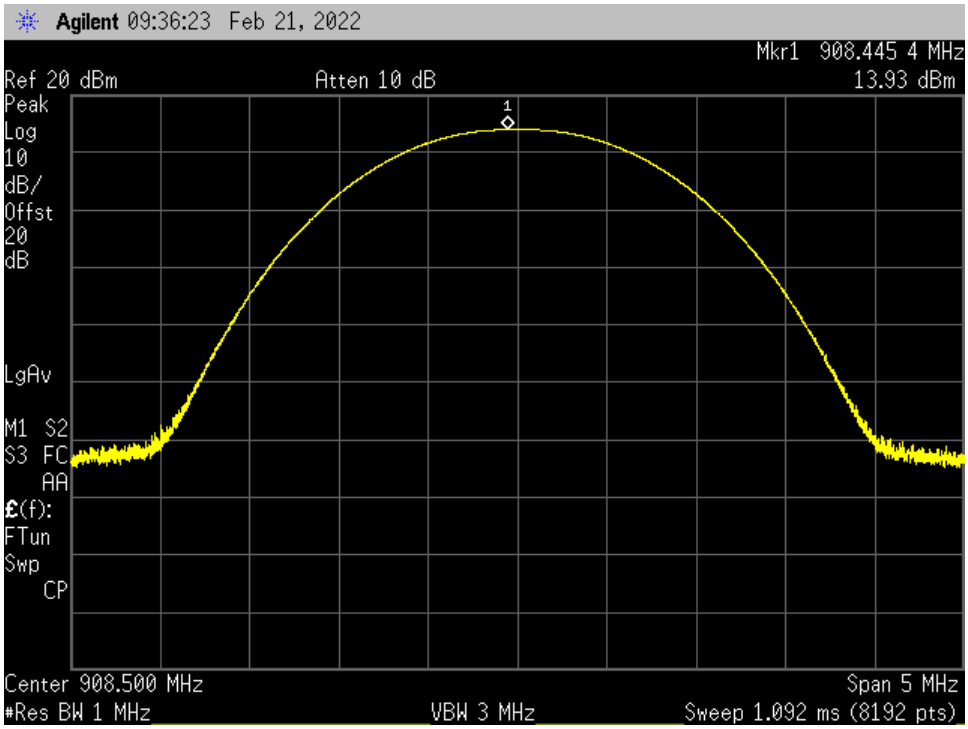


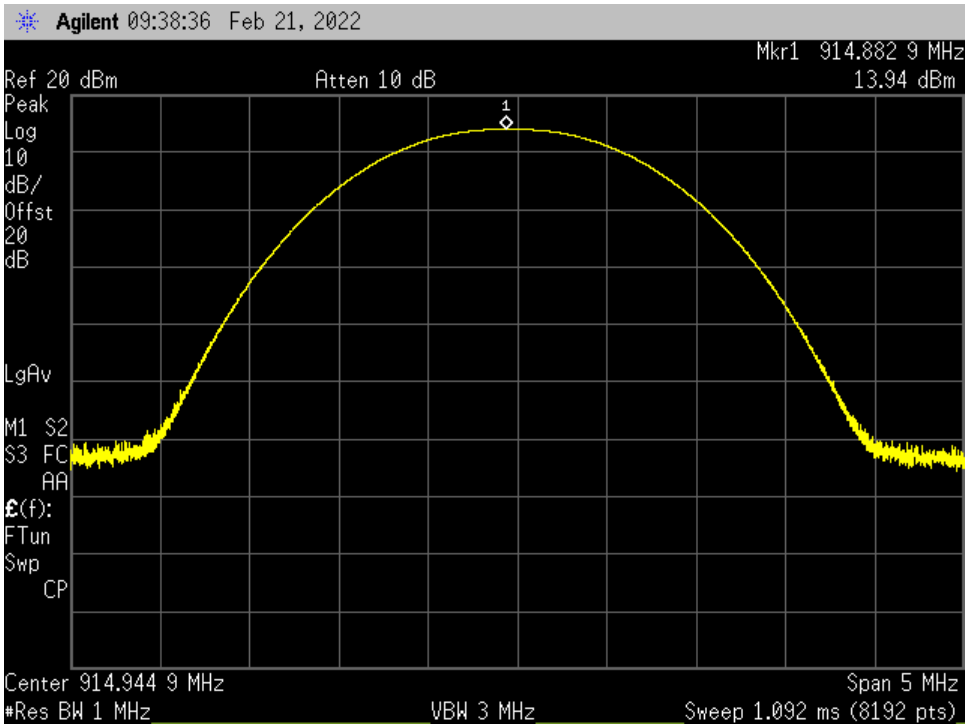



Agilent 09:39:05 Feb 21, 2022
Mkr1 914.848 7 MHz
Ref 20 dBm
Atten 10 dB
13.95 dBm
Peak
Log
10
dB/
Offst
20
dB
LgAv
M1 S2
S3 FC
AA
£(f):
FTun
Swp
CP
Center 914.944 9 MHz
Span 5 MHz
#Res BW 1 MHz
VBW 3 MHz
Sweep 1.092 ms (8192 pts)

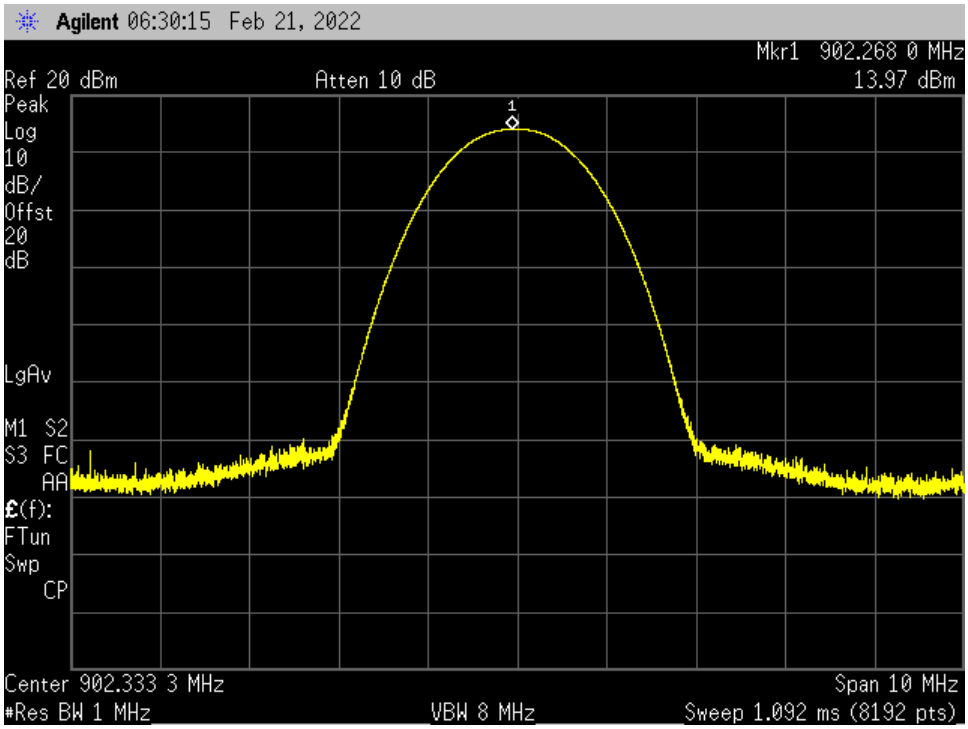
LoRa FHSS Spread Factor 9

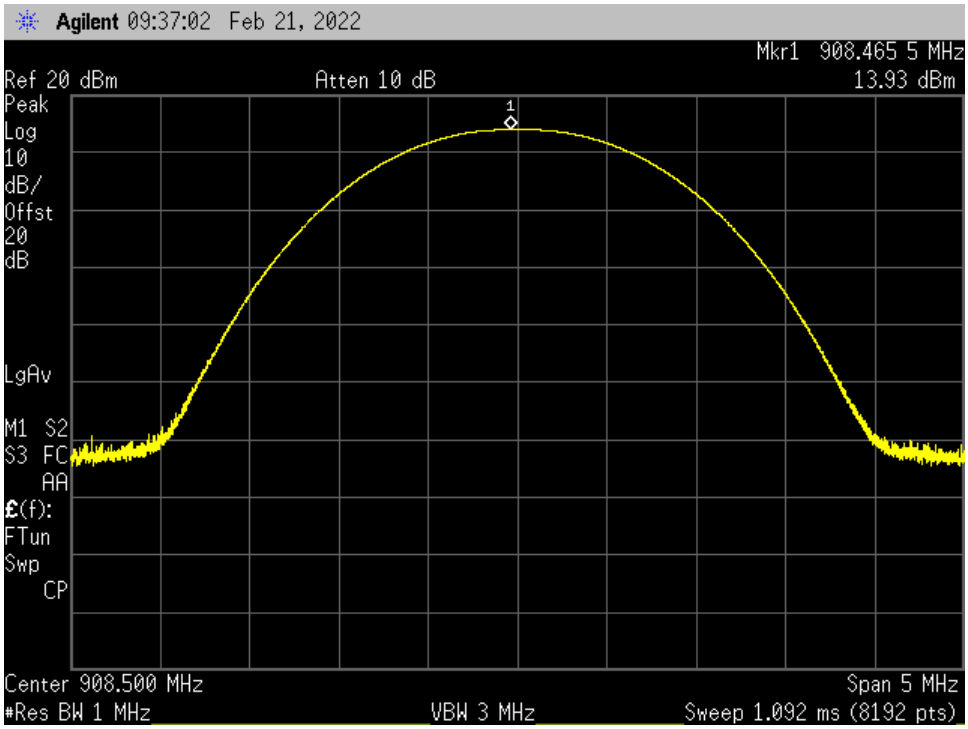


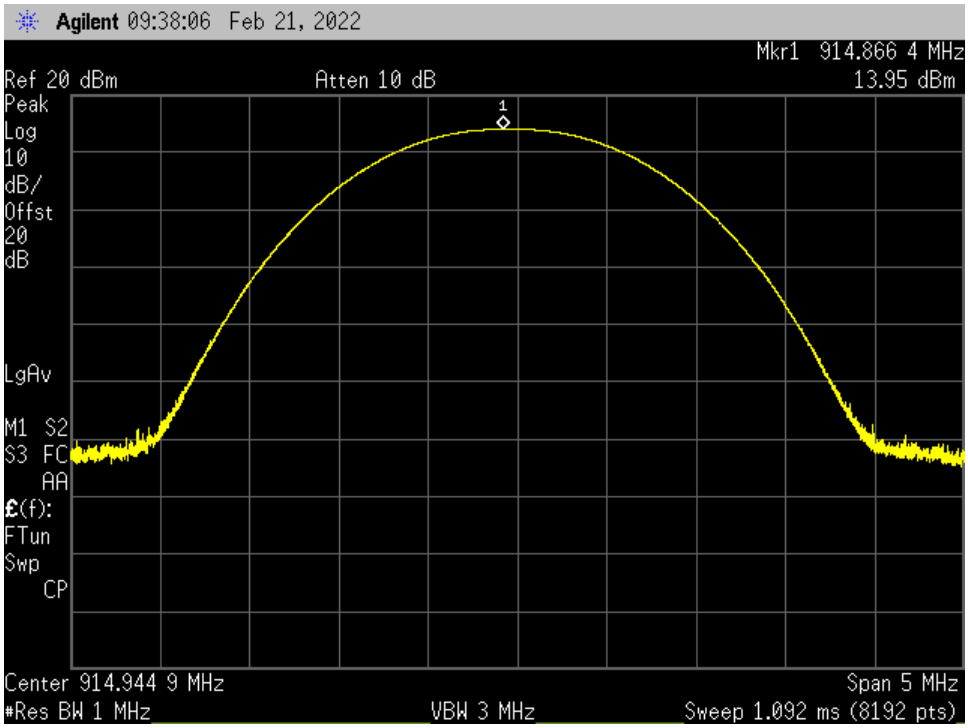



Agilent 09:38:36 Feb 21, 2022
Mkr1 914.882 9 MHz
Ref 20 dBm
Atten 10 dB
13.94 dBm
Peak
Log
10
dB/
Offst
20
dB
LgAv
M1 S2
S3 FC
AA
£(f):
FTun
Swp
CP
Center 914.944 9 MHz
Span 5 MHz
#Res BW 1 MHz
VBW 3 MHz
Sweep 1.092 ms (8192 pts)

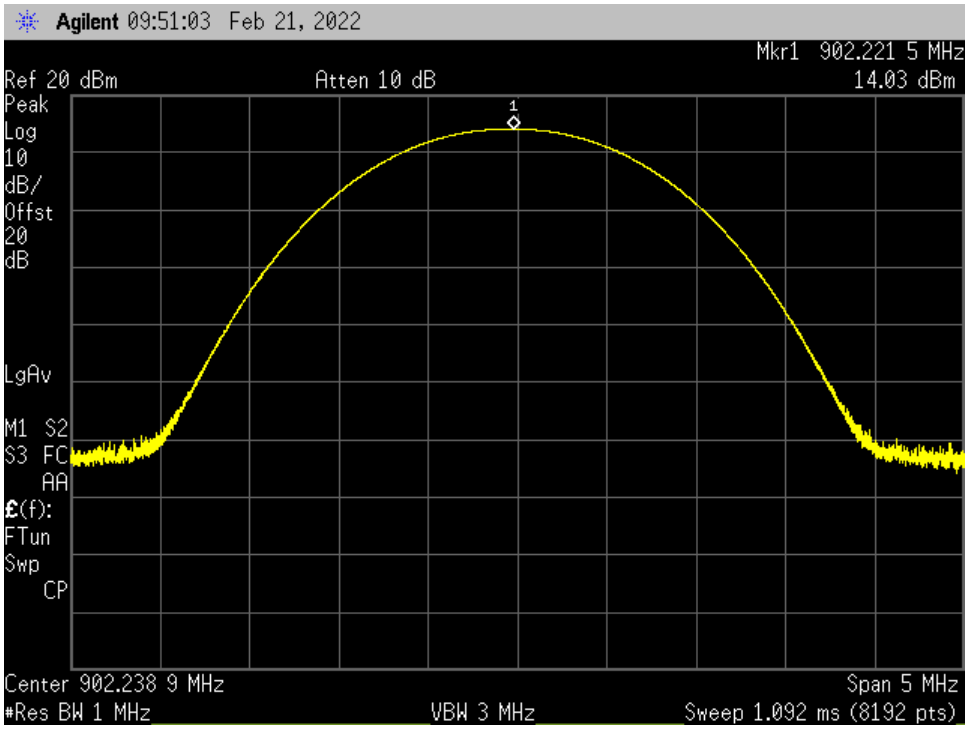
LoRa FHSS Spread Factor 10

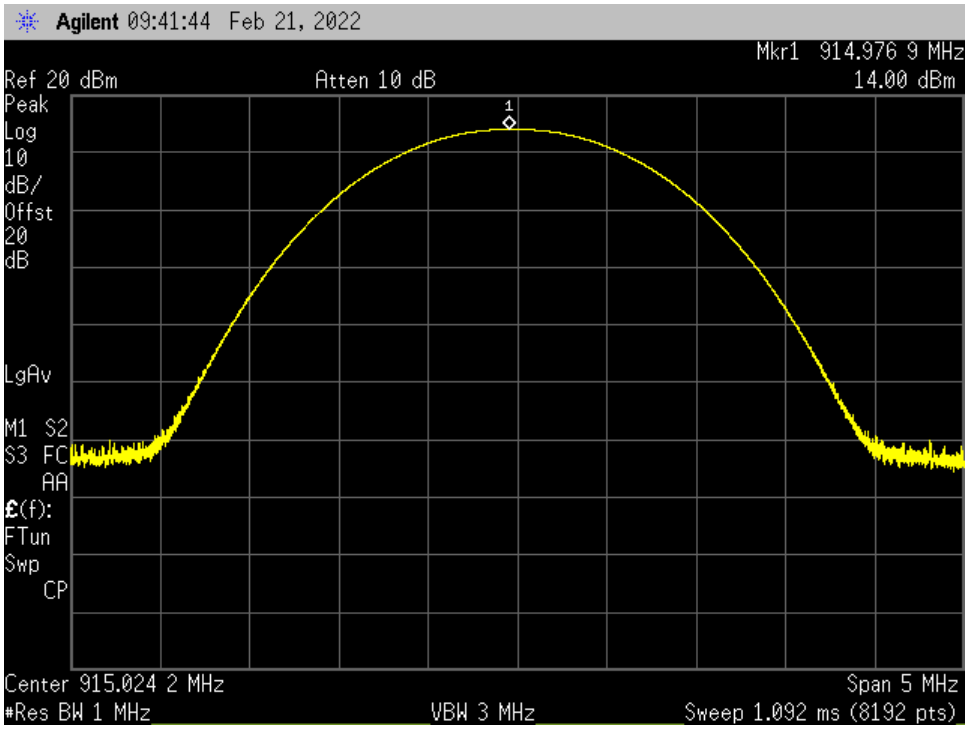


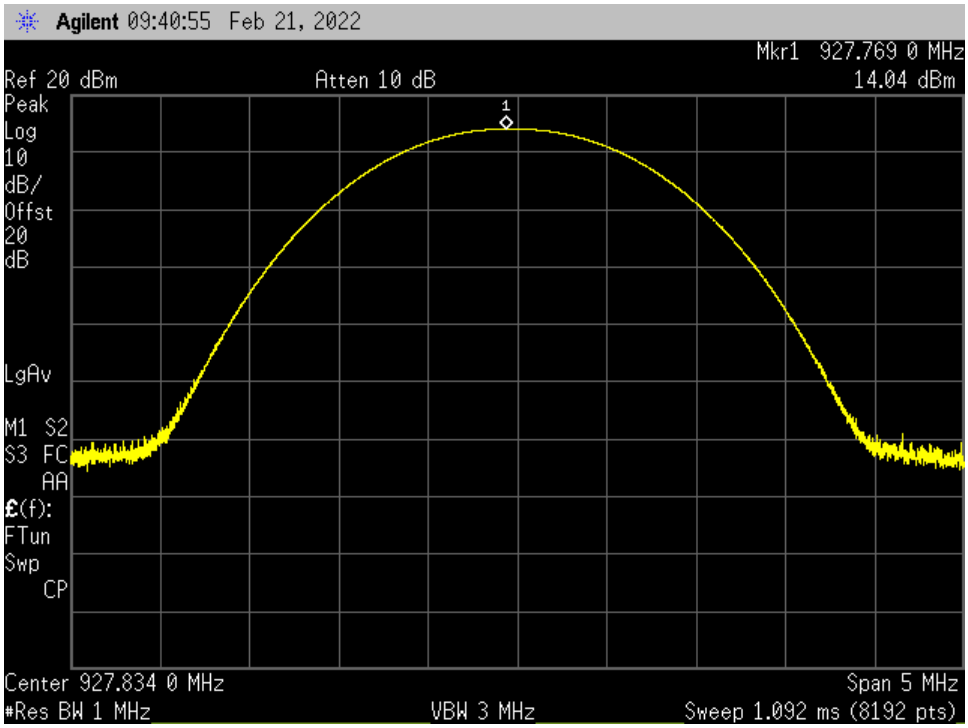



Agilent 09:38:06 Feb 21, 2022
Mkr1 914.866 4 MHz
Ref 20 dBm
Atten 10 dB
13.95 dBm
Peak
Log
10
dB/
Offst
20
dB
LgAv
M1 S2
S3 FC
AA
£(f):
FTun
Swp
CP
Center 914.944 9 MHz
Span 5 MHz
#Res BW 1 MHz
VBW 3 MHz
Sweep 1.092 ms (8192 pts)

Sidewalk FSK

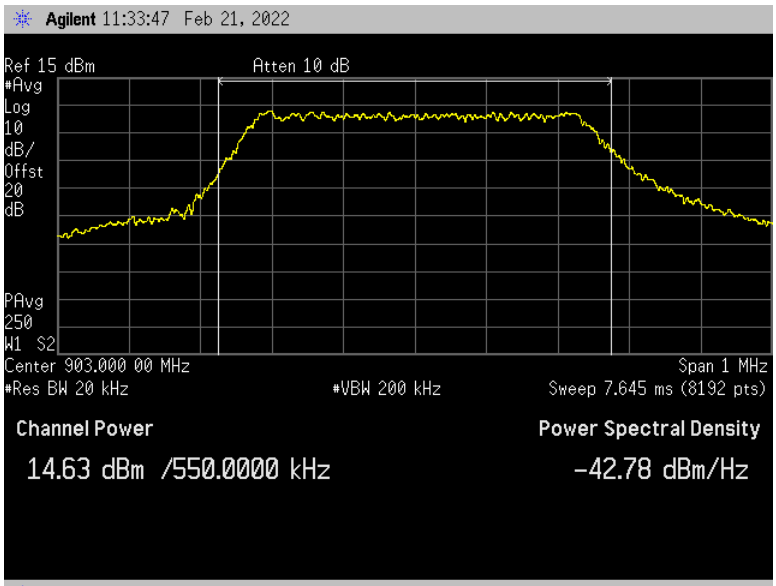


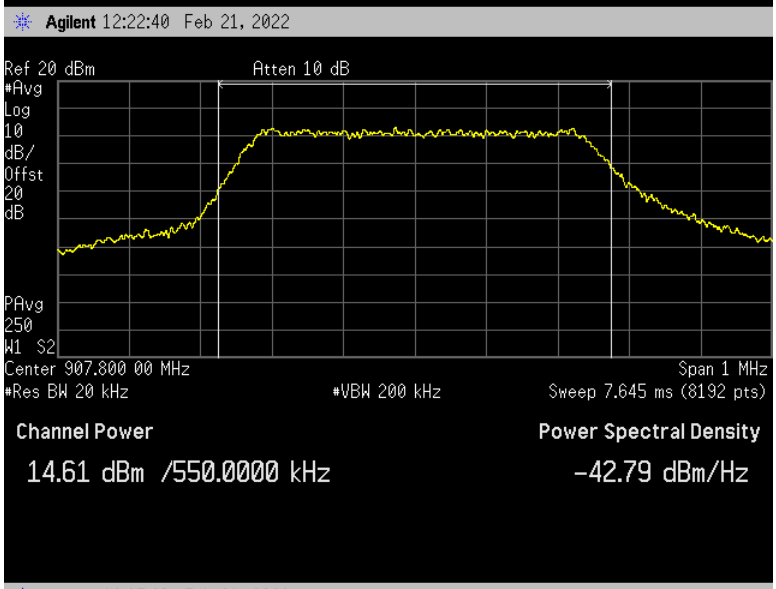


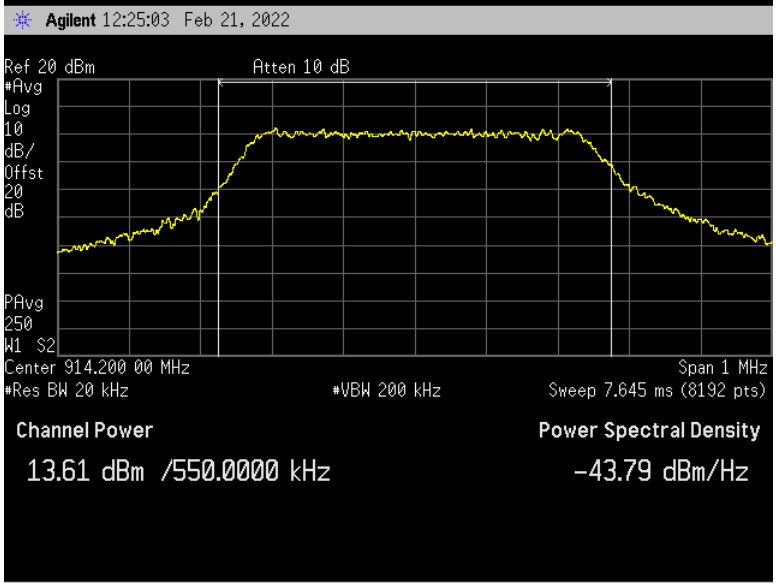

Agilent 09:40:55 Feb 21, 2022
Mkr1 927.769 0 MHz
Ref 20 dBm
Atten 10 dB
14.04 dBm
Peak
Log
10
dB/
Offst
20
dB
LgAv
M1 S2
S3 FC
AA
£(f):
FTun
Swp
CP
Center 927.834 0 MHz
Span 5 MHz
#Res BW 1 MHz
VBW 3 MHz
Sweep 1.092 ms (8192 pts)

