Test Report Serial Number:	**45461674 R1.0**
Test Report Date:	**15 July 2021**
Project Number:	**1536**

EMC Test Report - New Certification

Applicant:

Zenner USA
15280 Addison Rs
Suite 240
Addison, TX, 75001, USA

FCC ID:	IC Registration Number
2ACOA-WM3	**26631-WM3**
Product Model Number / HVIN	Product Marketing Name / PMN
100-0024-001 **100-0025-001**	**Stealth Reader**

In Accordance With:

CFR Title 47, Part 15 Subpart C (§15.247), Part 15 Subpart B
Digital Transmission System (DTS)

RSS-Gen, RSS-247 Issue 2
Digital Transmissions Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

Approved By:

Ben Hewson, President
Celltech Labs Inc.
21-364 Lougheed Rd.
Kelowna, BC, V1X 7R8
Canada

Test Lab Certificate: 2470.01 **IC Registration 3874A-1** **FCC Registration: CA3874**

Table of Contents

Table of Figures

Table of Plots

Table of Tables

1.0 DOCUMENT CONTROL

Revision History					
Samples Tested By:	Art Voss, P.Eng.		**Date(s) of Evaluation:**	28 June - 13 July, 2021	
Report Prepared By:	Art Voss, P.Eng.		**Report Reviewed By:**	Ben Hewson	
Report Revision	**Description of Revision**		**Revised Section**	**Revised By**	**Revision Date**
0.1	Initial Draft Release		n/a	Art Voss	14 July 2021
0.2	Revised Draft - Additional HVIN		n/a	Art Voss	15 July 2021
1.0	Initial Release		n/a	Art Voss	15 July 2021

2.0 CLIENT AND DUT INFORMATION

Client Information	
Applicant Name	**Zenner USA**
Applicant Address	15280 Addison Rd, Suite 240
	Addison, TX, 75001
	USA
DUT Information	
Device Identifier(s):	**FCC ID:** **2ACOA-WM3**
	ISED ID: **26631-WM3**
Device Model(s) / HVIN:	100-0024-001
	100-0025-001
Device Marketing Name / PMN:	Stealth Reader
Test Sample Serial No.:	9998092
Device Type:	Digital Transceiver
FCC Equipment Class:	Digital Transmission System (DTS)
	Spread Spectrum Transmitter (DSS)
ISED Equipment Class:	Spread Spectrum/Digital Device (902-928MHz)
Transmit Frequency Range:	MESH Mode (DSS): 902-928MHz
	Drive-By Mode (DSS): 902-928MHz
	Lora Mode (DSS): 902-915MHz
	Lora Mode (DTS): 902-915MHz
Manuf. Max. Rated Output Power:	MESH Mode (DSS): 500mW (27dBm)
	Drive-By Mode (DSS): 500mW (27dBm)
	Lora Mode (DSS): 500mW (27dBm)
	Lora Mode (DTS): 100mW (20dBm)
Antenna Type and Gain:	0dBi Max*, Helical
Modulation:	FSK
DUT Power Source:	3.6 VDC Li-Metal
DUT Dimensions [LxWxH] (cm)	H x W x D: 13X13X4.5
Deviation(s) from standard/procedure:	None
Modification of DUT:	None

* Information regarding antenna type and gain provided by applicant.

3.0 SCOPE

Preface:

This Certification Report was prepared on behalf of:

Zenner USA

,(the '*Applicant*"), in accordance with the applicable Federal Communications Commission (FCC) CFR 47 and Innovation, Scientific and Economic Development (ISED) Canada rules parts and regulations (the '*Rules*'). The scope of this investigation was limited to only the equipment, devices and accessories (the '*Equipment*') supplied by the *Applicant*. The tests and measurements performed on this *Equipment* were only those set forth in the applicable *Rules* and/or the Test and Measurement Standards they reference. The *Rules* applied and the Test and Measurement Standards used during this evaluation appear in the Normative References section of this report. The limits set forth in the technical requirements of the applicable *Rules* were applied to the measurement results obtained during this evaluation and ,unless otherwise noted, these limits were used as the Pass/Fail criteria. The Pass/Fail statements made in this report apply to only the tests and measurements performed on only the *Equipment* tested during this evaluation. Where applicable and permissible, information including test and measurement data and/or results from previous evaluations of same or similar equipment, devices and/or accessories may be cited in this report.

Device Operation:

The Zenner USA Model/HVIN: 100-0024-001 & 100-0025-001 (WM3) are utility meter (water meter) digital data transceivers operating in the 902-928MHz band. The WM3 is a hybrid device consisting of three (3) modes of Digital Spread Spectrum and one (1) mode of Digital Transmitter System. The DSS modes are MESH, Drive-By and Long Range (LoRa) operating with 20dB bandwidths of 230kHz, 400kHz and 150kHz, respectively. The MESH and Drive-By modes transmit on 50 hopping channels between 902 and 928MHz. The LoRa mode transmits on 64 hopping channels between 902 and 915MHz. The DTS mode is also a LoRa transmitter operating with a DTS bandwidth in excees of 500kHz between 902 and 915MHz. All modes modulate using FSK. Both model varaints are identical with the exception of the interface cable used to connect to the metering equipment.