DTS Plots (Average) Examples

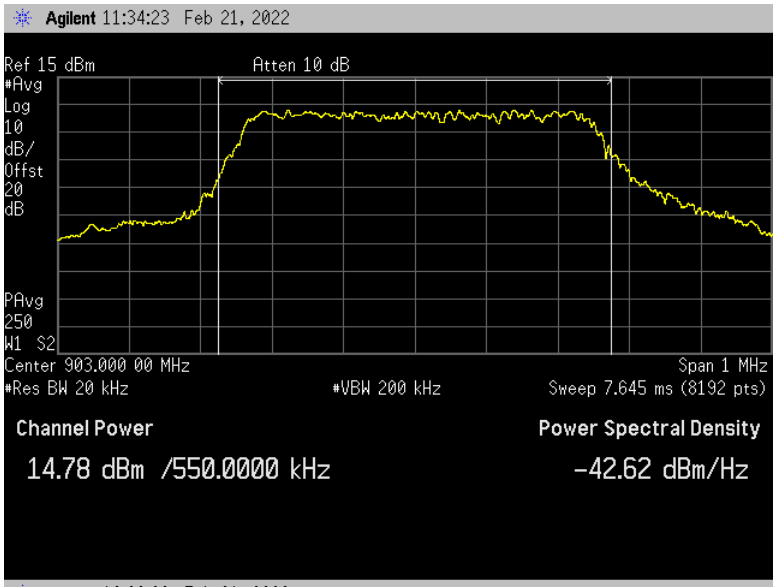
LoRa DTS Spread Factor 7

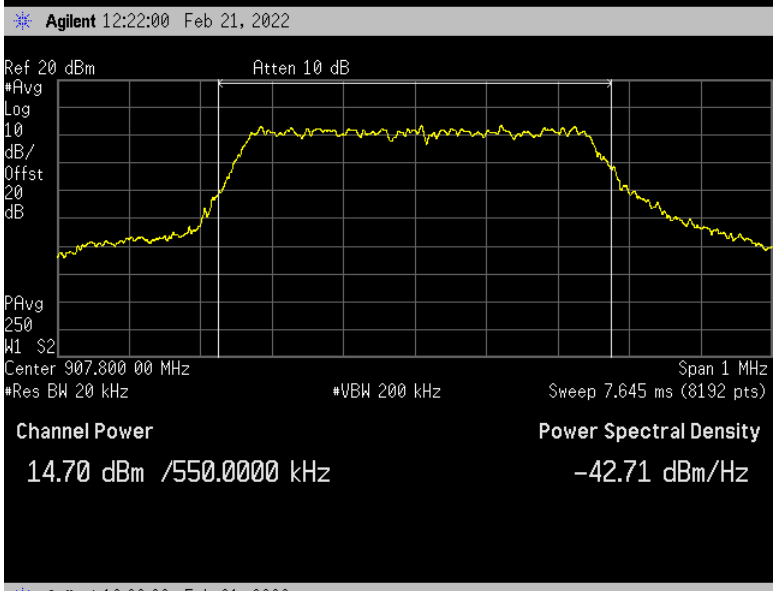


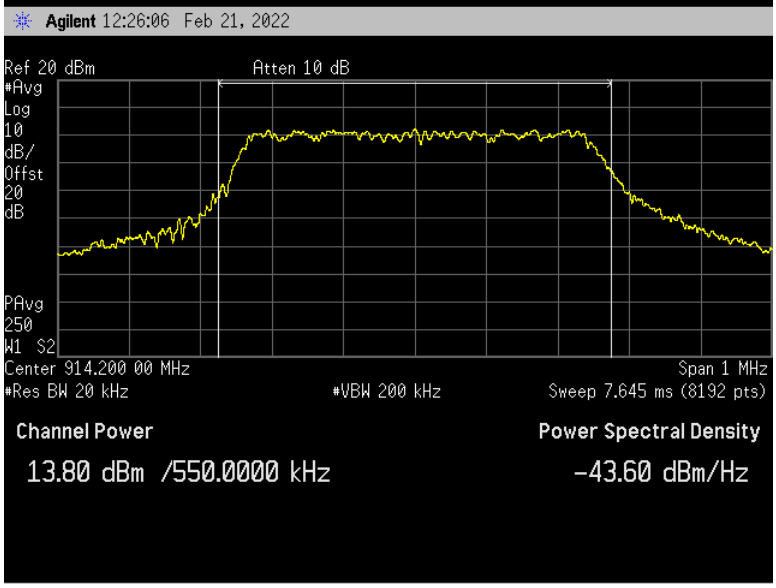




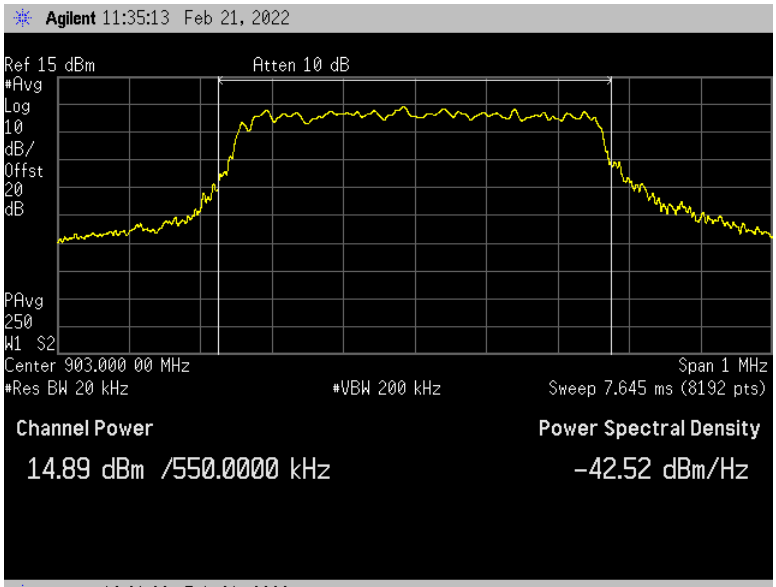
LoRa DTS Spread Factor 8

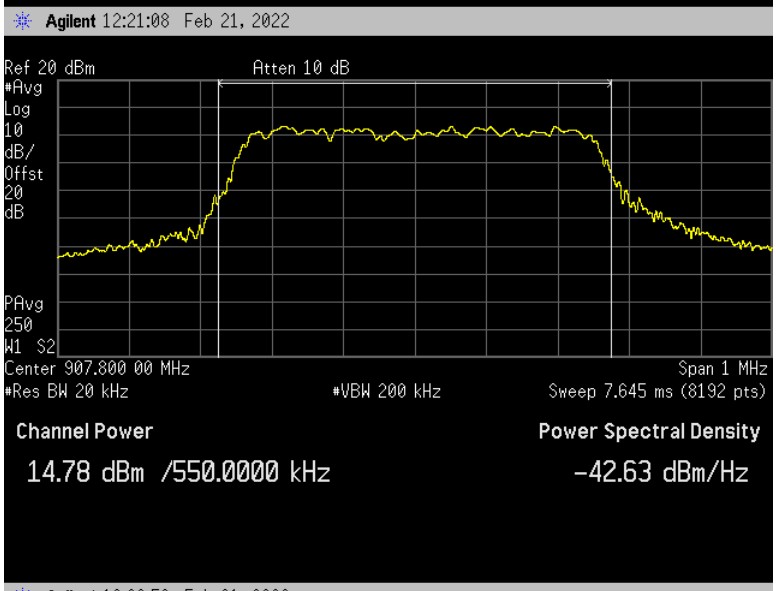


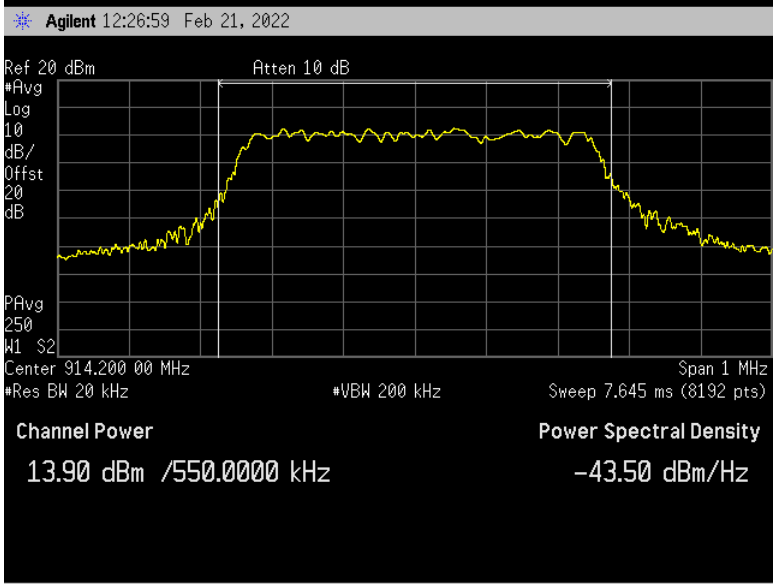




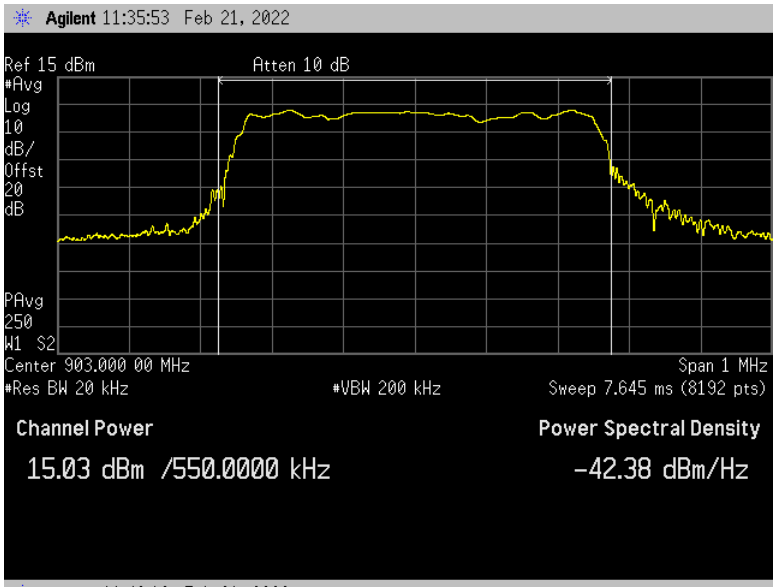
LoRa DTS Spread Factor 9

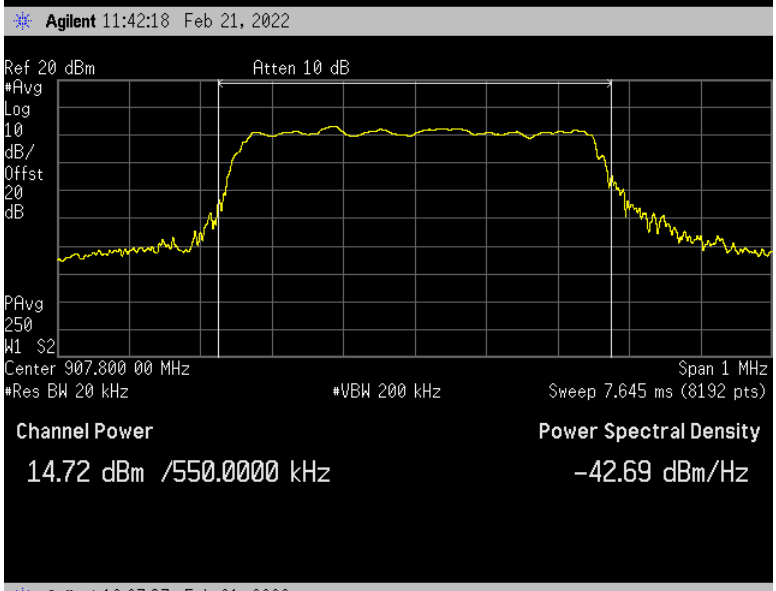


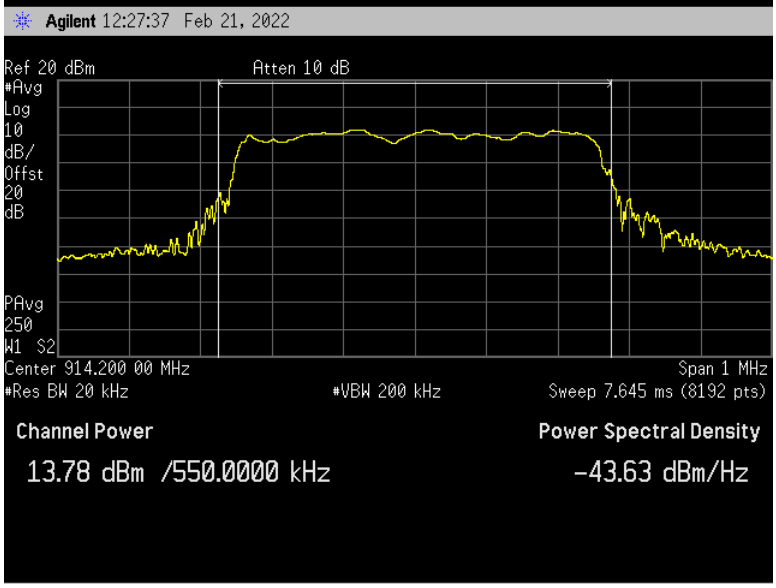




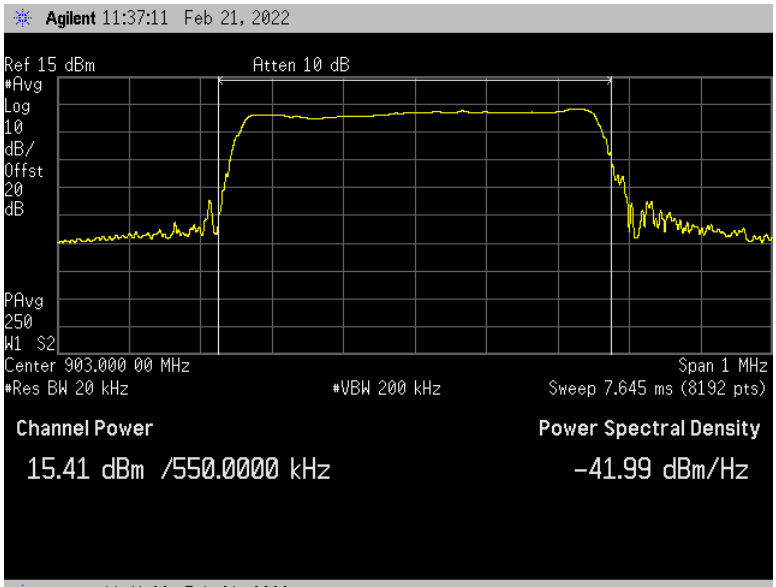
LoRa DTS Spread Factor 10

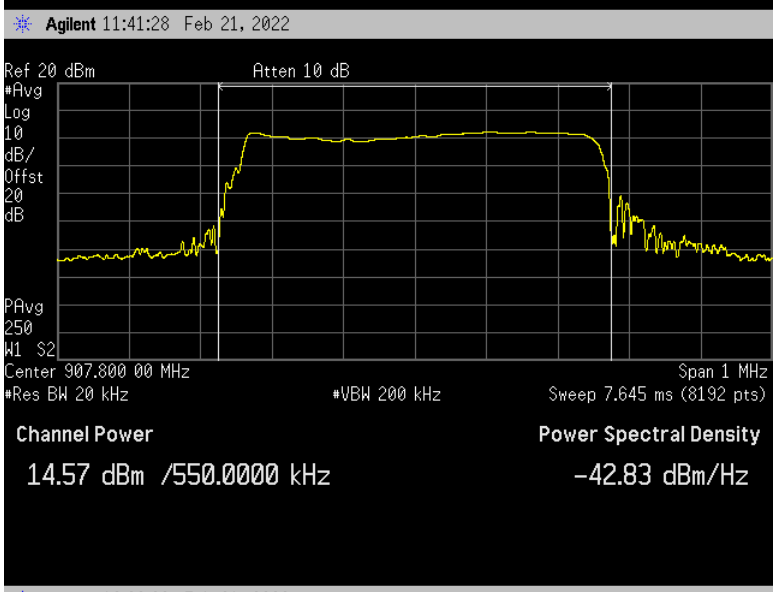


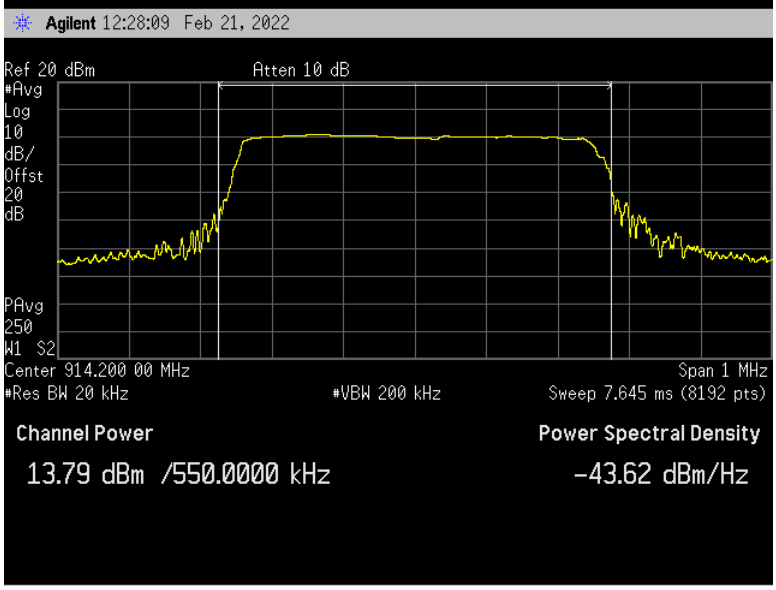




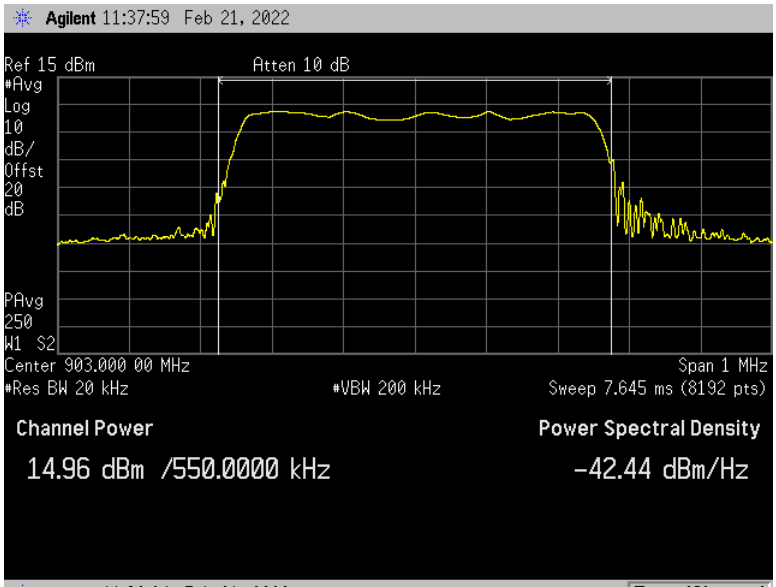
LoRa DTS Spread Factor 11

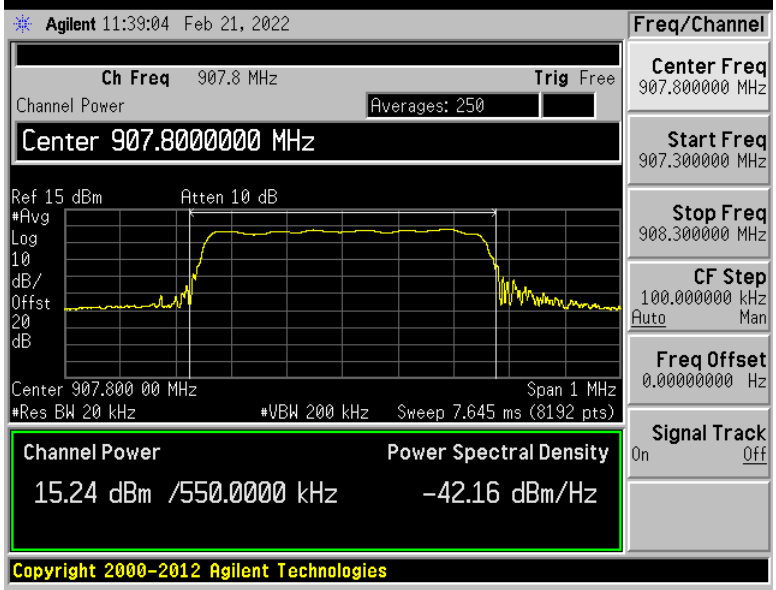


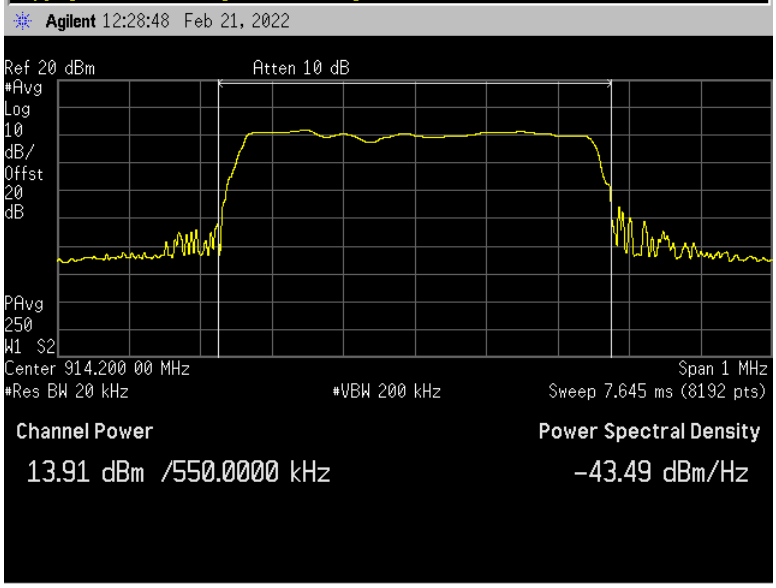




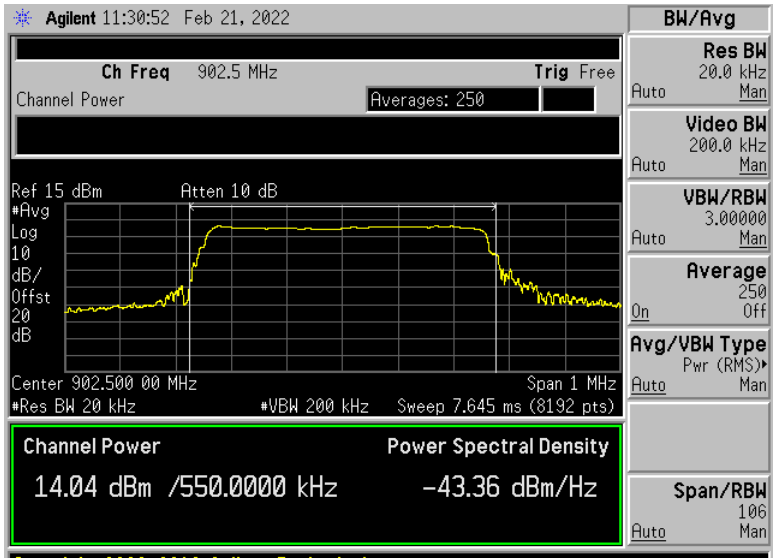
LoRa DTS Spread Factor 12

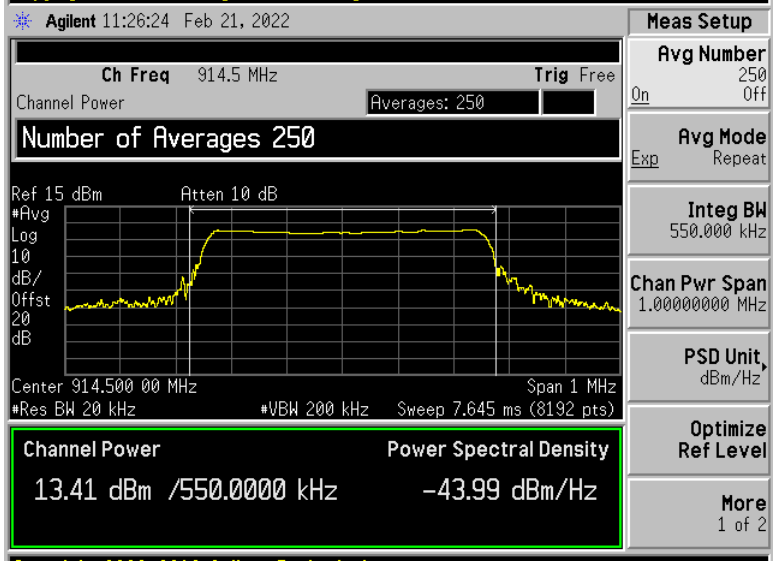


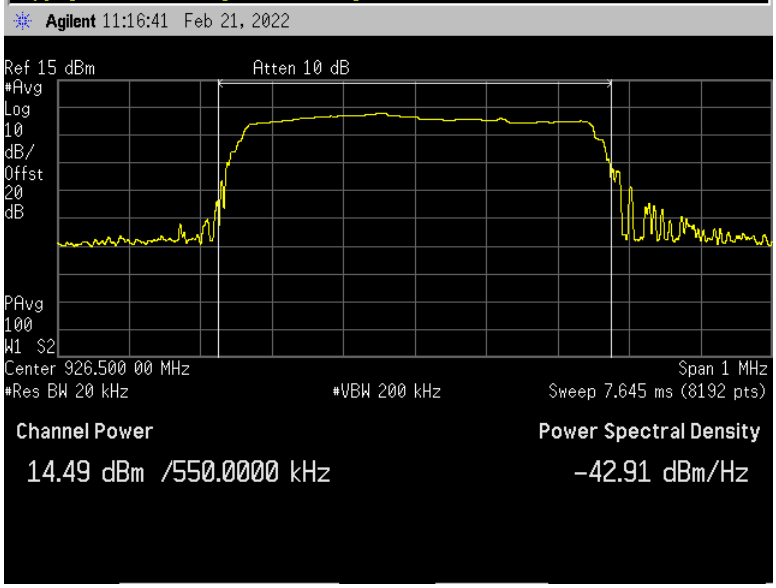




Sidewalk LoRa DTS







Power Spectral Density [DTS]

Engineer: Alex Macon
Test Date: 11/14/2022

Test Procedure

The test methods and settings of ANSI C63.10 Clause 11.10.3 AVGPSD-1 were used to demonstrate compliance matching the Averaging method used to demonstrate Maximum Conducted Output Power.

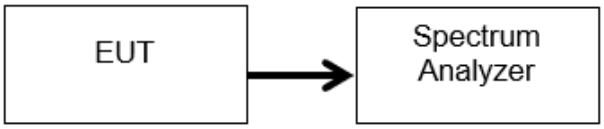
Limit

47 CFR 15.247(e) & RSS-247 Clause 5.2 (b)
For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

Spectrum Analyzer Settings:

Span	At least 1.5 times the OBW
RBW	3 kHz ≤ RBW ≤ 100 kHz
VBW	≥ [3 x RBW]
Sweep	Auto
Detector	RMS (power averaging)
Trace Mode	Average
Trace Count	≥ 100
Method	Peak Marker Function

Test Setup



Test Data

Tabular Data

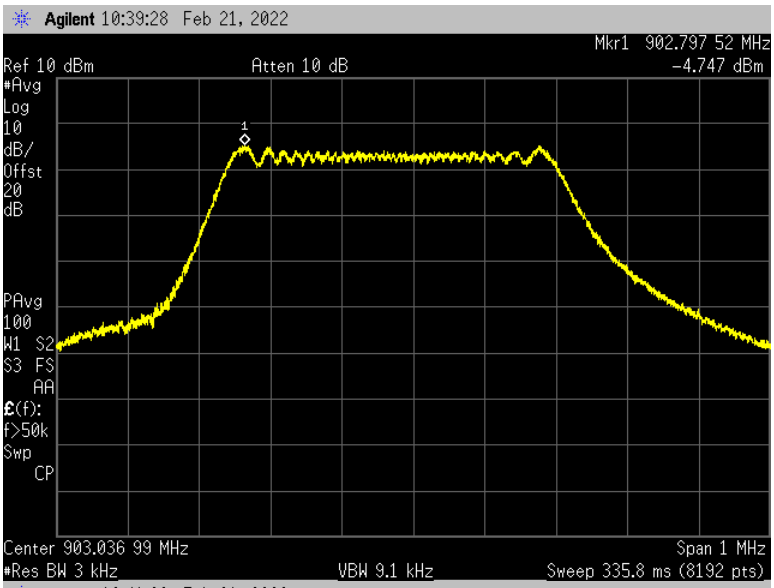
Mode	SF	Frequency	Measured PSD	Limit	Margin
	#	MHz	dBm	dBm	dB
LoRa DTS	7	903	-4.75	8.00	-12.75
LoRa DTS	7	907.8	-4.28	8.00	-12.28
LoRa DTS	7	914.2	-5.56	8.00	-13.56
LoRa DTS	8	903	-3.76	8.00	-11.76
LoRa DTS	8	907.8	-3.94	8.00	-11.94
LoRa DTS	8	914.2	-5.29	8.00	-13.29
LoRa DTS	9	903	-3.72	8.00	-11.72
LoRa DTS	9	907.8	-4.05	8.00	-12.05
LoRa DTS	9	914.2	-5.49	8.00	-13.49
LoRa DTS	10	903	-3.82	8.00	-11.82
LoRa DTS	10	907.8	-3.33	8.00	-11.33
LoRa DTS	10	914.2	-4.39	8.00	-12.39
LoRa DTS	11	902.3	-2.89	8.00	-10.89
LoRa DTS	11	908.5	-2.26	8.00	-10.26
LoRa DTS	11	914.9	-2.75	8.00	-10.75
LoRa DTS	12	902.3	-0.97	8.00	-8.97
LoRa DTS	12	908.5	-1.18	8.00	-9.18
LoRa DTS	12	914.9	-1.40	8.00	-9.40
Sidewalk LoRa DTS	11	902.5	-3.82	8.00	-11.82
Sidewalk LoRa DTS	11	914.5	-3.41	8.00	-11.41
Sidewalk LoRa DTS	11	926.5	-3.98	8.00	-11.98

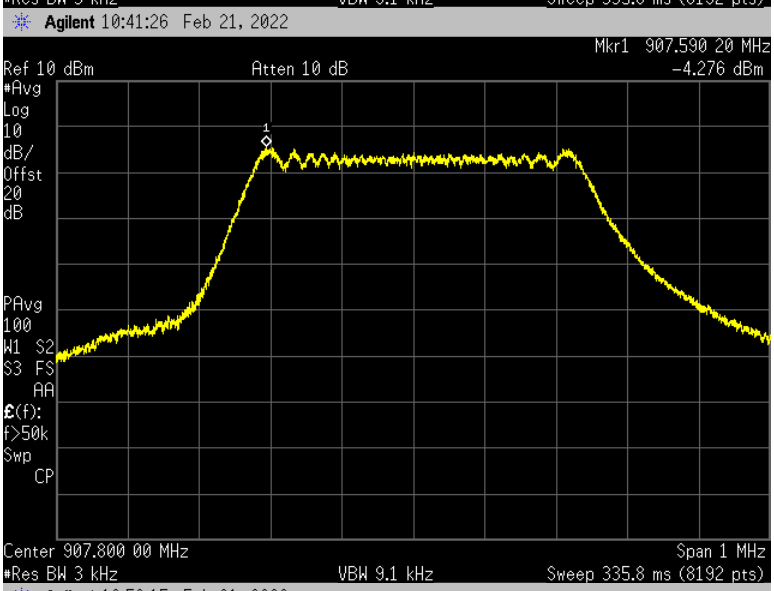
Measured PSD = Raw PSD + Loss

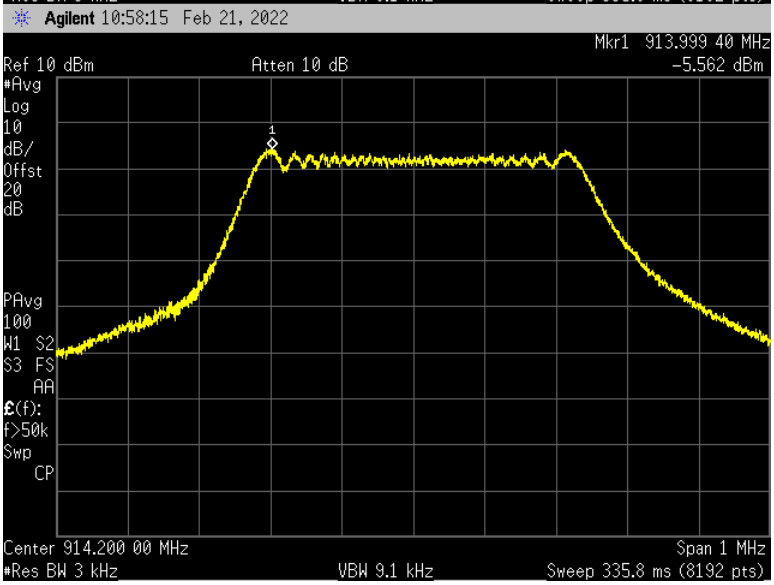
Margin = Limit - Measured PSD

Plot Examples

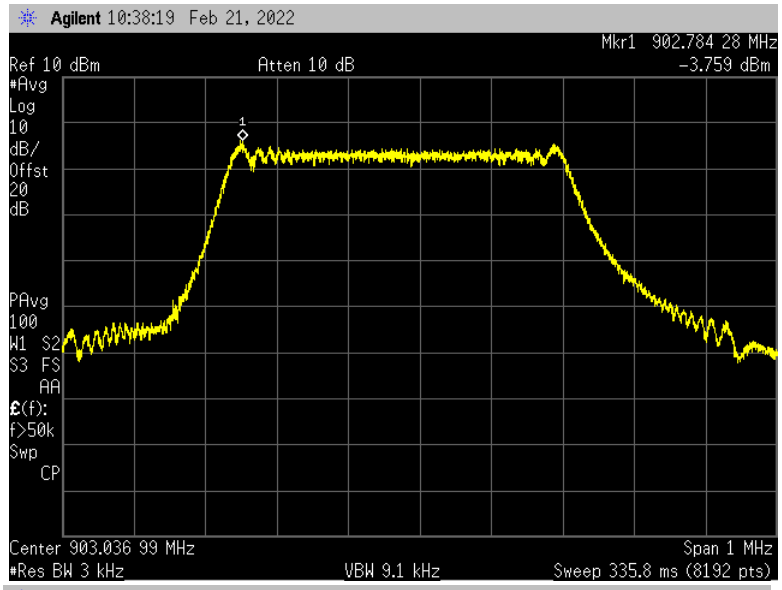
Spread Factor 7

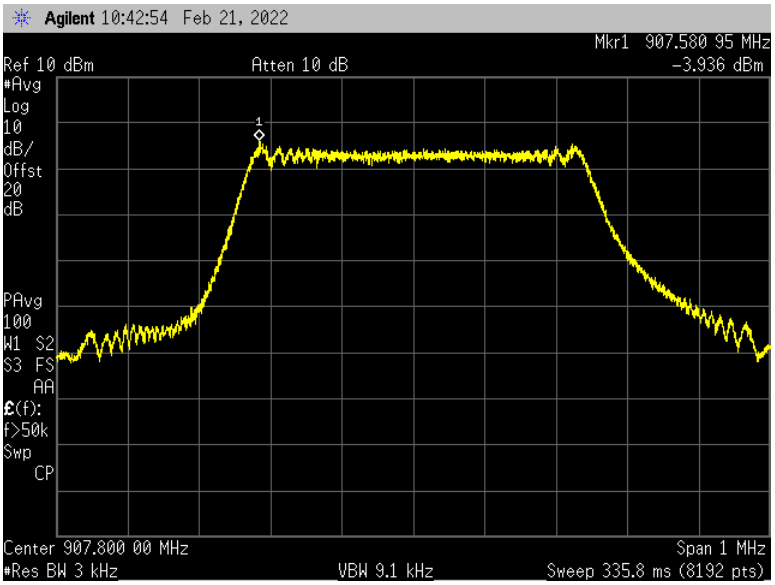


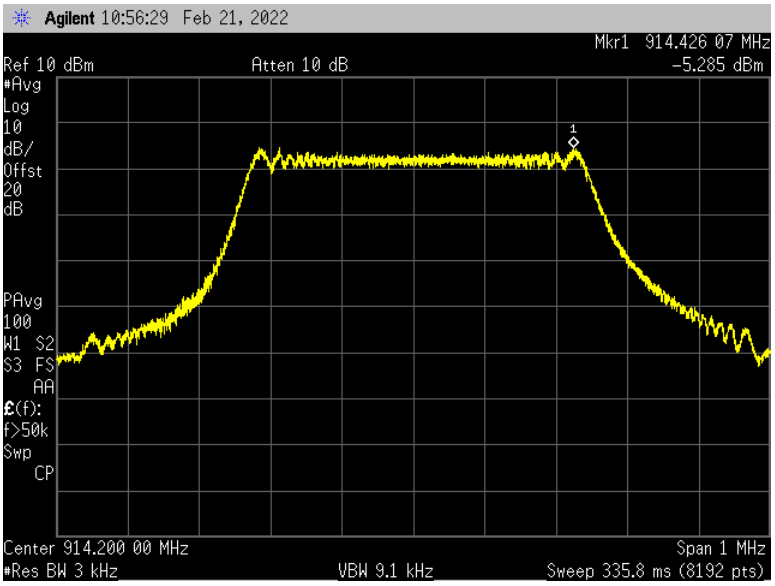




Spread Factor 8







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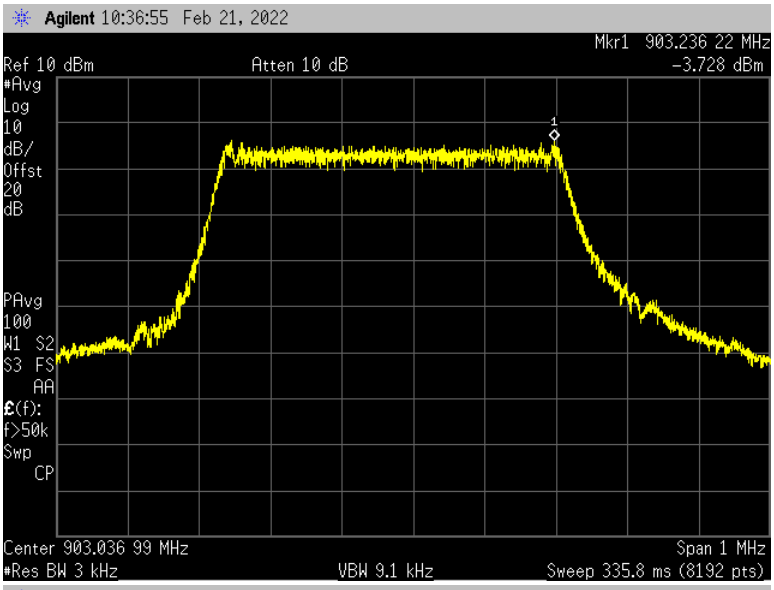

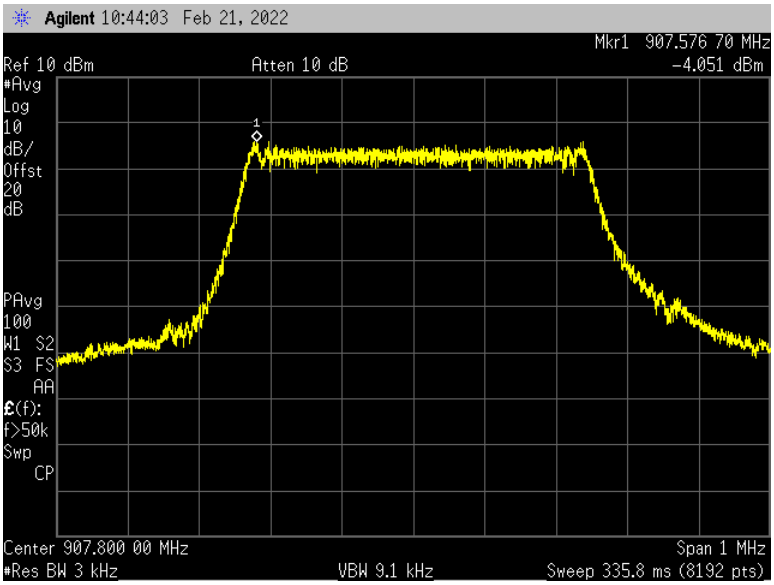

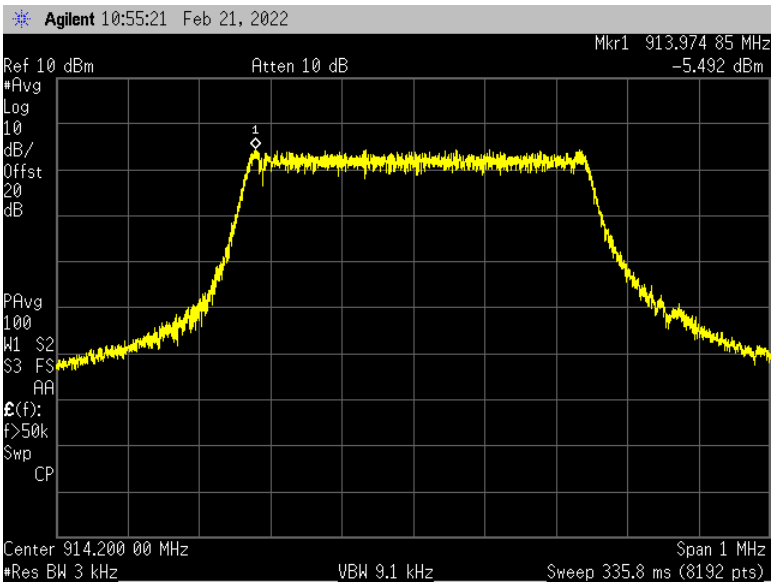

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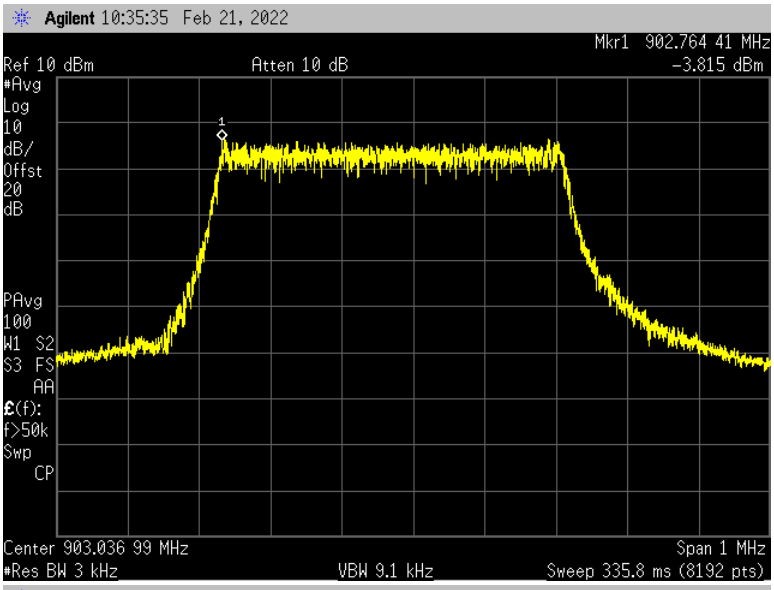
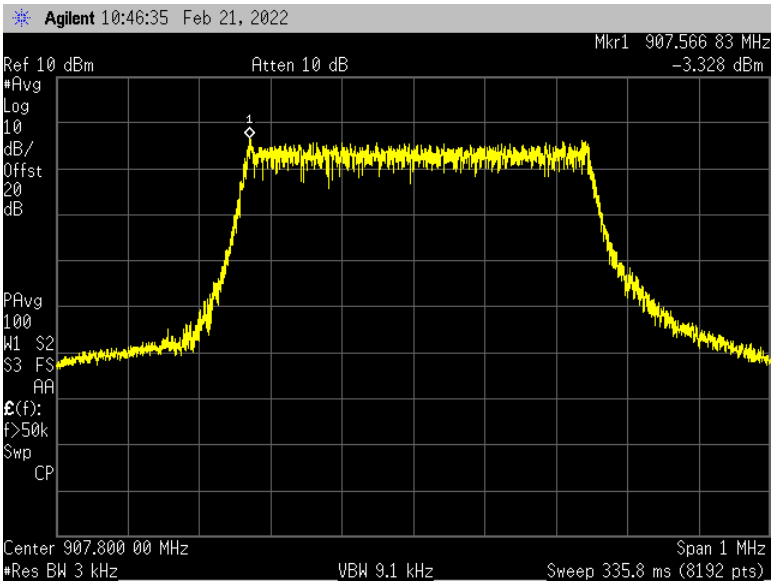
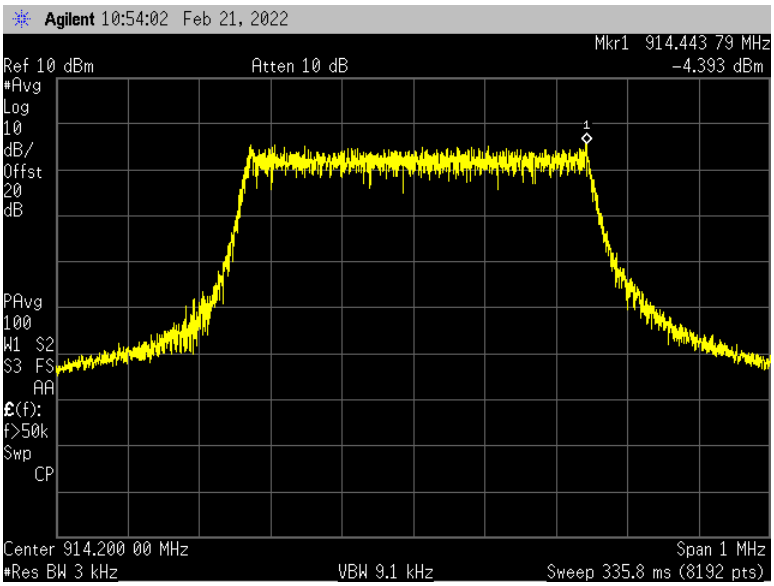
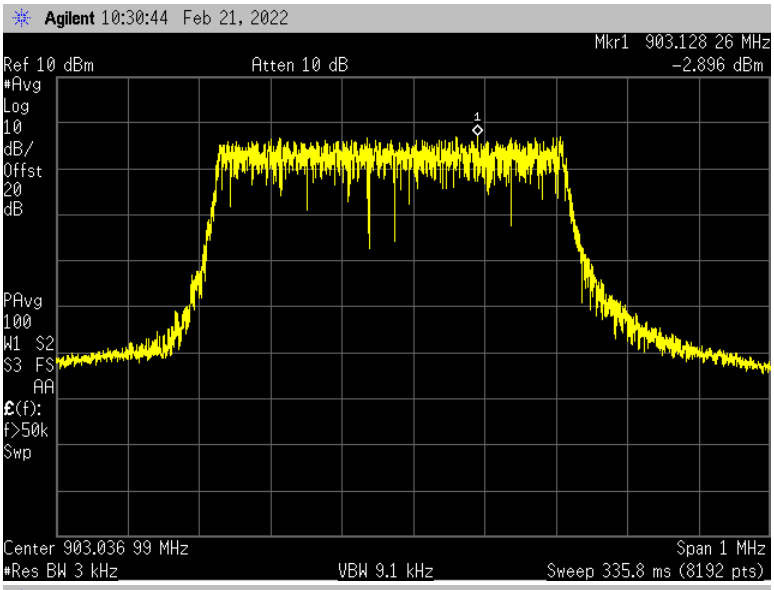
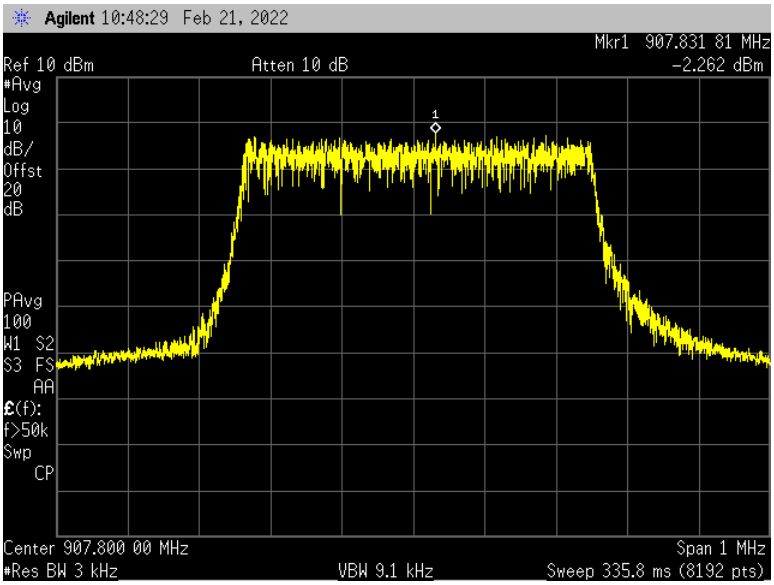


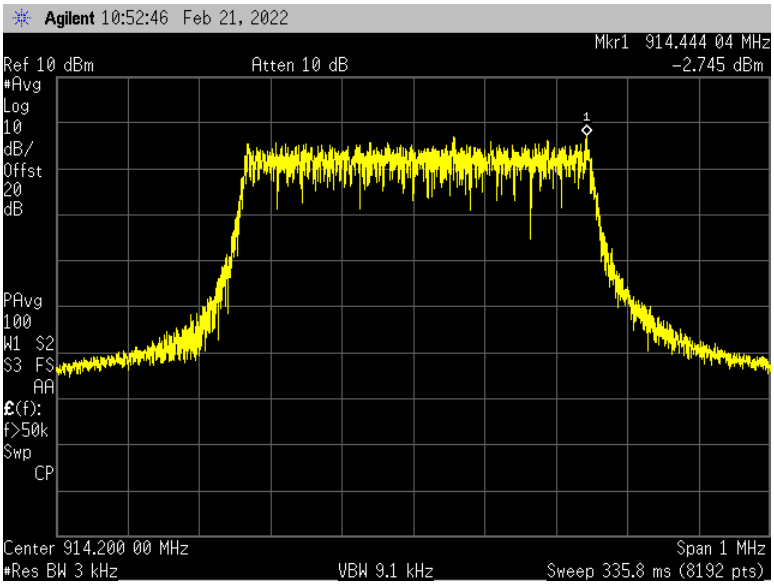




Spread Factor 11







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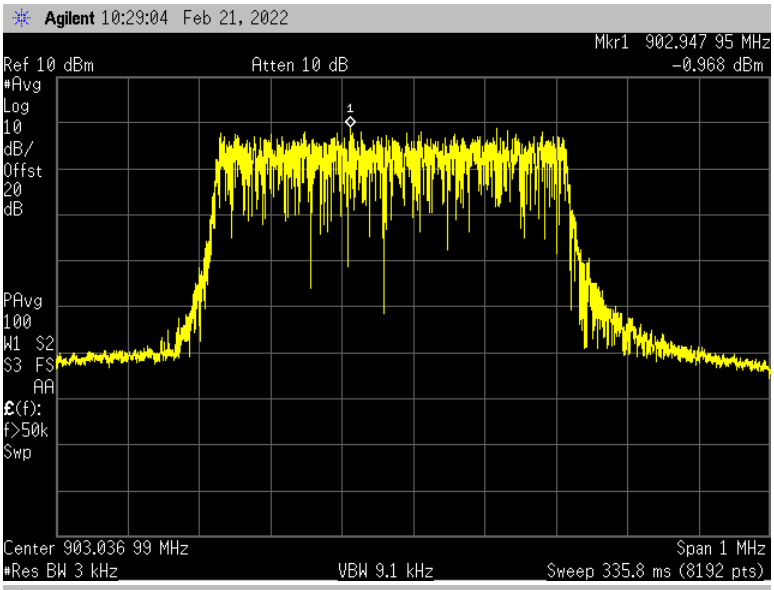
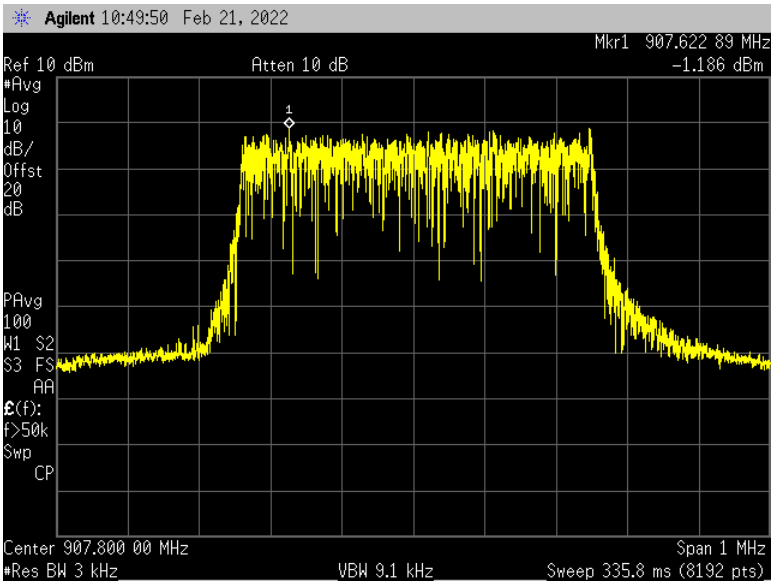
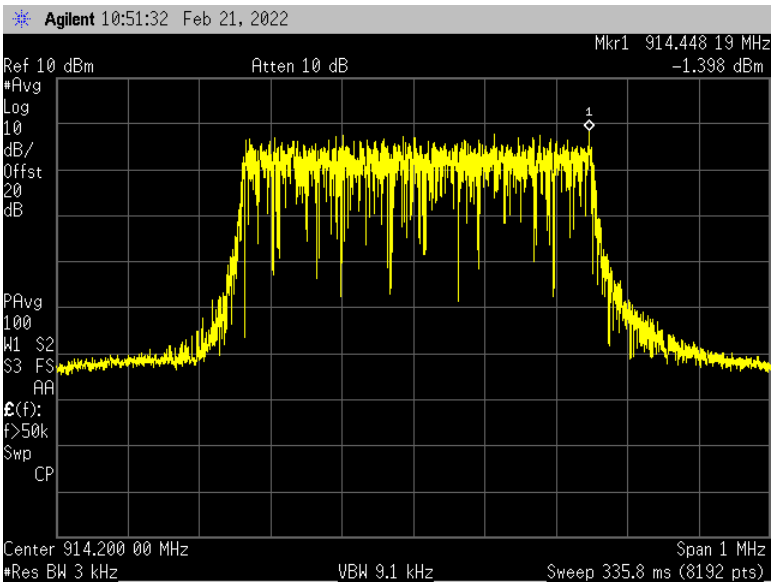






Carrier Frequency Separation [DSS]

Engineer: Aaron S. Froehlich
Test Date: 11/02/2022

Test Procedure

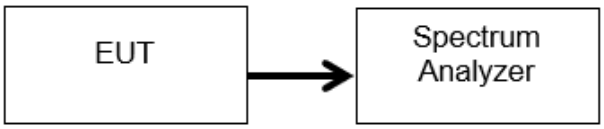
The test methods and settings of ANSI C63.10 Clause 7.8.2 were utilized to demonstrate compliance. The EUT was configured for Sidewalk FSK operation during the test. Unmodulated frequency hopping was not possible.

Markers were placed on the channel peak levels and the marker delta function was used to record the frequency separation between two adjacent channels.

Limit

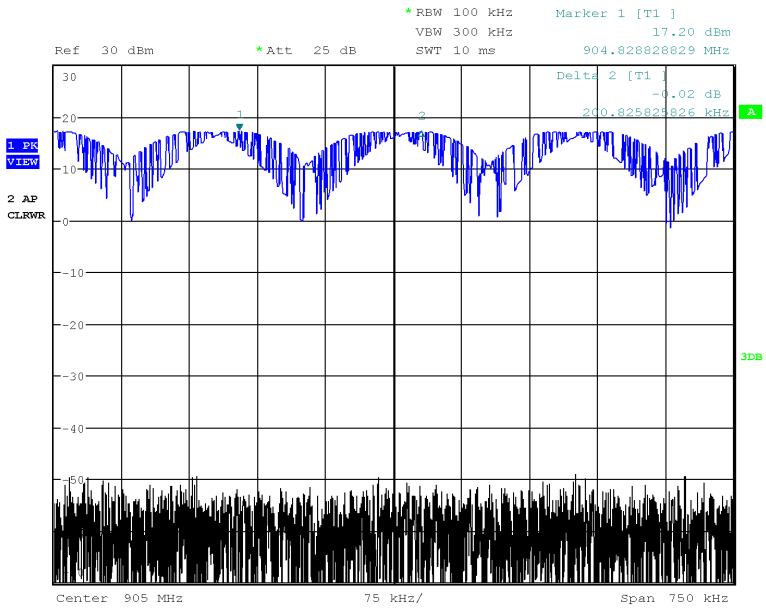
47 CFR 15.247(a)(1) & RSS 247 5.1.b.
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Test Setup



Test Data

Min 20 dB BW (MHz)	CFS (MHz)	Margin (MHz)	Result
0.102	0.201	-0.099	Compliant



Number of Hopping Frequencies [DSS]

Engineer: Aaron S. Froehlich
Test Date: 11/02/2022

Test Procedure

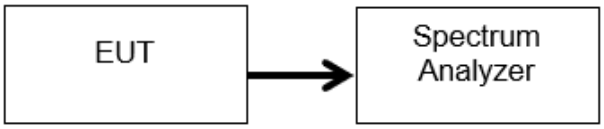
The test methods of ANSI C63.10 Clause 7.8.3 were utilized to demonstrate compliance. The EUT was tested under LoRa FHSS SF 7 and Sidewalk FSK modes of operation.

The number of frequencies were manually counted. Each frequency range was divided into 2 to make counting easier with the middle channel appearing on both plots, but only being counted once.

Limit

47 CFR 15.247(a)(1)(i) & RSS 247 5.1.c.
If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies.

Test Setup

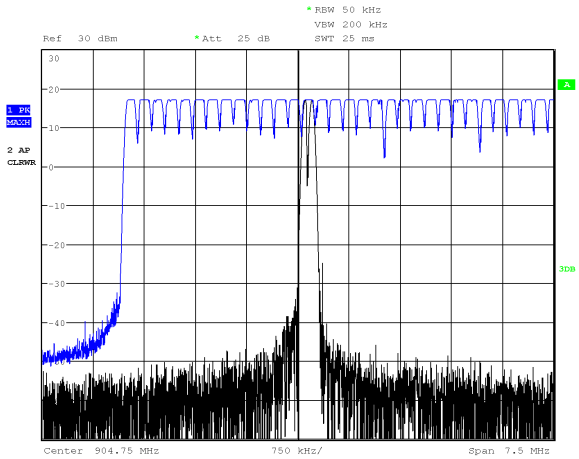


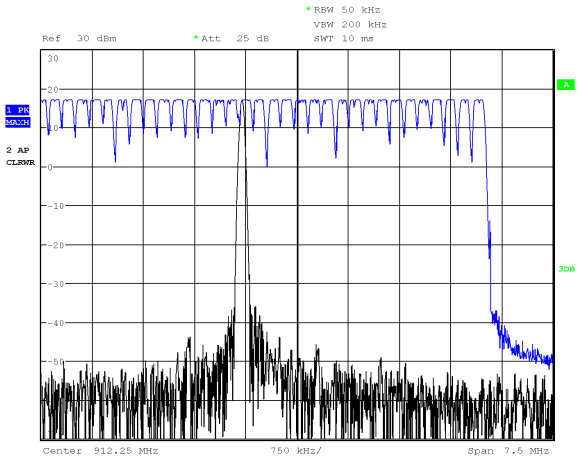
Test Data

Mode	20 dB BW	Frequencies	Limit	Margin
	kHz	#	#	#
LoRa FHSS	149	64	50	-14
Sidewalk FSK	112	129	50	-79

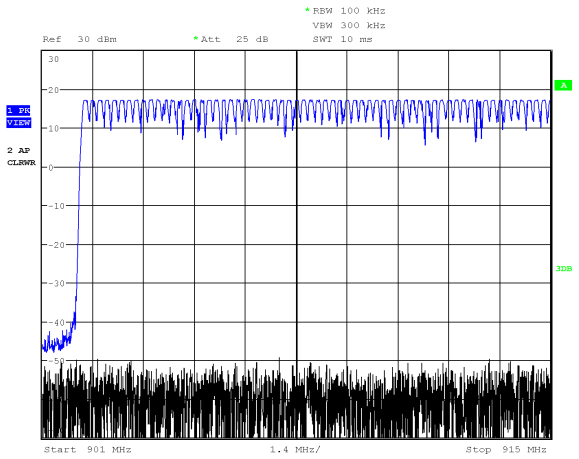
Plots

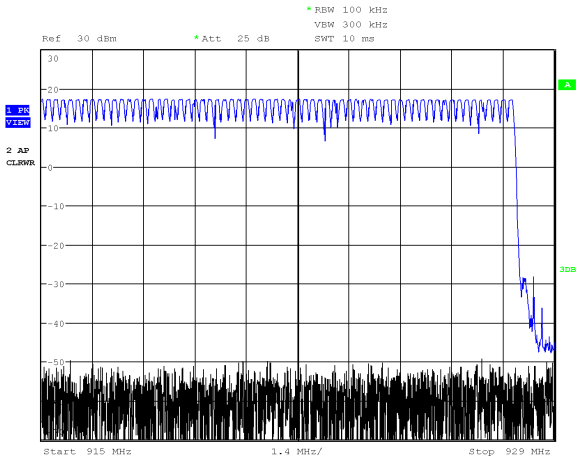
LoRa FHSS





Sidewalk FSK





Time of Occupancy (Dwell Time) [DSS]

Engineer: Aaron S. Froehlich
Test Date: 8/19/2022

Test Procedure

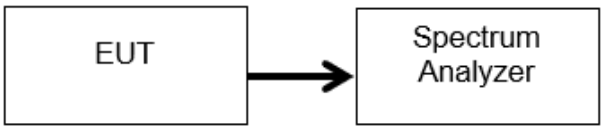
The method of ANSI C63.10 Clause 7.8.4 was used to demonstrate compliance. Two measurements were made for each mode of operation. A short sweep to determine the transmit time per hop, followed by a longer sweep time to count the number of transmissions within the observation period. The number of hops in the longer sweep has been multiplied by the ratio of the requirement period to the sweep time. The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements.

Video Triggering with a negative offset was utilized to allow accurate time domain measurements.

Limit

47 CFR 15.247(a)(1)(i)
The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.

Test Setup



Test Data

Tabular Data

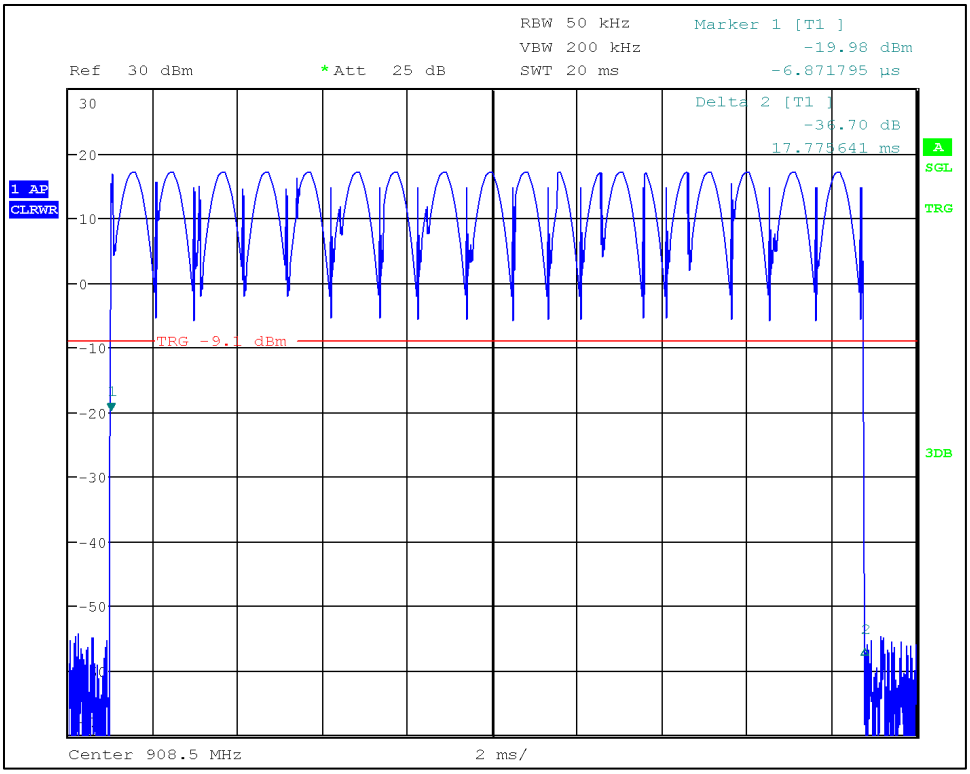
Data Rate	SF	Duration (MS)	Hops Observed	Required Period (S)	Sweep Time (S)	Total Hops	Total Occupancy (mS)	Limit (mS)	Margin (mS)	Result
LoRa FHSS	7	17.776	4	20	25.6	3.125	55.55	400	-344.45	Compliant
LoRa FHSS	8	383.079	1	20	25.6	0.781	299.28	400	-100.72	Compliant
LoRa FHSS	9	358.013	1	20	25.6	0.781	279.70	400	-120.30	Compliant
LoRa FHSS	10	304.640	1	20	25.6	0.781	238.00	400	-162.00	Compliant
Sidewalk FSK	na	39.707	4	20	51.6	1.55	61.56	400	-338.44	Compliant

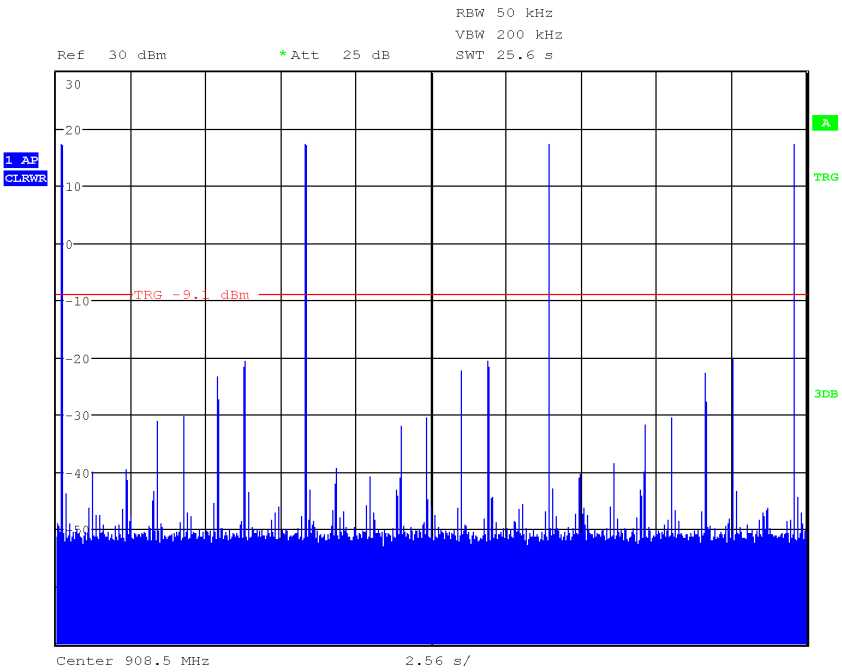
Total Hops = Hops Observed • Required Period / Sweep Time

Total Occupancy = Duration • Total Hops

Plots

LoRa FHSS Spread Factor 7





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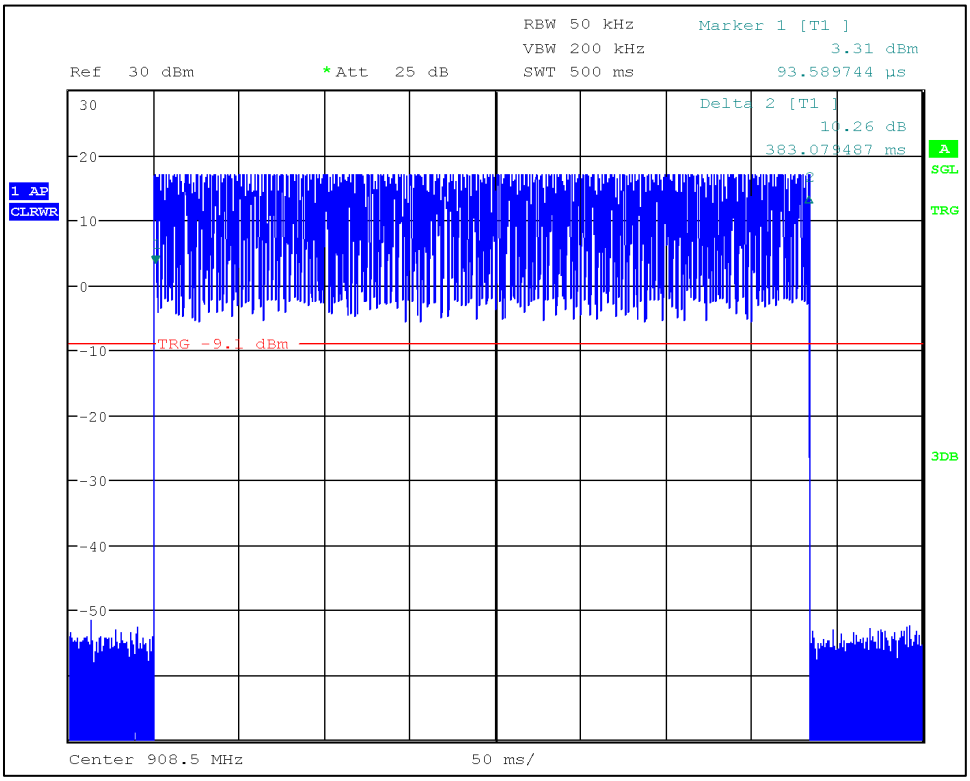

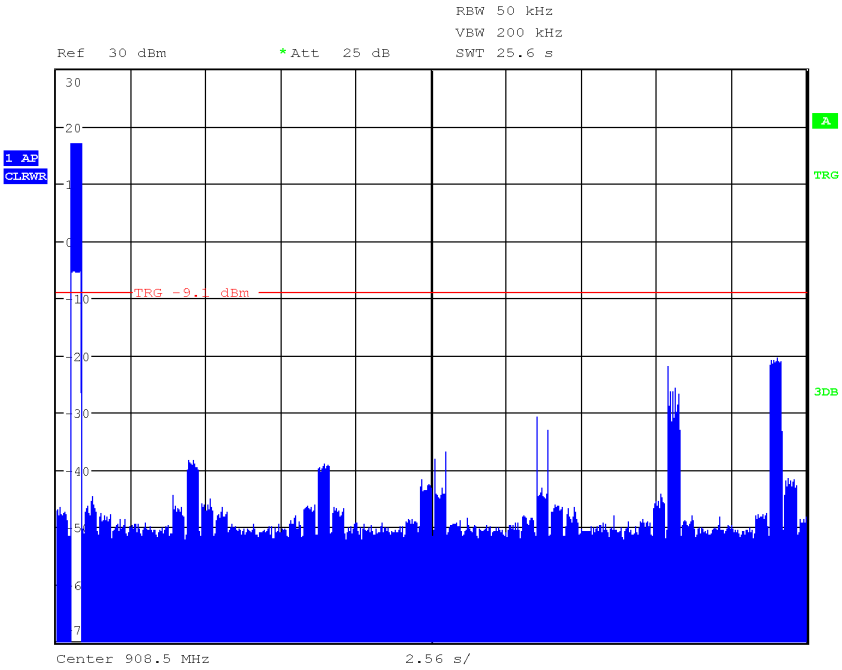

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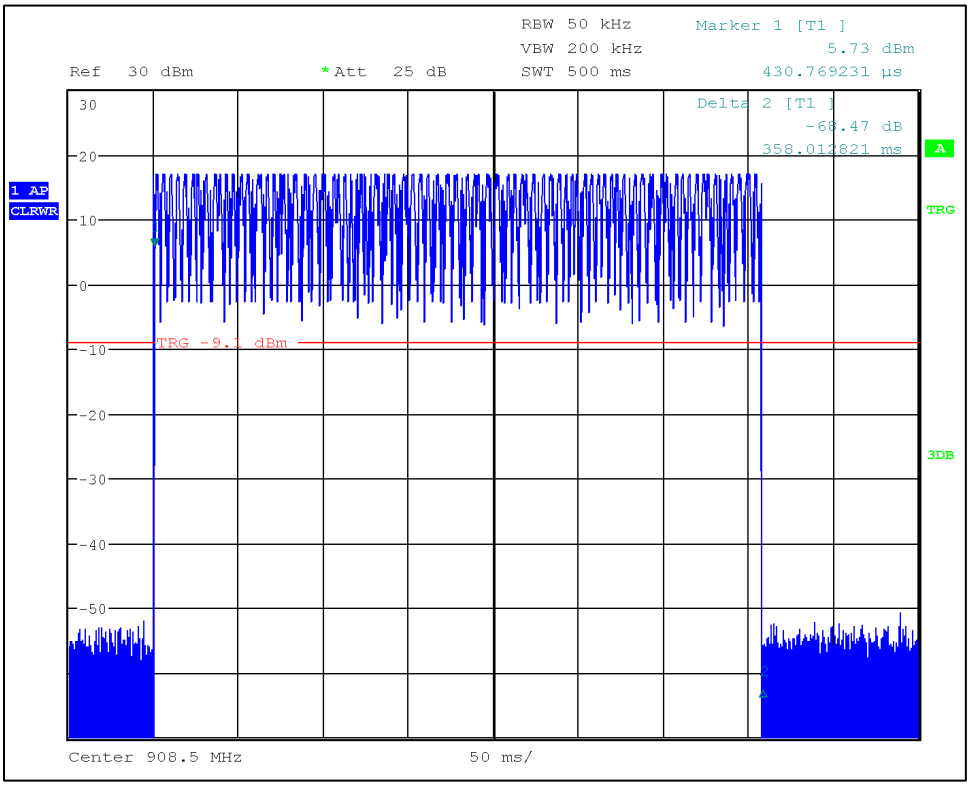
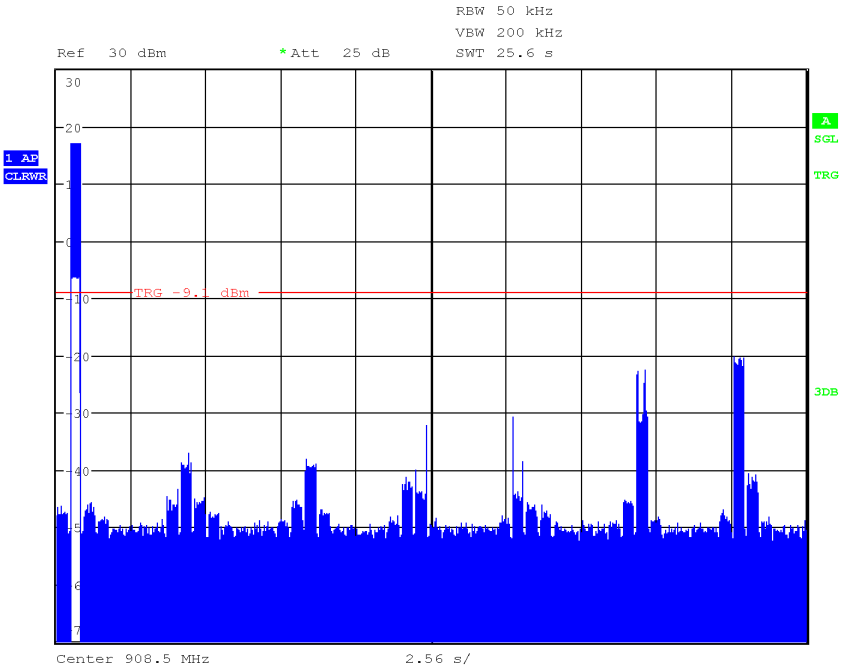
LoRa FHSS Spread Factor 9





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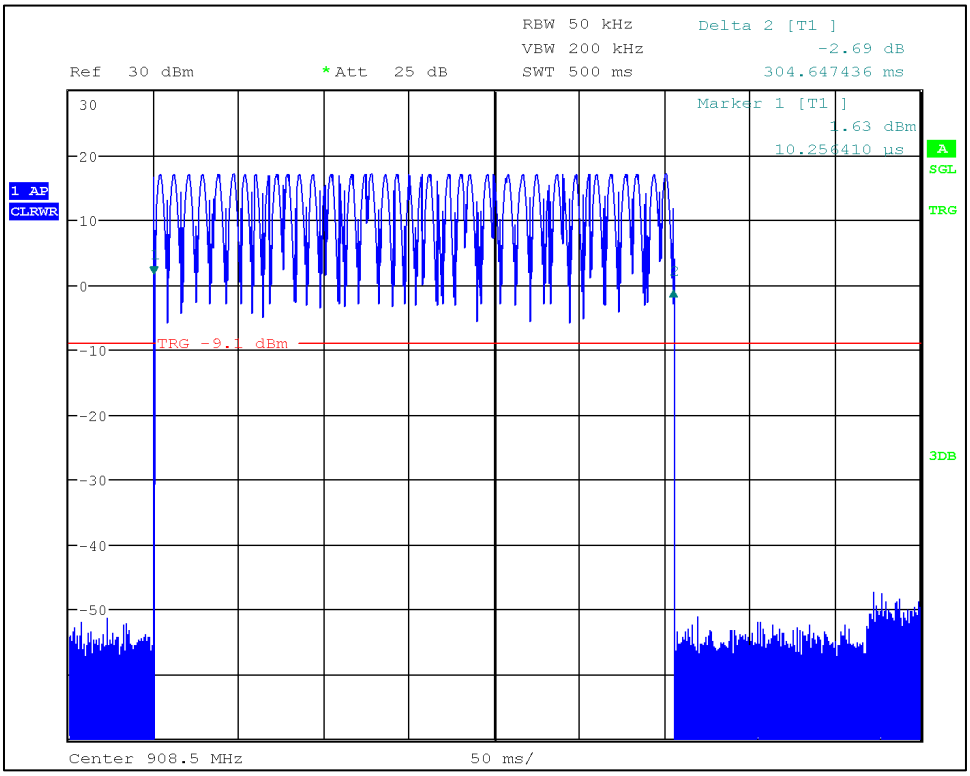
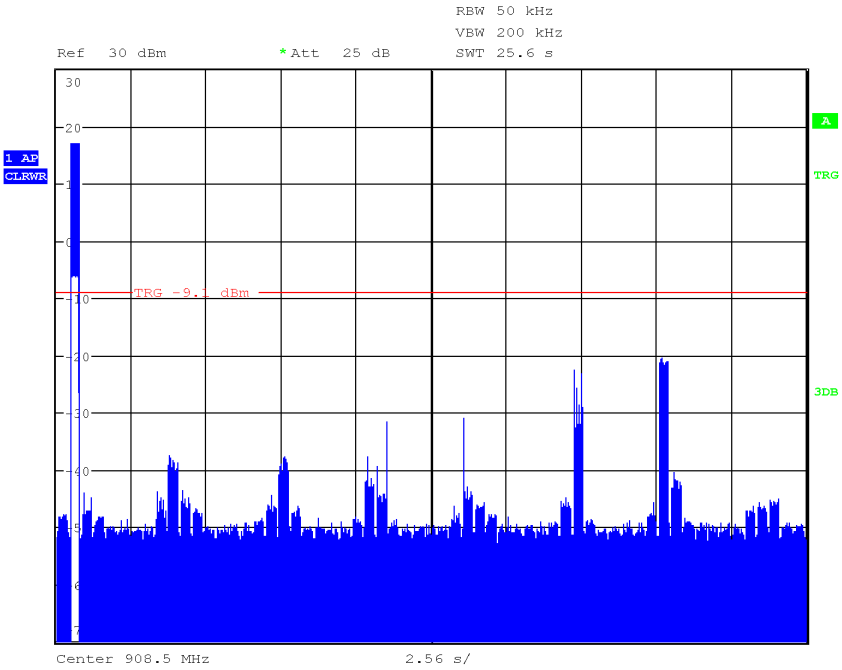
LoRa FHSS Spread Factor 10





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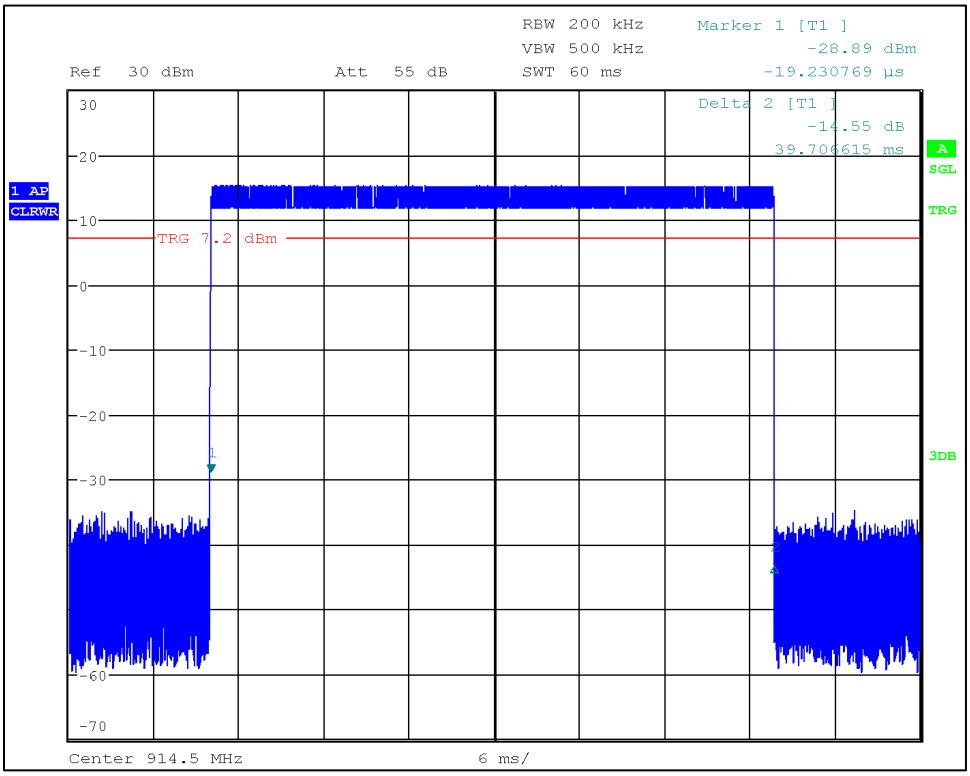
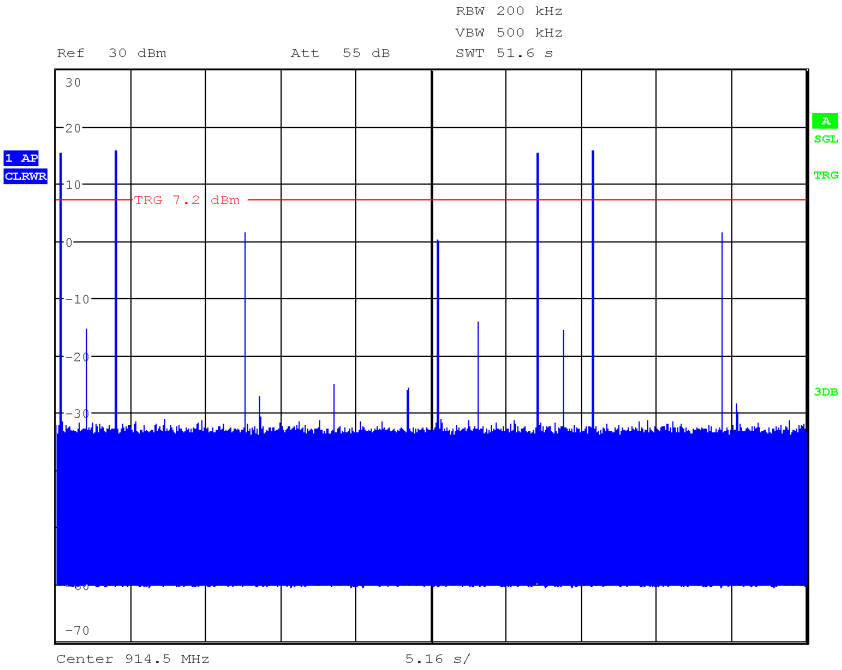
Date: 2.NOV.2022 17:35:03

Sidewalk FSK





condspur_b3_1g2g

Date: 2.NOV.2022 21:40:12

Emissions at Band Edges [DTS & DSS]

Engineer: Aaron S. Froehlich

Test Date: 11/03/2022

Test Procedure

Clause 7.8.6 of ANSI C63.10 directs the use of the methods of Clause 6.10 for Band Edge measurements of DSS (aka FHSS) devices, in both single channel and hopping modes of operation. The relative antenna port conducted method of Clause 6.10.4 was used to demonstrate Band Edge Compliance with the 902-928 MHz Band for both DTS and DSS modes of operation.

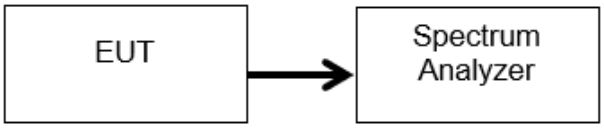
Worst case test modes were determined IAW C63.10 Clause 5.6.2.2 a).

Limits

47 CFR 15.247(d) & RSS 247 Section 5.5

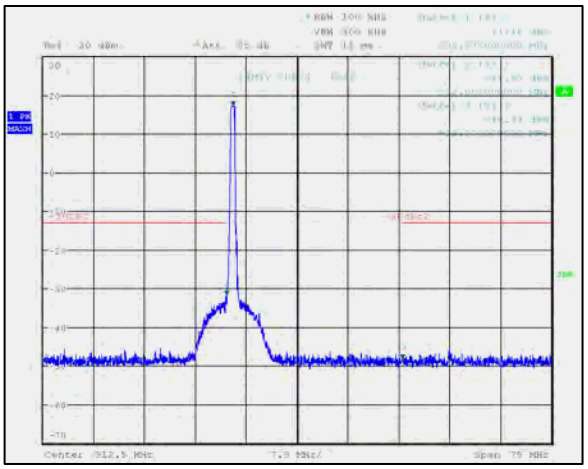
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

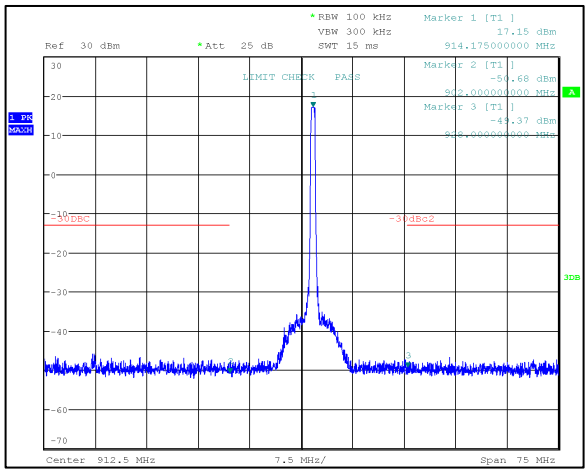
Test Setup



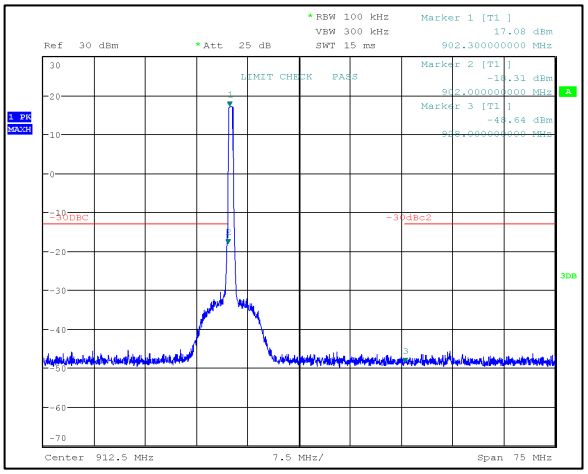
Band Edge Test Data

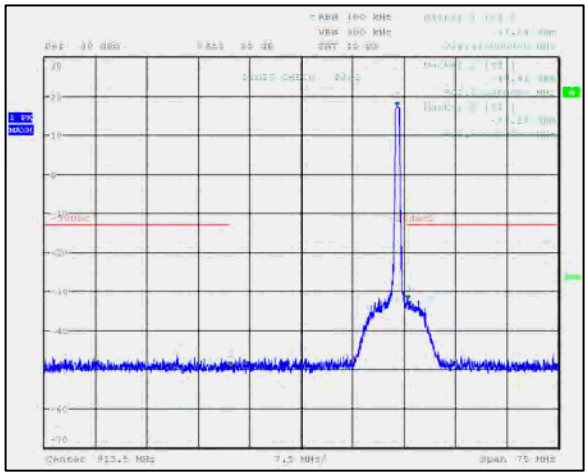
LoRa DTS



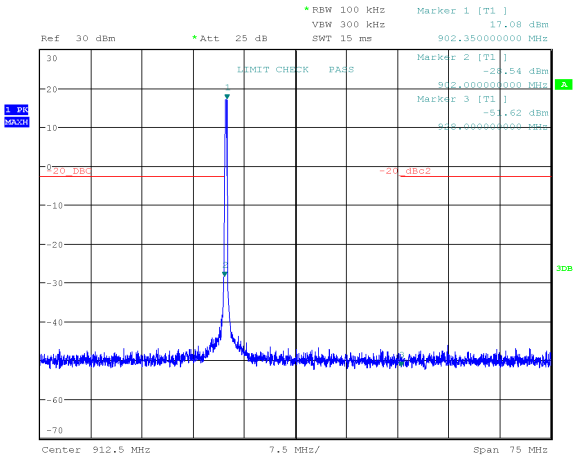


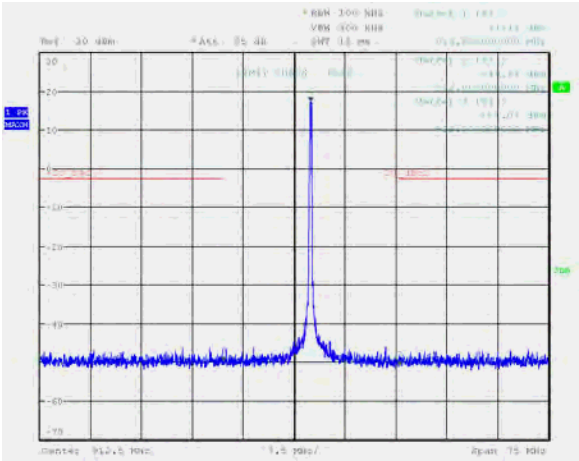
Sidewalk LoRa DTS

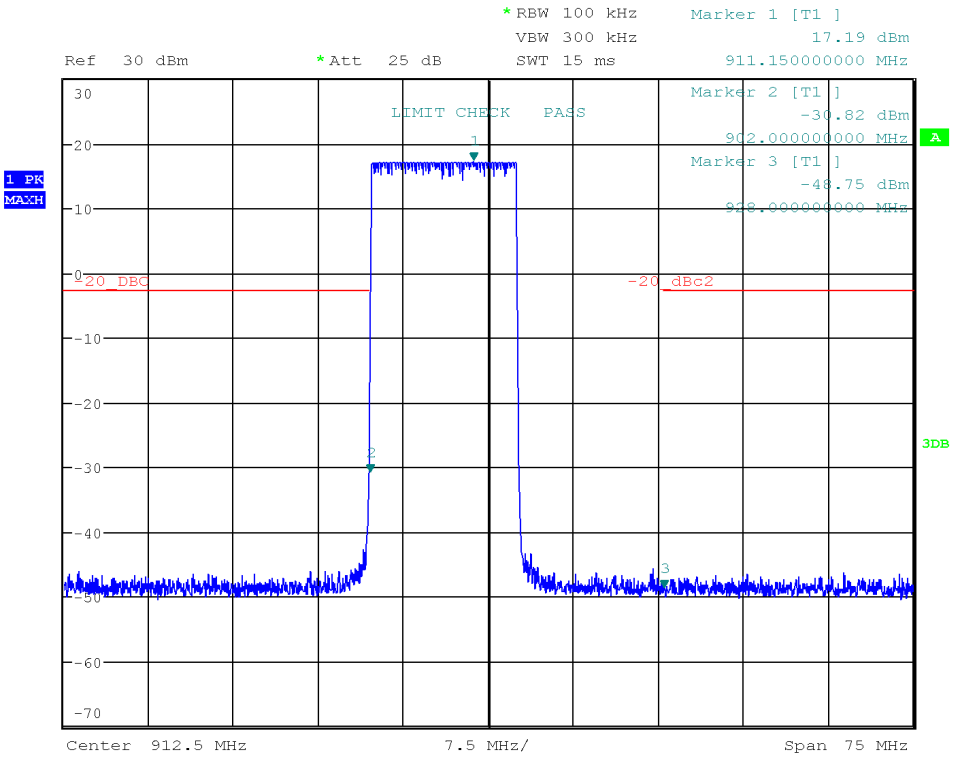




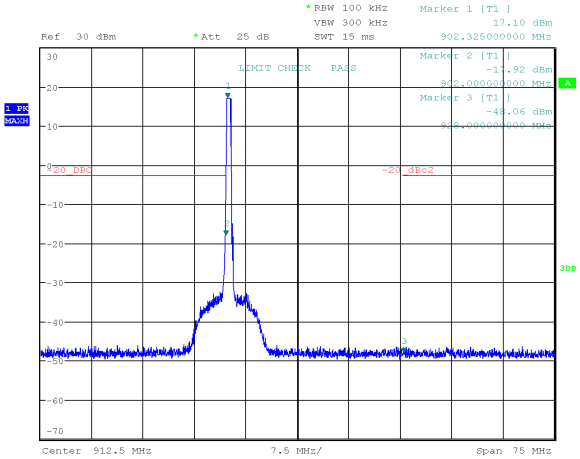
LoRa FHSS SF 8

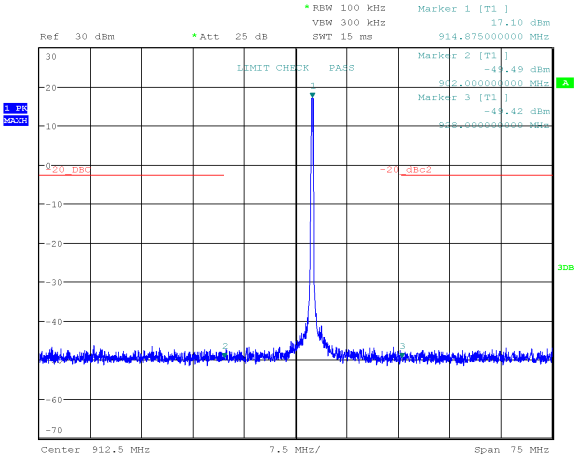


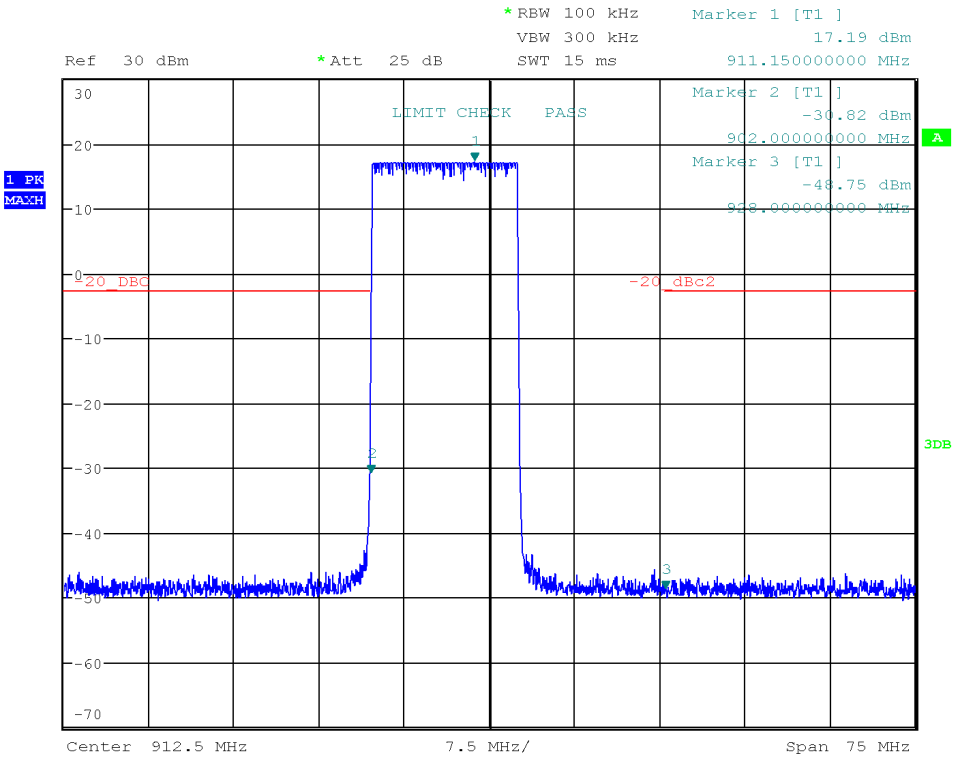




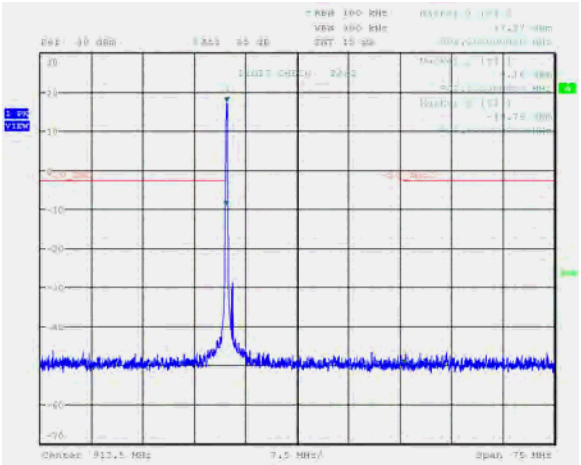
LoRa FHSS SF 10

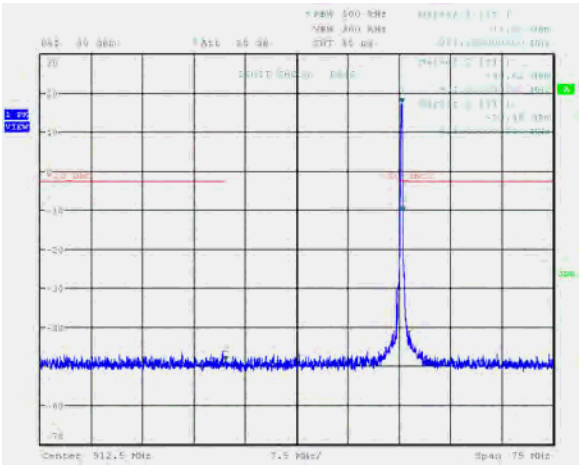


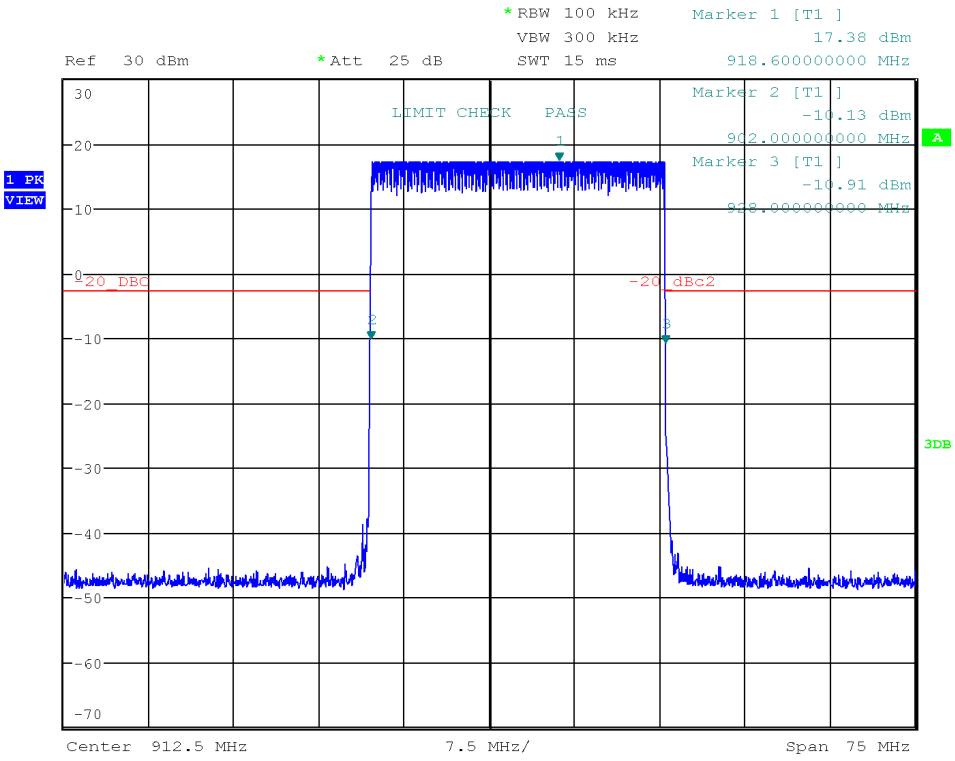




Sidewalk FSK







Conducted Spurious Emissions

Engineer: Aaron S. Froehlich
Test Date: 11/03/2022

Test Procedure

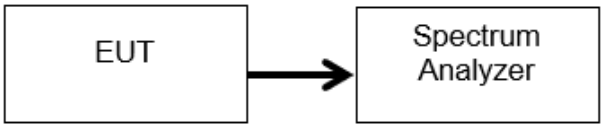
Conducted Spurious Emissions has been measured using the methods of ANSI C63.10 clause 7.8.8. The antenna port was connected to a spectrum analyzer and the range of 30 MHz to 10 times the operating frequency was scanned with a resolution bandwidth of 100 kHz, video bandwidth pf 300 kHz and a coupled sweep time. The frequency range was subdivided into 17 evenly spaced subranges with 30001 sweep points per subrange.

Per ANSI C63.10 Clause 5.6.2.2 b) the mode with the highest output power for each modulation family has been tested and reported.

Limits

47 CFR 15.247(d) & RSS 247 Section 5.5
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

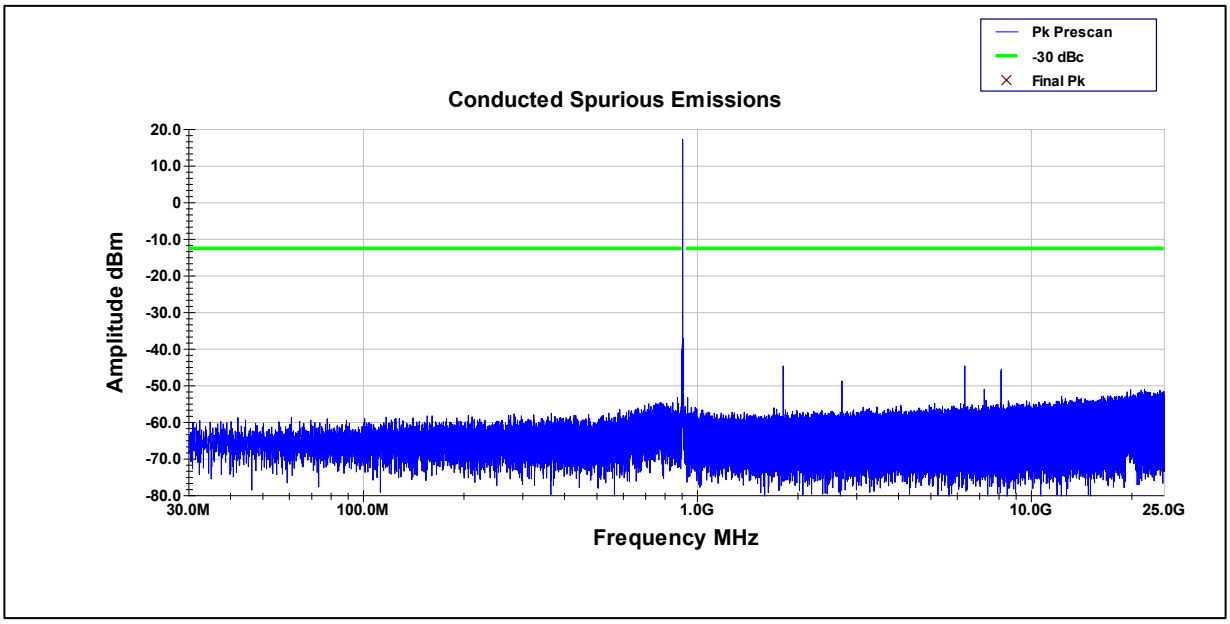
Test Setup



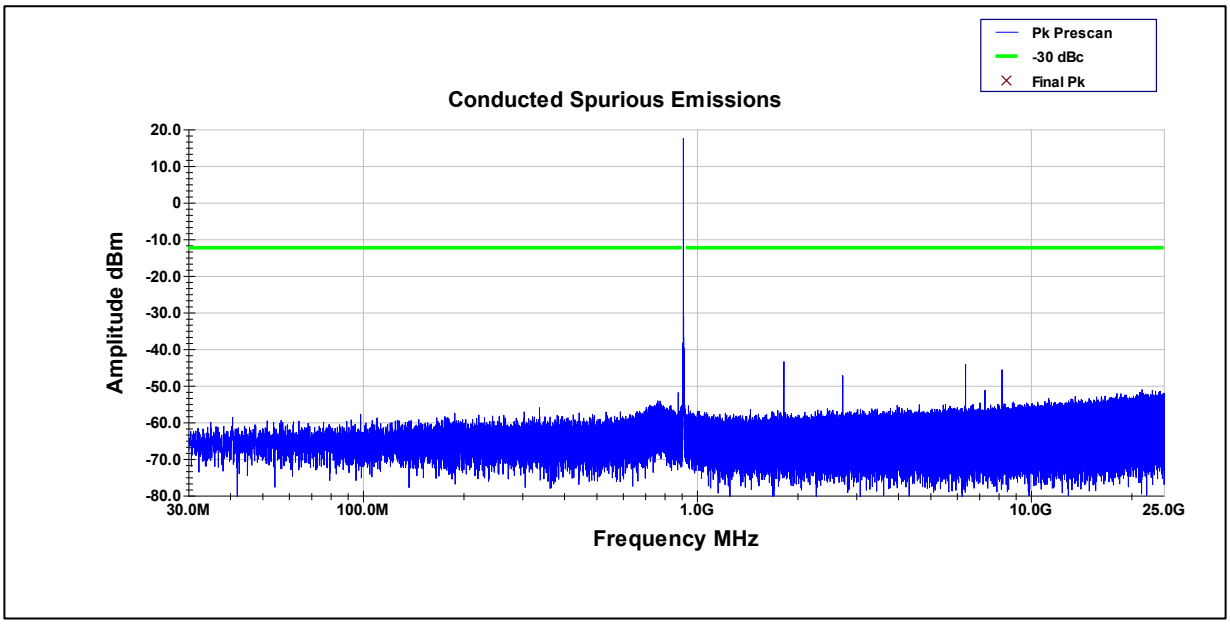
Test Data

LoRa DTS

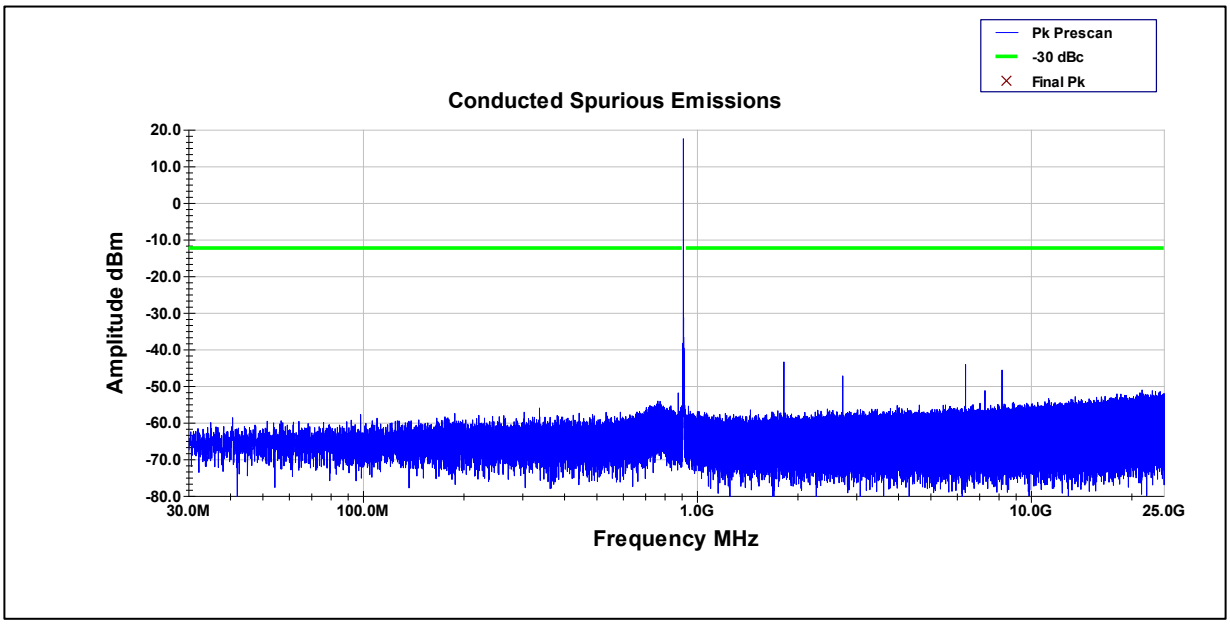
SF 11 Low Ch



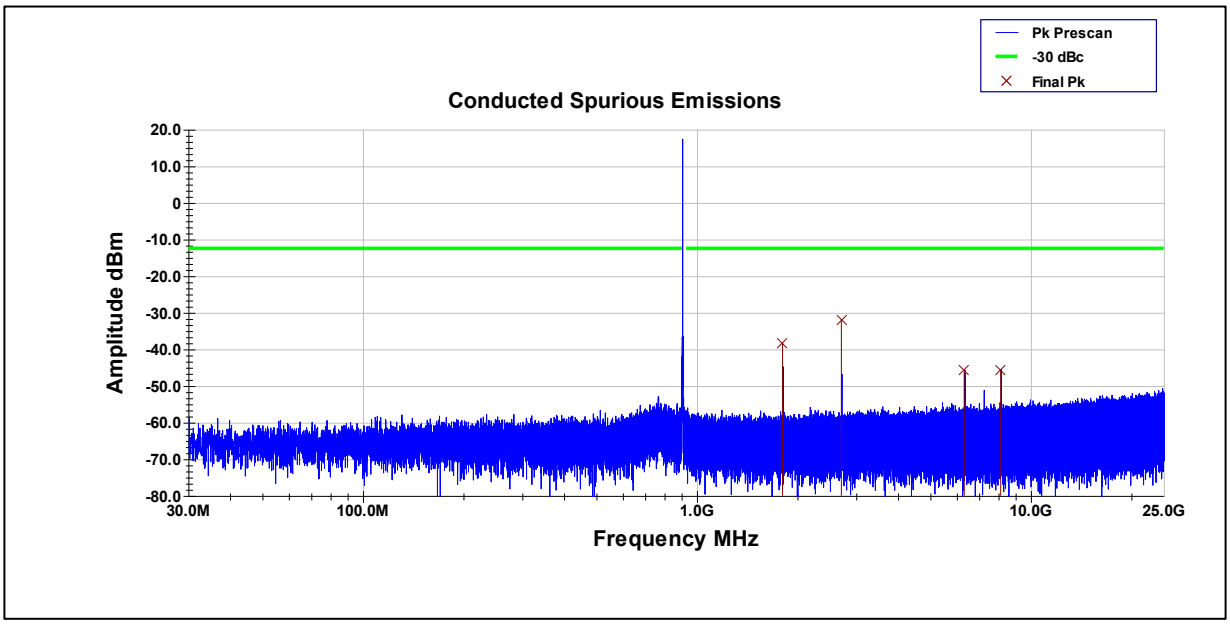
SF 11 Mid Ch



SF 11 High Ch

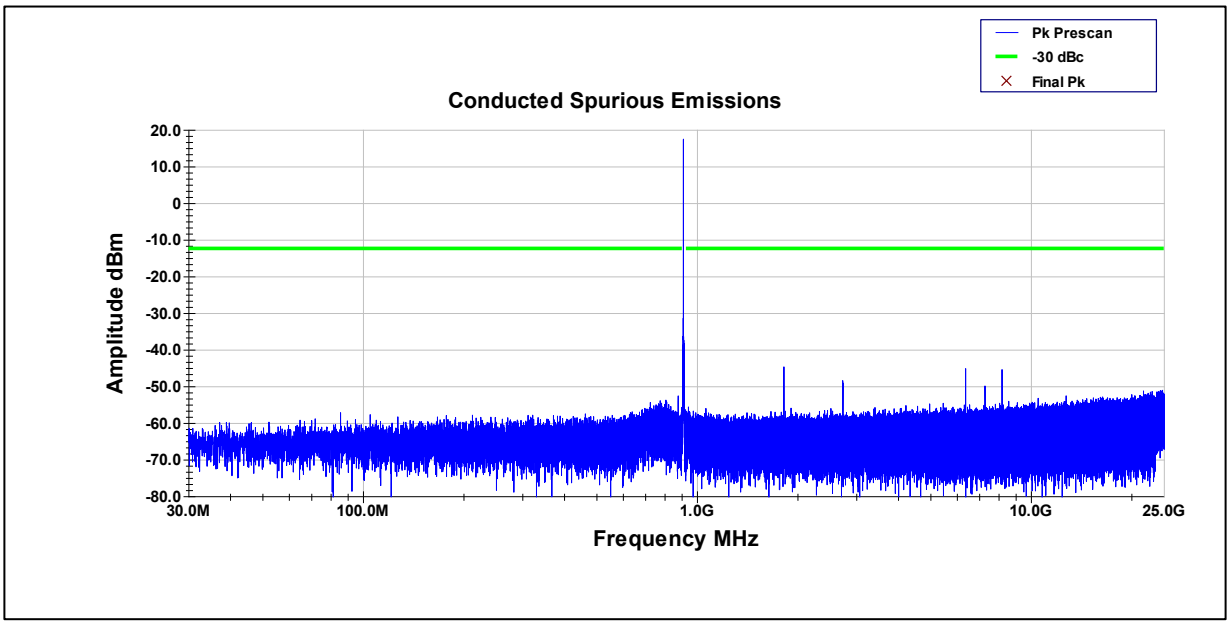

Pk Prescan
-30 dBc
Final Pk
Conducted Spurious Emissions
Amplitude dBm
20.0
10.0
0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
30.0M
100.0M
1.0G
10.0G
25.0G
Frequency MHz

SF 12 Low Ch

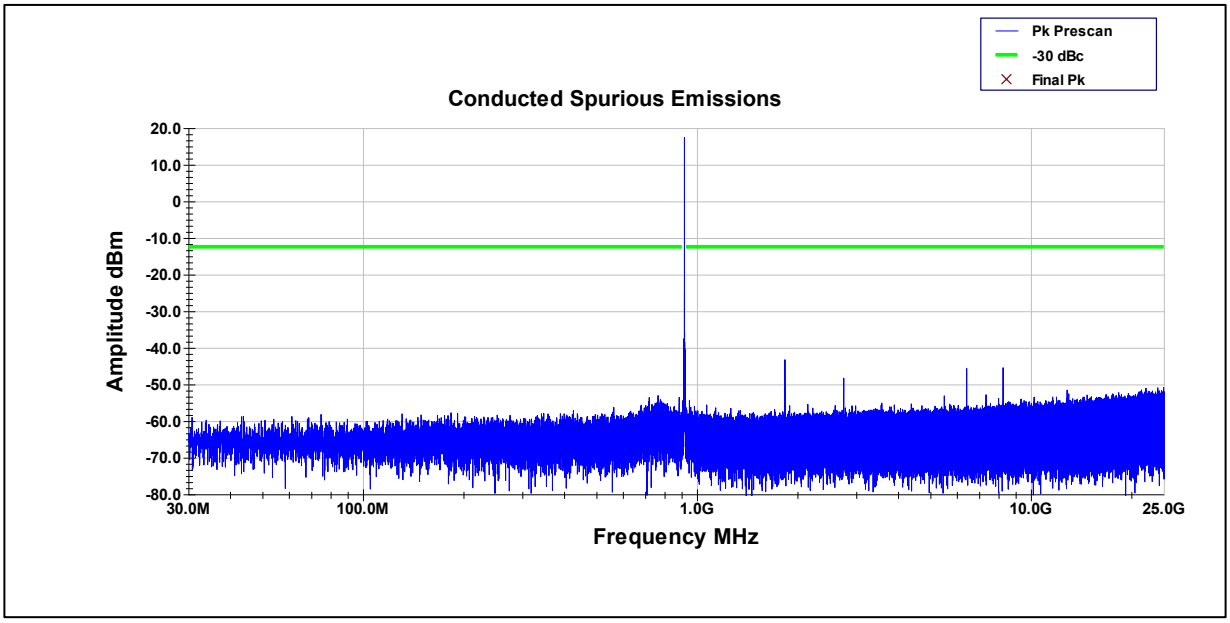


Frequency	Raw Pk	Final Pk	Path Loss	Limit	Pk Margin
(MHz)	dBm	dBm	dB	dBm	dB
1.8058 GHz	-39.54	-38.45	1.09	-12.46	-26.00
2.7091 GHz	-33.25	-31.91	1.34	-12.46	-19.45
6.3198 GHz	-47.98	-45.69	2.29	-12.46	-33.24
8.1285 GHz	-48.66	-45.82	2.83	-12.46	-33.37
Final = Raw + Path Loss					
Margin = Final - Limit					

SF 12 Mid Ch

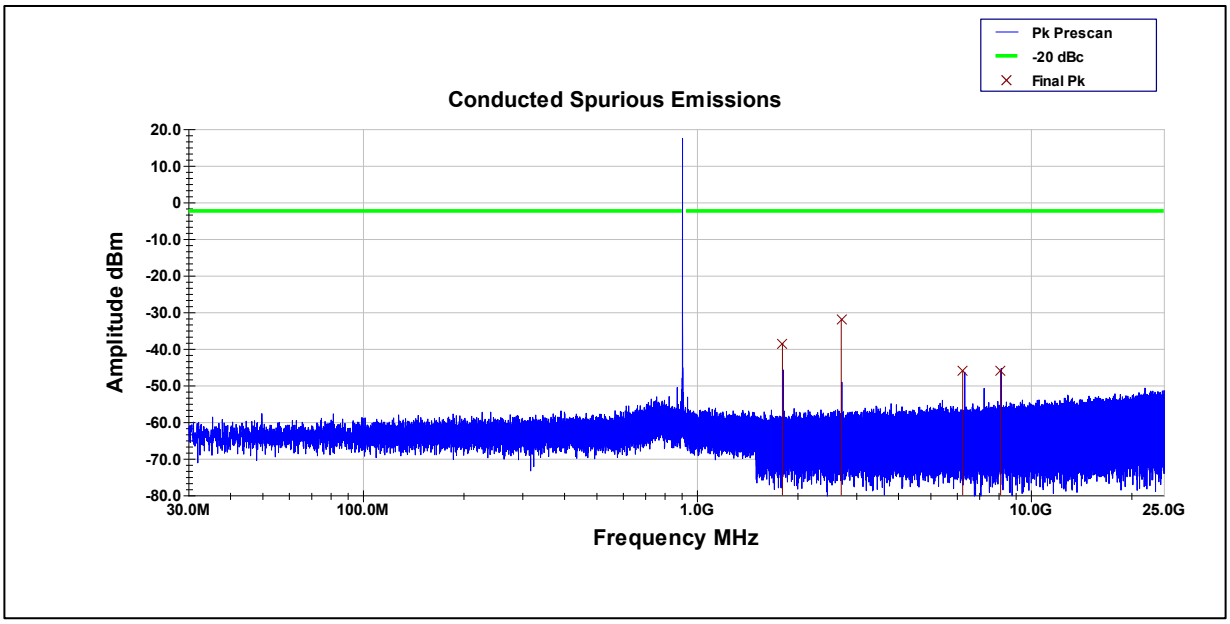


SF 12 High Ch



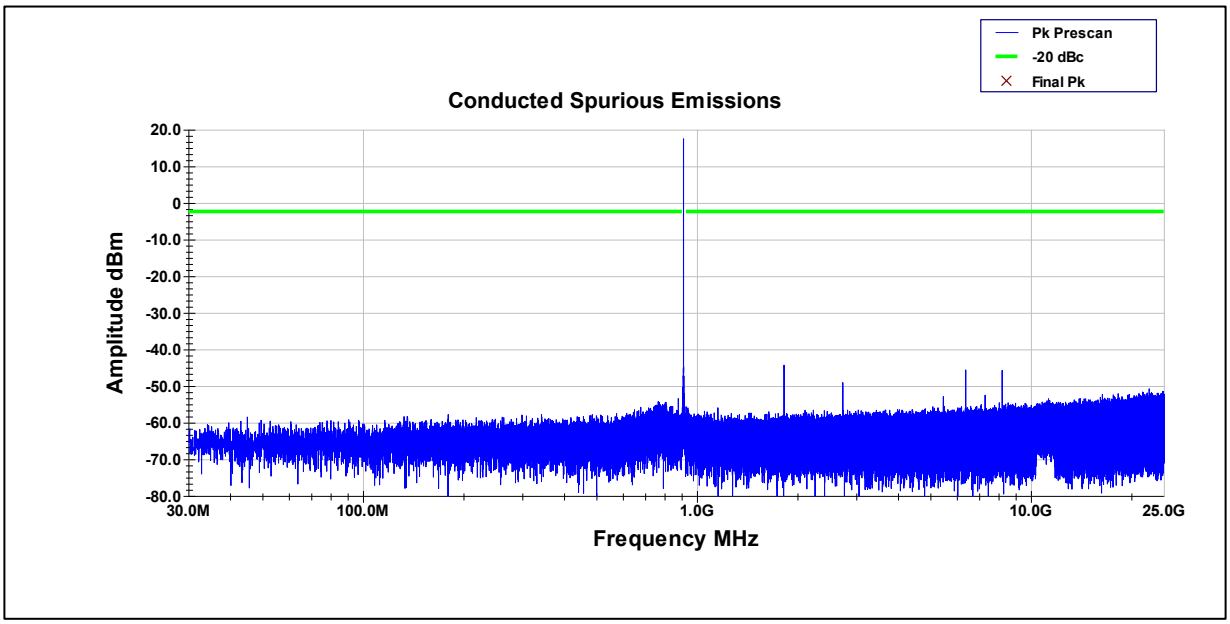
LoRa FHSS

SF7 Low Ch

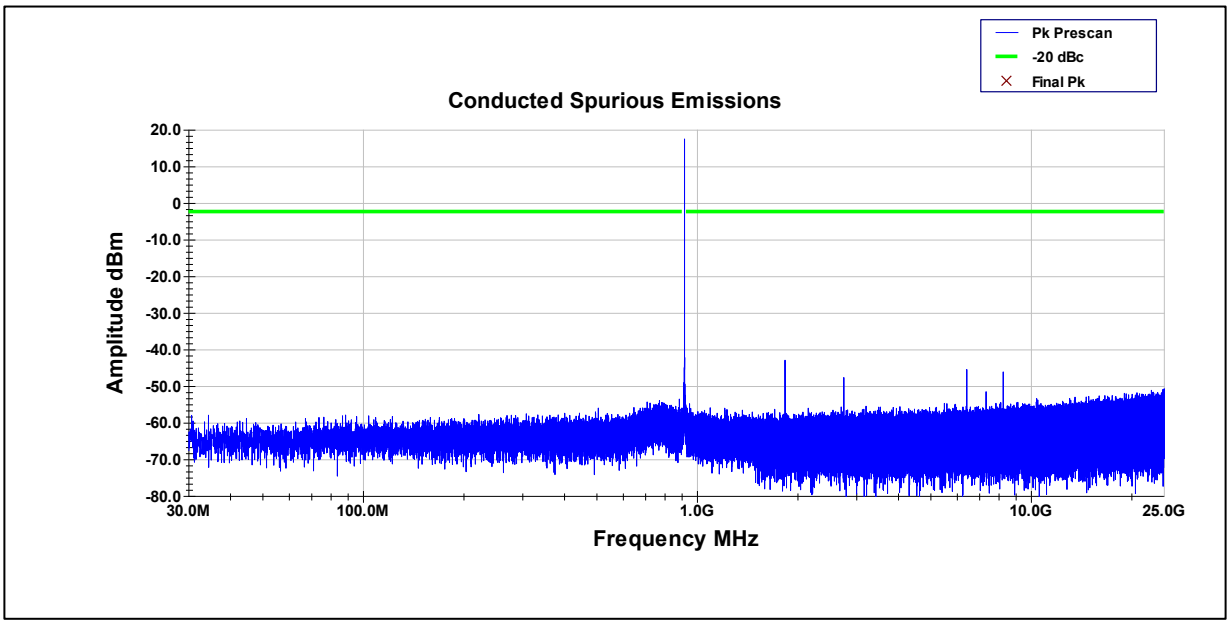


Frequency	Raw Pk	Final Pk	Path Loss	Limit	Pk Margin
(MHz)	dBm	dBm	dB	dBm	dB
1.8046 GHz	-39.63	-38.53	1.10	-2.36	-36.17
2.7069 GHz	-33.25	-31.91	1.34	-2.36	-29.55
6.2534 GHz	-48.20	-45.93	2.26	-2.36	-43.57
8.121 GHz	-48.71	-45.92	2.80	-2.36	-43.55
Final = Raw + Path Loss					
Margin = Final - Limit					

SF 7 Mid Ch


Pk Prescan
-20 dBc
Final Pk
Conducted Spurious Emissions
Amplitude dBm
20.0
10.0
0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
30.0M
100.0M
1.0G
10.0G
25.0G
Frequency MHz

SF 7 High Ch


Pk Prescan
-20 dBc
Final Pk
Conducted Spurious Emissions
Amplitude dBm
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10.0
0
-10.0
-20.0
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-40.0
-50.0
-60.0
-70.0
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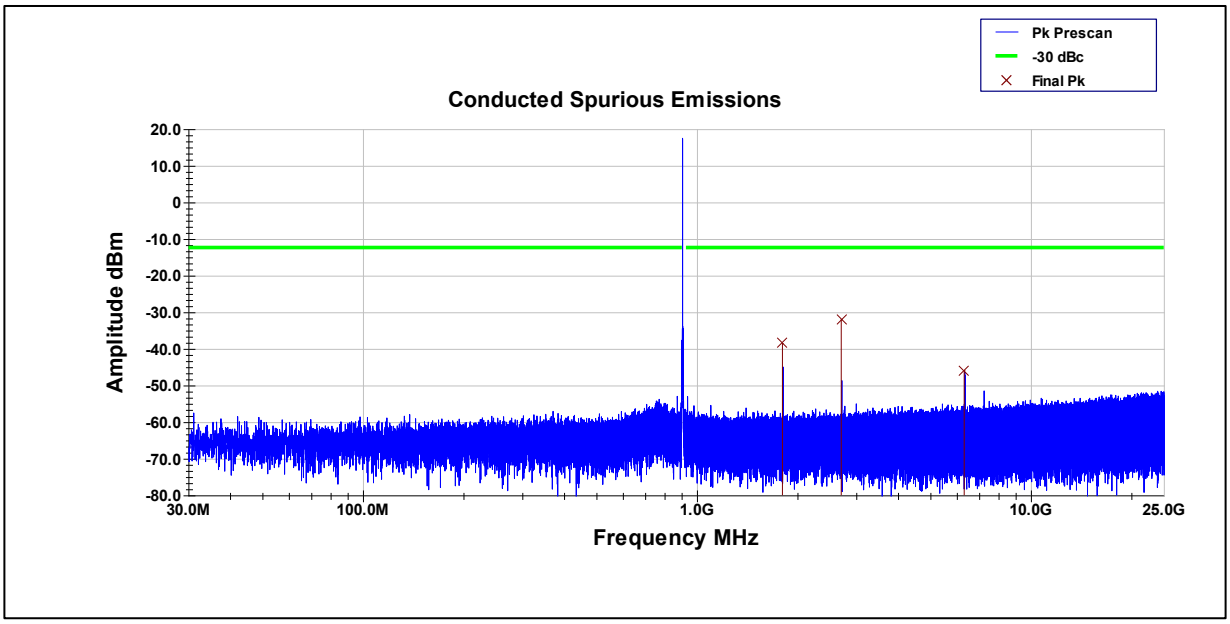
30.0M
100.0M
1.0G
10.0G
25.0G
Frequency MHz

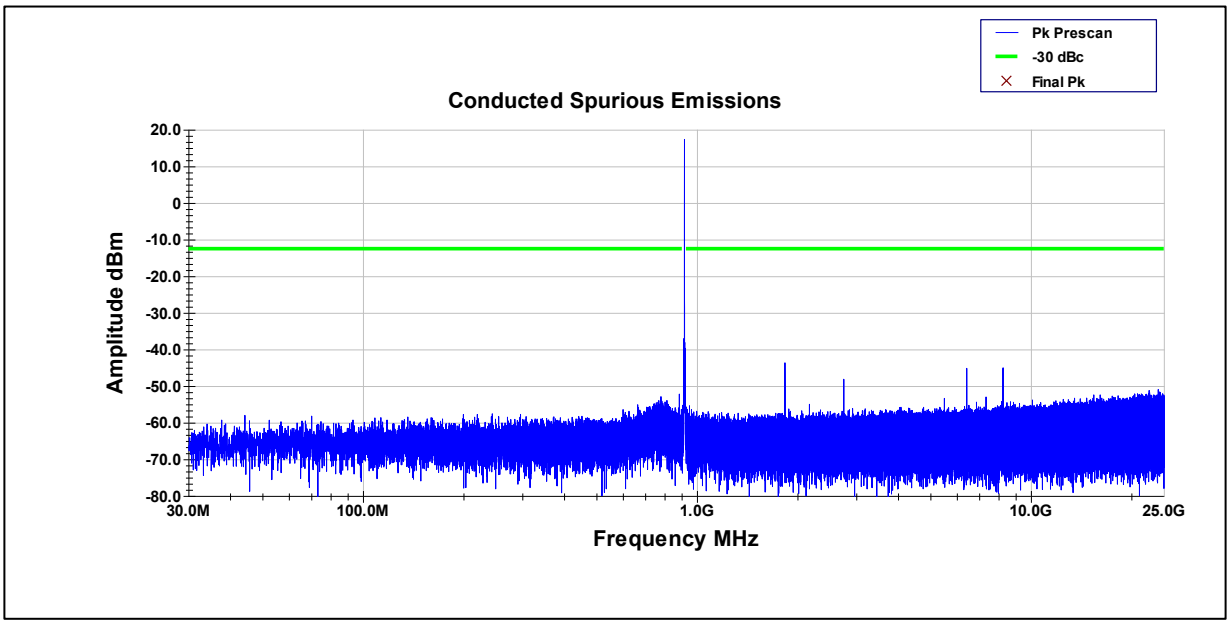
Sidewalk LoRa DTS

Low Ch

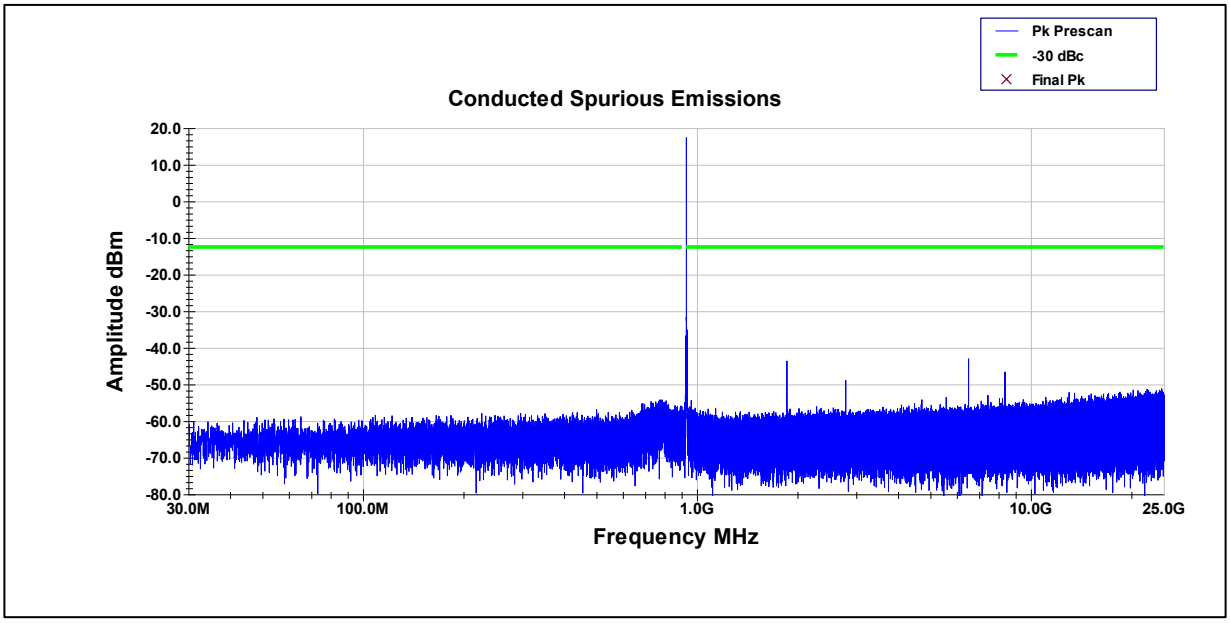


Frequency	Raw Pk	Final Pk	Path Loss	Limit	Pk Margin
(MHz)	dBm	dBm	dB	dBm	dB
1.8046 GHz	-39.58	-38.48	1.10	-12.38	-26.11
2.7077 GHz	-33.26	-31.91	1.34	-12.38	-19.54
6.3183 GHz	-48.16	-45.86	2.29	-12.38	-33.48
Final = Raw + Path Loss					
Margin = Final - Limit					

Mid Ch

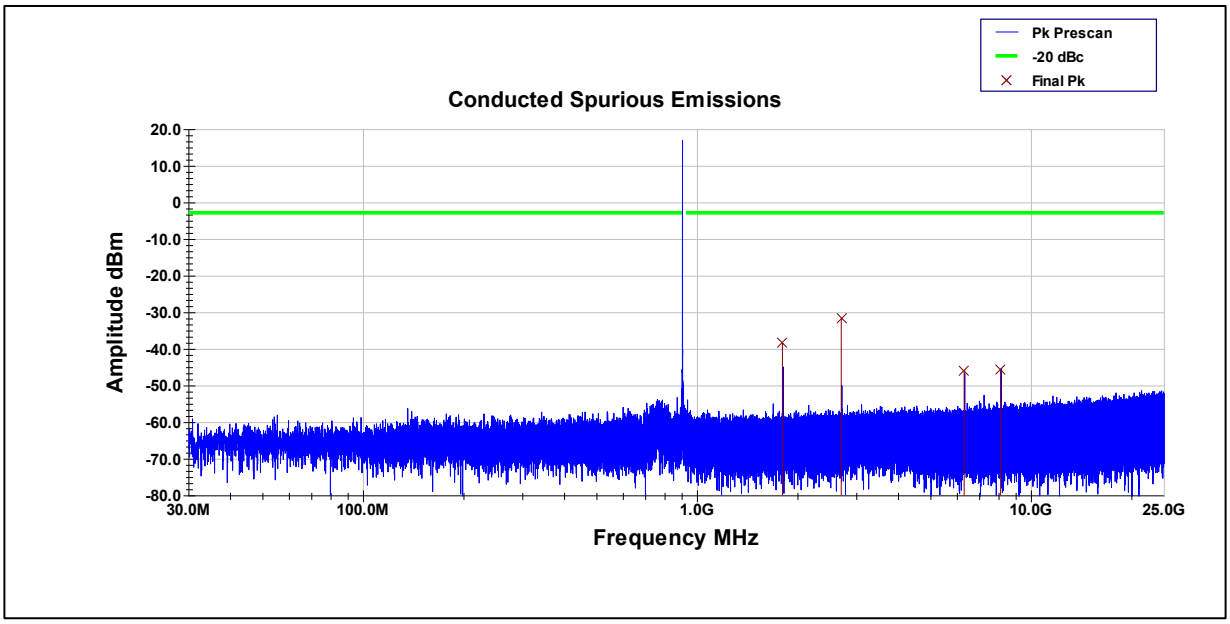


High Ch



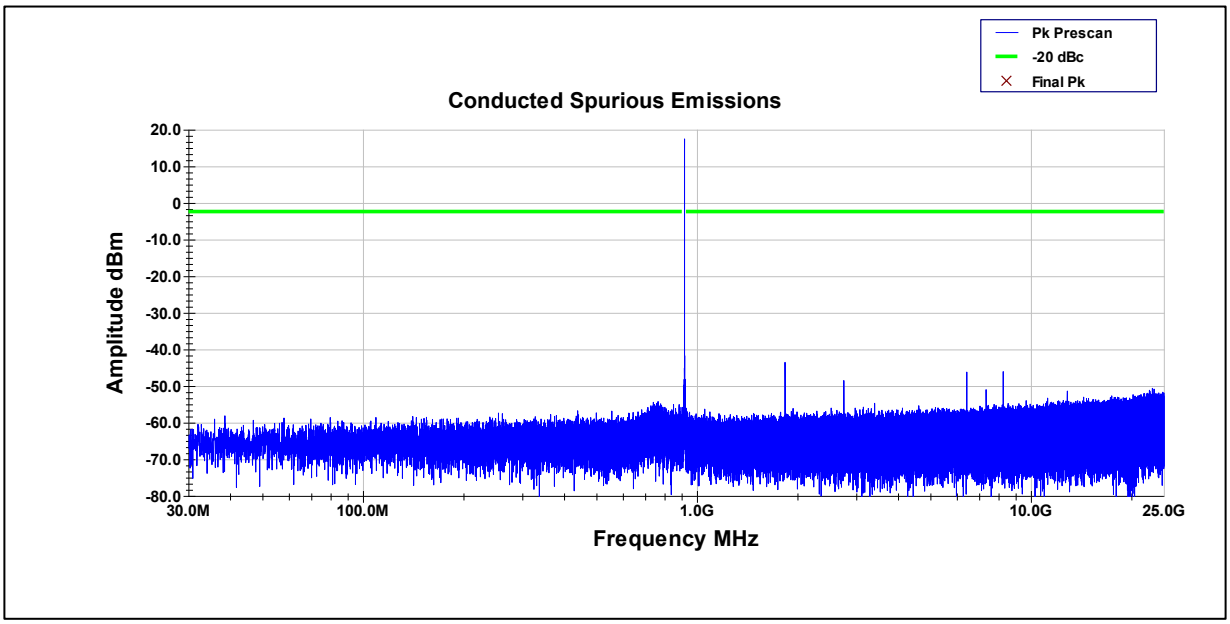
Sidewalk FSK

Low Ch

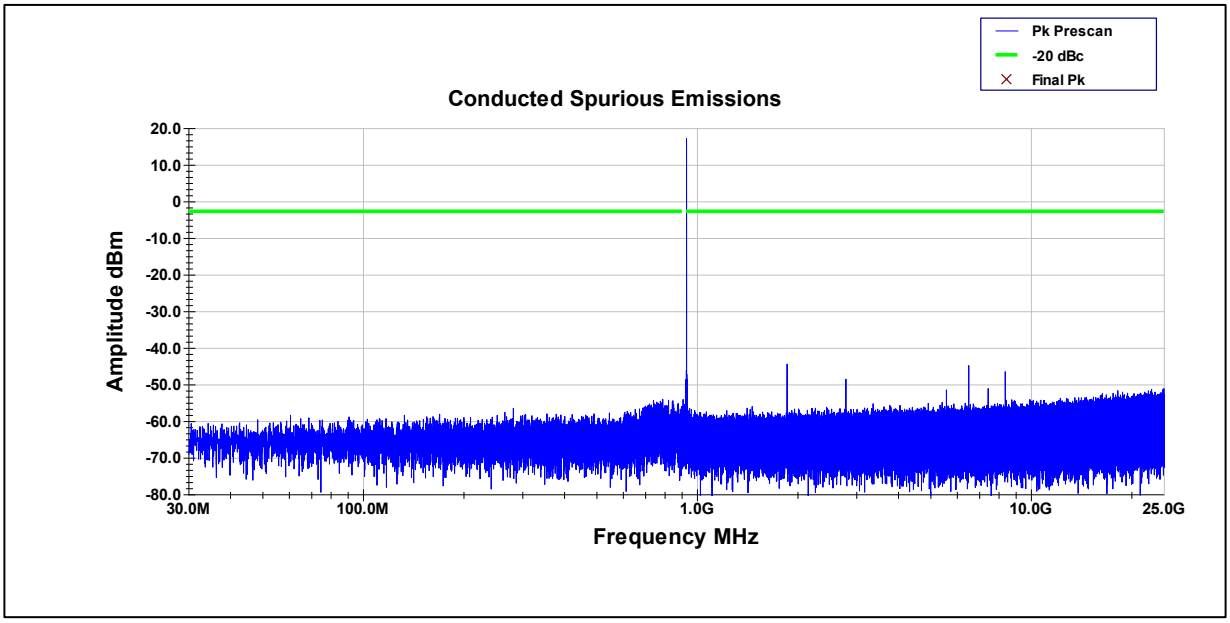


Frequency	Raw Pk	Final Pk	Path Loss	Limit	Pk Margin
(MHz)	dBm	dBm	dB	dBm	dB
1.8043 GHz	-39.56	-38.47	1.10	-2.89	-35.57
2.7068 GHz	-33.05	-31.70	1.34	-2.89	-28.81
6.3149 GHz	-48.24	-45.93	2.30	-2.89	-43.04
8.1201 GHz	-48.55	-45.76	2.79	-2.89	-42.87
Final = Raw + Path Loss					
Margin = Final - Limit					

Mid Ch



High Ch



Emissions in Restricted Frequency Bands

Engineer: Aaron S. Froehlich
Test Date: 9/2/2022

Test Procedure: 30-1000 MHz

Per ANSI C63.10 Clause 5.6.2.2 b) the worst case modes to be tested for spurious emissions is Lora DTS SF12. A simultaneous transmission of 1 Mbps BLE and 2440 was also active during all radiated tests below.

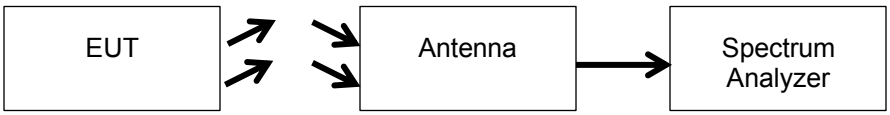
Testing below 1 GHz was performed with the appropriate antennas transmit antennas in place.

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The EUT was set to transmit on the lowest, middle and highest frequency of operation, as well as frequency hopping, at the maximum power level. The EUT was tested, in 3 orthogonal axis, by rotating it 360° with the receive antenna in both the vertical and horizontal orientation while raised from 1 to 4 meters to ensure the TX signal levels were maximized. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Spurious Emissions.

All emissions from 30 MHz to 1 GHz were examined.
Measured Level includes antenna and receiver cable correction factors.
Correction factors were input into the spectrum analyzer before recording “Measured Level”.

RBW = 100 KHz
VBW = 300 KHz
Detector – Quasi Peak

Test Setup



Test Procedure: ≥ 1 GHz

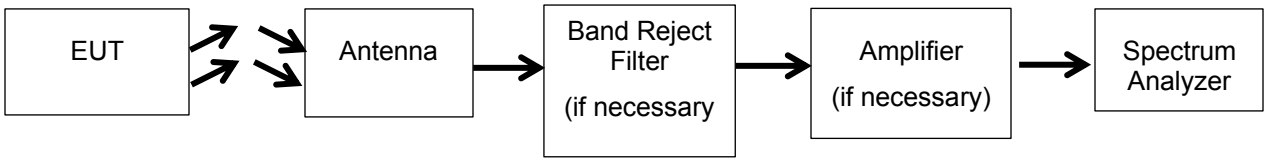
Per ANSI C63.10 Clause 5.6.2.2 b) the worst case modes to be tested for spurious emissions is Lora DTS SF12. A simultaneous transmission of 1 Mbps BLE and 2440 was also active during all radiated tests below.

Testing above 1 GHz was performed with the antenna ports terminated to comply with the cabinet case emission requirements. Emissions seen at 1.8 GHz are not within a restricted band and are therefore subject to the 100 kHZ 30 dBc requirements and are compliant.

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The EUT was set to transmit on the lowest, middle and highest frequency of operation at the maximum power level. The EUT was tested, in 3 orthogonal axis, by rotating it 360° with the receive antenna in both the vertical and horizontal orientation while raised from 1 to 4 meters to ensure the TX signal levels were maximized. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Spurious Emissions.

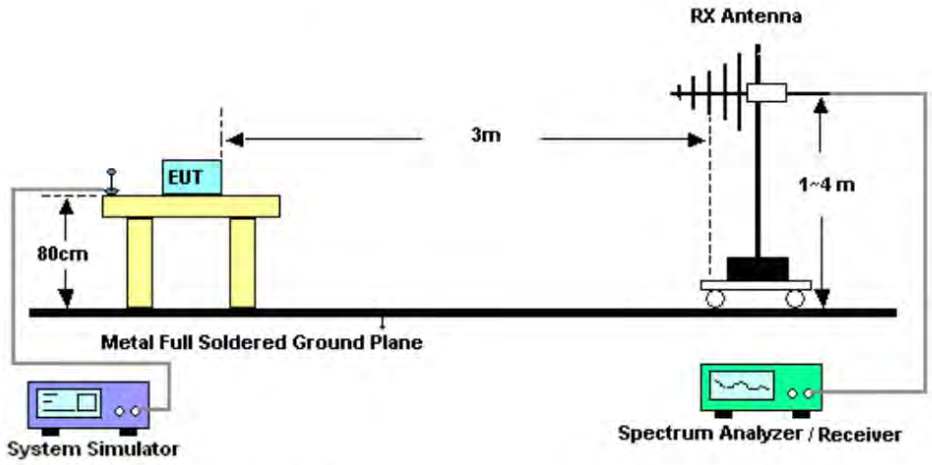
RBW = 1 MHz
VBW = 3 MHz
Detector – Peak

Test Setup

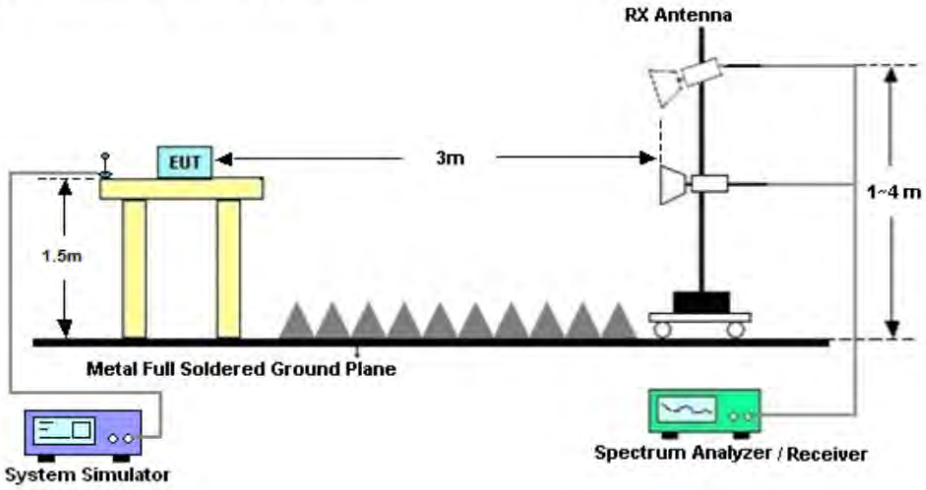


Chamber Setup Diagrams

For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



Test Procedure: Conducted

Conducted Spurious Emissions in the restricted bands has been measured using the methods of ANSI C63.10 clause 11.12.2. The antenna port was connected to a spectrum analyzer and the range of 1 GHz to 10 times the operating frequency was scanned with a resolution bandwidth of 1 MHz, video bandwidth of 3 MHz and a coupled sweep time.

Per ANSI C63.10 Clause 5.6.2.2 b) the mode with the highest output power, and highest PSD for each modulation family has been tested and reported.

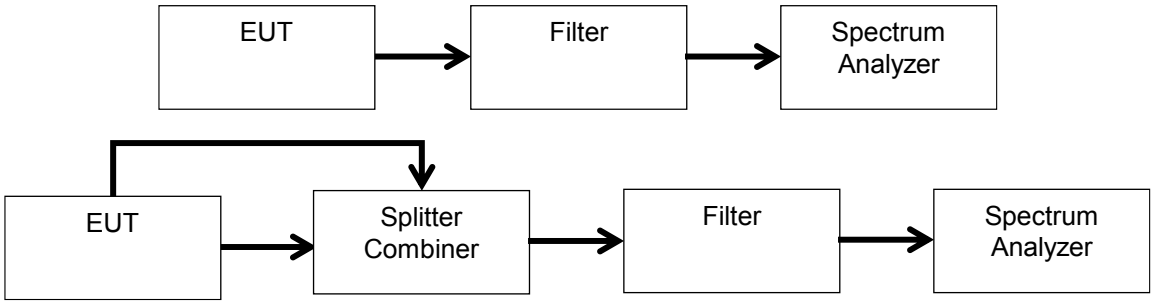
For simultaneous transmission, a combiner was used to measure both the 900 MHz radio and the 2.4 GHz BLE radio simultaneously. The cables and splitter were swept and the losses incorporated in the measurement.

The emissions at 1.8 GHz is not within a restricted band and is therefore subject to 15.247(d) requirements and has been found to be compliant.

Limits

47 CFR 15.247(d) & RSS 247 Section 5.5
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

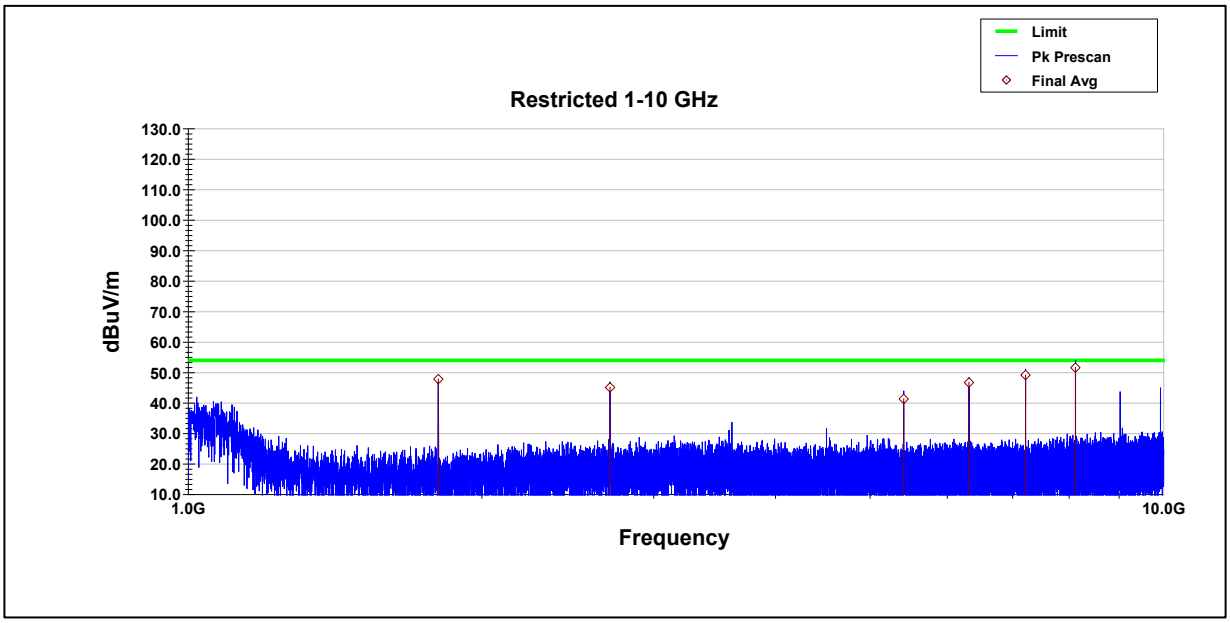
Test Setup



Conducted Test Data

1-10 GHz

LoRa FHSS SF7 Low Ch

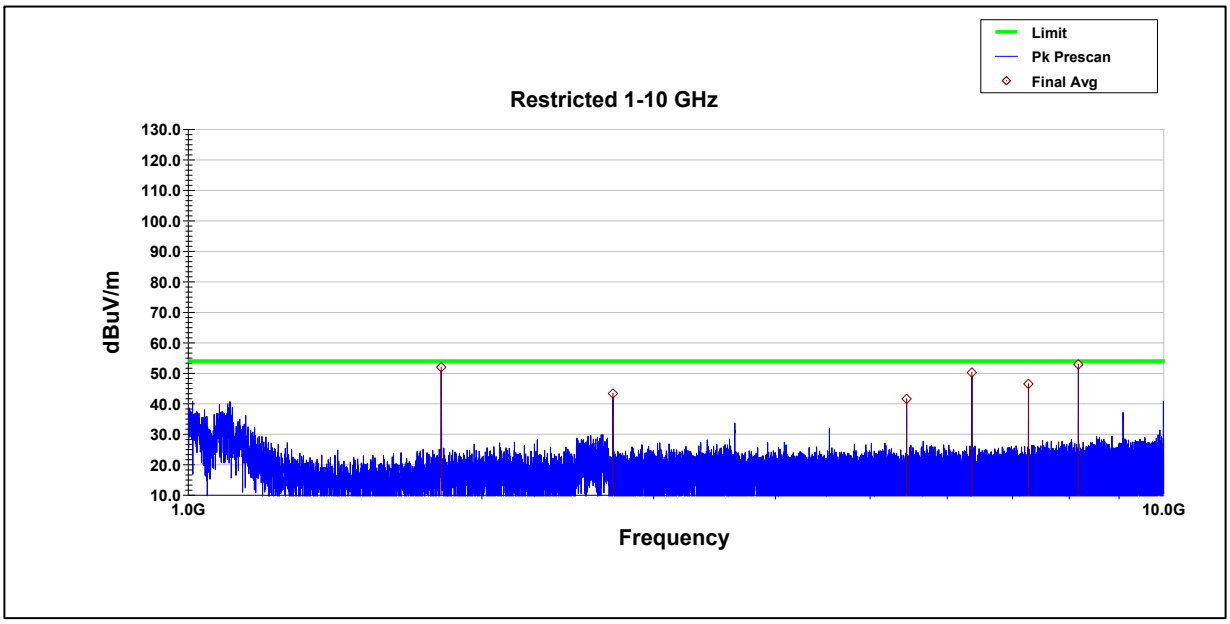


Frequency	Raw Avg	Path Loss	Converstion	Final Avg	Limit	Margin
MHz	dBm	dB	dB	dBuV/m	dBuV/m	dB
1804.573	-52.50	5.10	95.30	47.90	54.00	-6.10
2706.868	-53.90	3.70	95.30	45.10	54.00	-8.90
5413.876	-58.40	4.50	95.30	41.30	54.00	-12.70
6315.966	-53.40	4.90	95.30	46.70	54.00	-7.30
7218.431	-51.10	5.00	95.30	49.20	54.00	-4.80
8120.757	-49.30	5.60	95.30	51.60	54.00	-2.40

Final = Raw + Path Loss + Conversion

Margin = Final - Limit

LoRa FHSS SF 7 Mid Ch

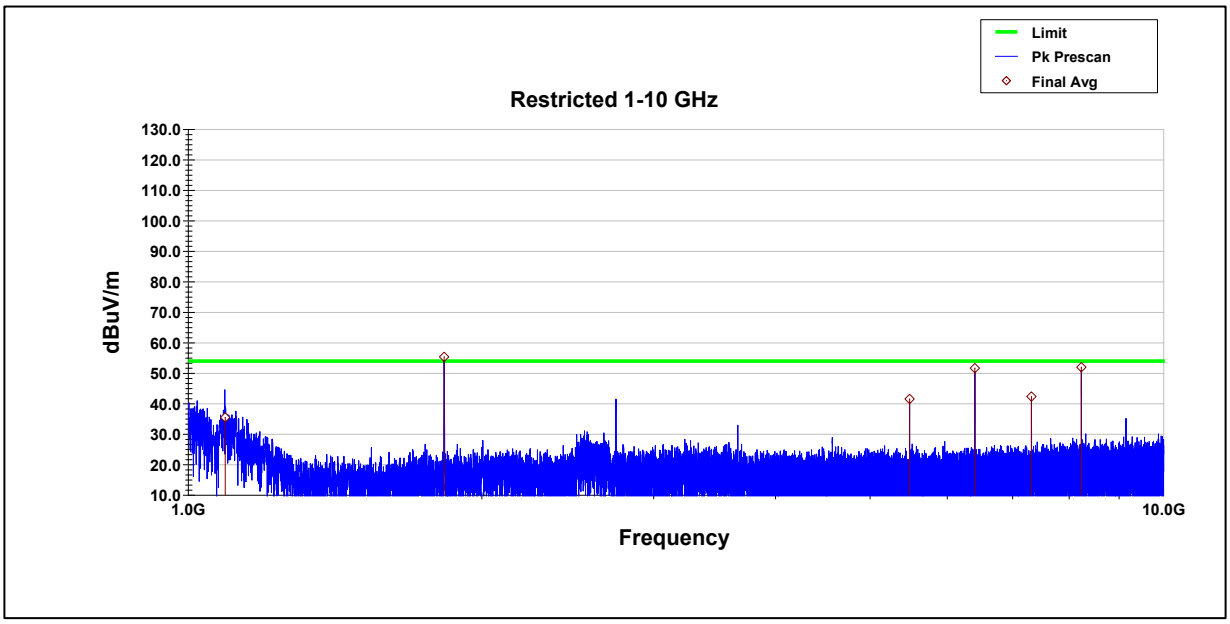


Frequency	Raw Avg	Path Loss	Converstion	Final Avg	Limit	Margin
MHz	dBm	dB	dB	dBuV/m	dBuV/m	dB
1816.965	-48.40	5.10	95.30	52.00	54.00	-2.00
2725.481	-55.60	3.70	95.30	43.30	54.00	-10.60
5451.016	-58.20	4.60	95.30	41.60	54.00	-12.40
6359.475	-49.90	4.90	95.30	50.20	54.00	-3.70
7267.874	-53.80	5.10	95.30	46.50	54.00	-7.50
8176.623	-47.70	5.40	95.30	52.90	54.00	-1.10

Final = Raw + Path Loss + Conversion

Margin = Final - Limit

LoRa FHSS SF 7 High Ch

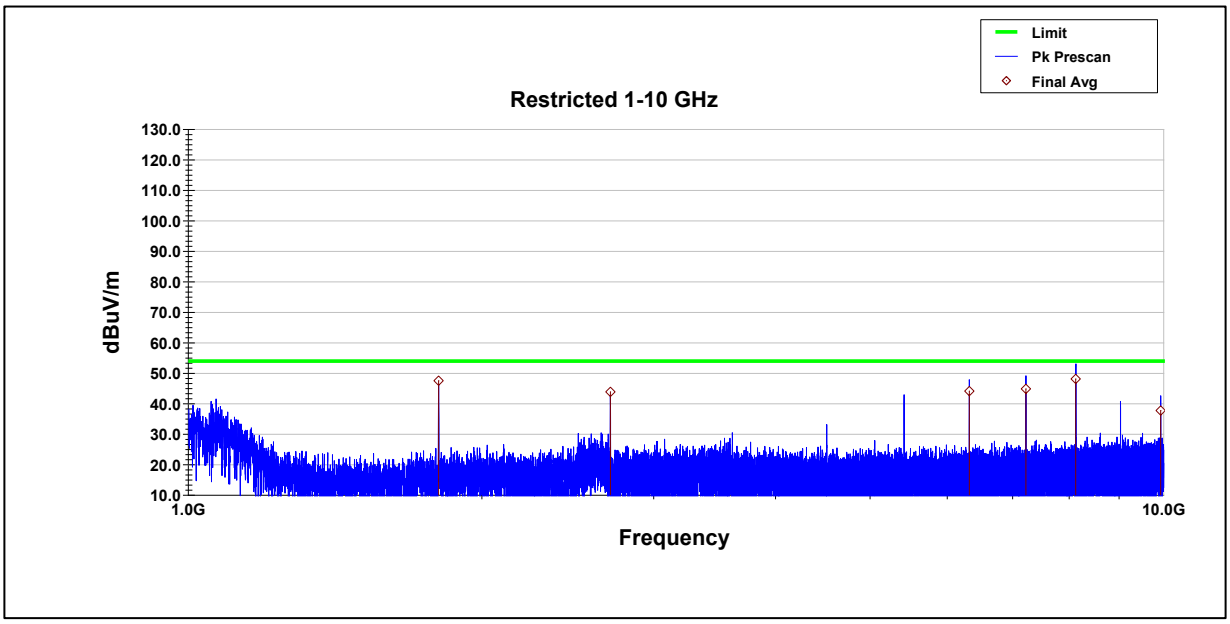


Frequency	Raw Avg	Path Loss	Converstion	Final Avg	Limit	Margin
MHz	dBm	dB	dB	dBuV/m	dBuV/m	dB
1091.379	-63.40	3.70	95.30	35.50	54.00	-18.50
1829.768	-45.00	5.10	95.30	55.40	54.00	1.40
5489.417	-58.30	4.60	95.30	41.60	54.00	-12.40
6404.374	-48.30	4.70	95.30	51.70	54.00	-2.30
7319.185	-57.80	4.90	95.30	42.30	54.00	-11.60
8234.019	-49.00	5.80	95.30	52.00	54.00	-2.00

Final = Raw + Path Loss + Conversion

Margin = Final - Limit

LoRa DTS SF 11 Low Ch

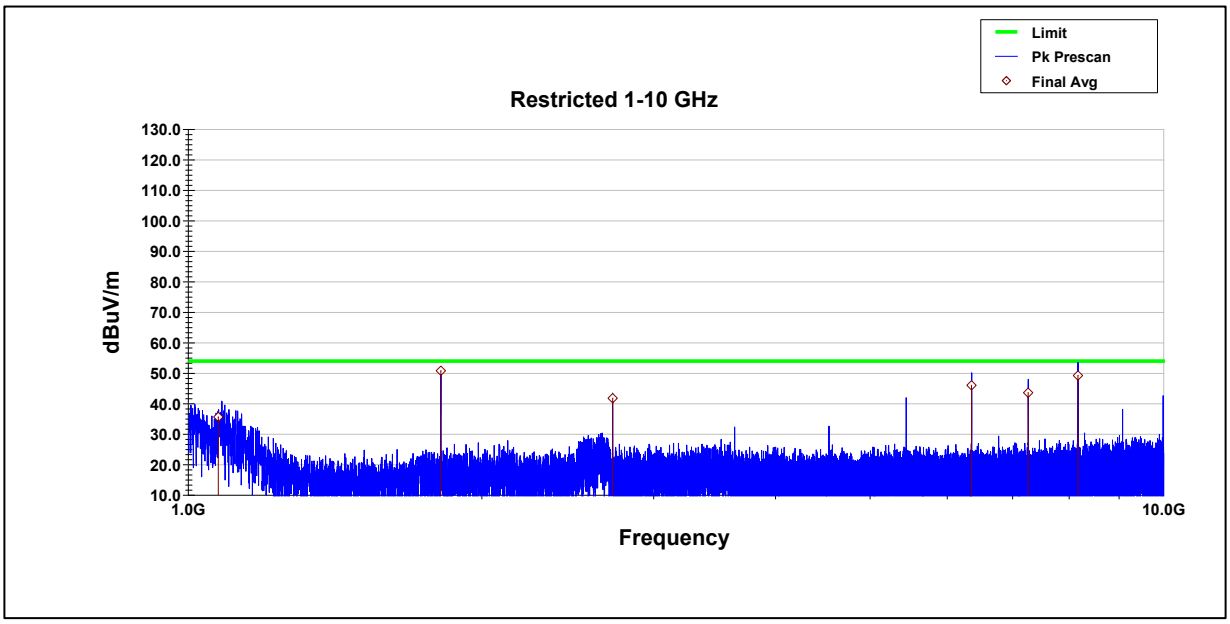


Frequency	Raw Avg	Path Loss	Converstion	Final Avg	Limit	Margin
MHz	dBm	dB	dB	dBuV/m	dBuV/m	dB
1805.968	-52.80	5.10	95.30	47.60	54.00	-6.40
2708.885	-55.10	3.70	95.30	43.90	54.00	-10.10
6321.702	-56.00	4.80	95.30	44.10	54.00	-9.90
7224.568	-55.40	5.00	95.30	44.90	54.00	-9.10
8125.8	-52.80	5.70	95.30	48.10	54.00	-5.80
9931.494	-63.30	5.90	95.30	37.80	54.00	-16.20

Final = Raw + Path Loss + Conversion

Margin = Final - Limit

LoRa DTS SF 11 Mid Ch

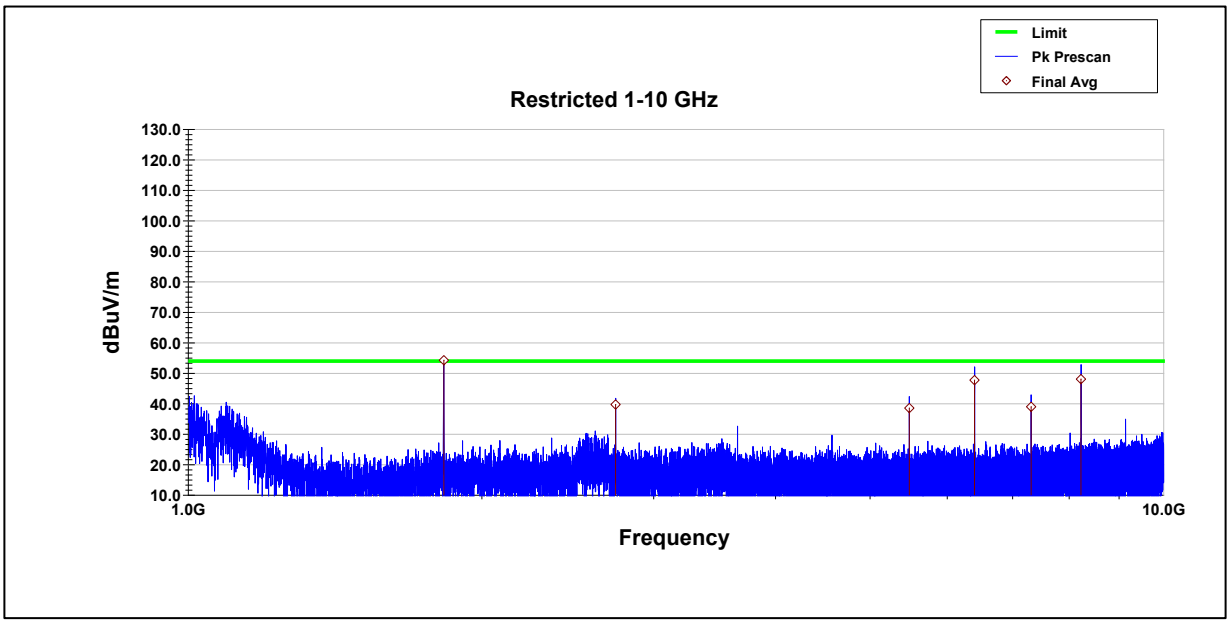


Frequency	Raw Avg	Path Loss	Converstion	Final Avg	Limit	Margin
MHz	dBm	dB	dB	dBuV/m	dBuV/m	dB
1073.47	-63.30	3.70	95.30	35.60	54.00	-18.30
1815.609	-49.60	5.10	95.30	50.80	54.00	-3.20
2723.322	-57.20	3.70	95.30	41.80	54.00	-12.20
6353.923	-54.10	4.90	95.30	46.00	54.00	-7.90
7262.725	-56.70	5.10	95.30	43.60	54.00	-10.40
8169.28	-51.30	5.30	95.30	49.30	54.00	-4.70

Final = Raw + Path Loss + Conversion

Margin = Final - Limit

LoRa DTS SF 11 High Ch



Frequency	Raw Avg	Path Loss	Converstion	Final Avg	Limit	Margin
MHz	dBm	dB	dB	dBuV/m	dBuV/m	dB
1828.4	-46.10	5.10	95.30	54.30	54.00	0.30
2742.66	-59.30	3.80	95.30	39.70	54.00	-14.20
5485.811	-61.20	4.60	95.30	38.60	54.00	-15.40
6399.194	-52.20	4.70	95.30	47.80	54.00	-6.20
7314.41	-61.20	4.90	95.30	39.00	54.00	-15.00
8226.659	-53.00	5.80	95.30	48.10	54.00	-5.90

Final = Raw + Path Loss + Conversion

Margin = Final - Limit