Requirement:

The transceivers of this *equipment* are subject to emissions evaluation in accordance with FCC: 47 CFR 2, 15C, ISED: RSS-Gen, and RSS-247. As per FCC 47 CFR §2.1093 and Health Canada Safety Code 6, an RF Exposure (MPE) evaluation is required for this *Equipment* and the results of the RF Exposure (MPE) evaluation appear in a separate report.

Application:

This is an application for a New Certification.

Scope:

The scope of this investigation is limited to the evaluation and reporting of the wanted and unwanted spurious emissions in accordance with the rule parts cited in Normative References section of this report.

4.0 TEST SUMMARY

TEST SUMMARY

Section	Description of Test	Procedure Reference	Applicable Rule Part(s) FCC	Applicable Rule Part(s) ISED	Test Date	Result
7.0	Occupied Bandwidth	ANSI C63.10-2013 KDB 558074 D01v05	§2.1049	RSS-Gen (6.7)	30 June 2021	Pass
8.0	DTS Bandwidth	ANSI C63.10-2013 KDB 558074 D01v05	§15.247(a)(2)	RSS-Gen (6.7) RSS-247 (5.2)(a)	30 June 2021	Pass
9.0	20dB Bandwidth	ANSI C63.10-2013 KDB 558074 D01v05	§15.247(a)(1)(i)	RSS-Gen (6.7) RSS-247 (5.1)(c)	4 July 2021	Pass
10.0	Conducted Power (Fundamental)	ANSI C63.10-2013 KDB 558074 D01v05 KDB 558074 D01v05	§2.1046 §15.247(b)(2) §15.247(b)(3)	RSS-Gen (6.12) RSS-247 (5.4)(a) RSS-247 (5.4)(d)	3 July 2021	Pass
11.0	Power Spectral Density	ANSI C63.10-2013 KDB 558074 D01v05	§15.247(e)	RSS-247 (5.2)(b)	4 July 2021	Pass
12.0	FHSS Hopping Characteristics	ANSI C63.4-2014 KDB 558074 D01v05	§15.247(a)(1)(iii)	RSS-247 (5.1)(d)	30 June, 3, 4, 13 July, 2021	Pass
13.0	FHSS Channel Separation	ANSI C63.4-2014 KDB 558074 D01v05	§15.247(a)(1)	RSS-247 (5.1)(b)	30 June, 3, 4, 13 July, 2021	Pass
14.0	FHSS Time of Occupancy	ANSI C63.4-2014 KDB 558074 D01v05	§15.247(a)(1)(iii)	RSS-247 (5.1)(d)	30 June, 3, 4, 13 July, 2021	Pass
15.0	Conducted Tx Spurious Emissions Band Edge	ANSI C63.10-2013 KDB 558074 D01v05	§2.1051 §15.247(d)	RSS-Gen (6.13) RSS-247 (5.5)	4 July 2021	Pass
16.0	Conducted Tx Spurious Emissions	ANSI C63.10-2013 KDB 558074 D01v05	§2.1051 §15.247(d)	RSS-Gen (6.13) RSS-247 (5.5)	4 July 2021	Pass
17.0	Radiated Tx Spurious Emissions And Restricted Band	ANSI C63.4-2014 KDB 558074 D01v05	§15.109 §15.247(d)	RSS-Gen (6.13)	5 July 2021	Pass
18.0	Radiated Rx Spurious Emissions	ANSI C63.4-2014 KDB 558074 D01v05	§15.109	RSS-Gen (7.4) ICES-003(6.2)	5 July 2021	Pass

Test Station Day Log					
Date	Ambient Temp (°C)	Relative Humidity (%)	Barometric Pressure (kPa)	Test Station	Tests Performed Section(s)
28 June 2021	29.2	18	101.1	**EMC**	**7**
30 June 2021	30.0	18	101.6	**EMC**	**7, 12, 13, 14**
2 July 2021	28.6	16	100.9	**EMC**	**9**
3 July 2021	27.6	14	100.7	**EMC**	**10**
4 July 2021	28.4	15	101.9	**EMC**	**9, 11 - 16**
5 July 2021	24.0	47	101.4	**OATS**	**17, 18**
13 July 2021	28.6	17	101.9	**EMC**	**12, 13, 14**

EMC - EMC Test Bench
SAC - Semi-Anechoic Chamber
OATS - Open Area Test Site
TC - Temperature Chamber
LISN - LISN Test Area
ESD - ESD Test Bench
IMM - Immunity Test Area
RI - Radiated Immunity Chamber

I attest that the data reported herein is true and accurate within the tolerance of the Measurement Instrument Uncertainty; that all tests and measurements were performed in accordance with accepted practices or procedures; and that all tests and measurements were performed by me or by trained personnel under my direct supervision. The results of this investigation are based solely on the test sample(s) provided by the client which were not adjusted, modified or altered in any manner whatsoever, except as required to carry out specific tests or measurements. This test report has been completed in accordance with ISO/IEC 17025.

Art Voss, P.Eng.
Technical Manager
Celltech Labs Inc.

15 July 2021
Date

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA A. F. VOSS # 31327

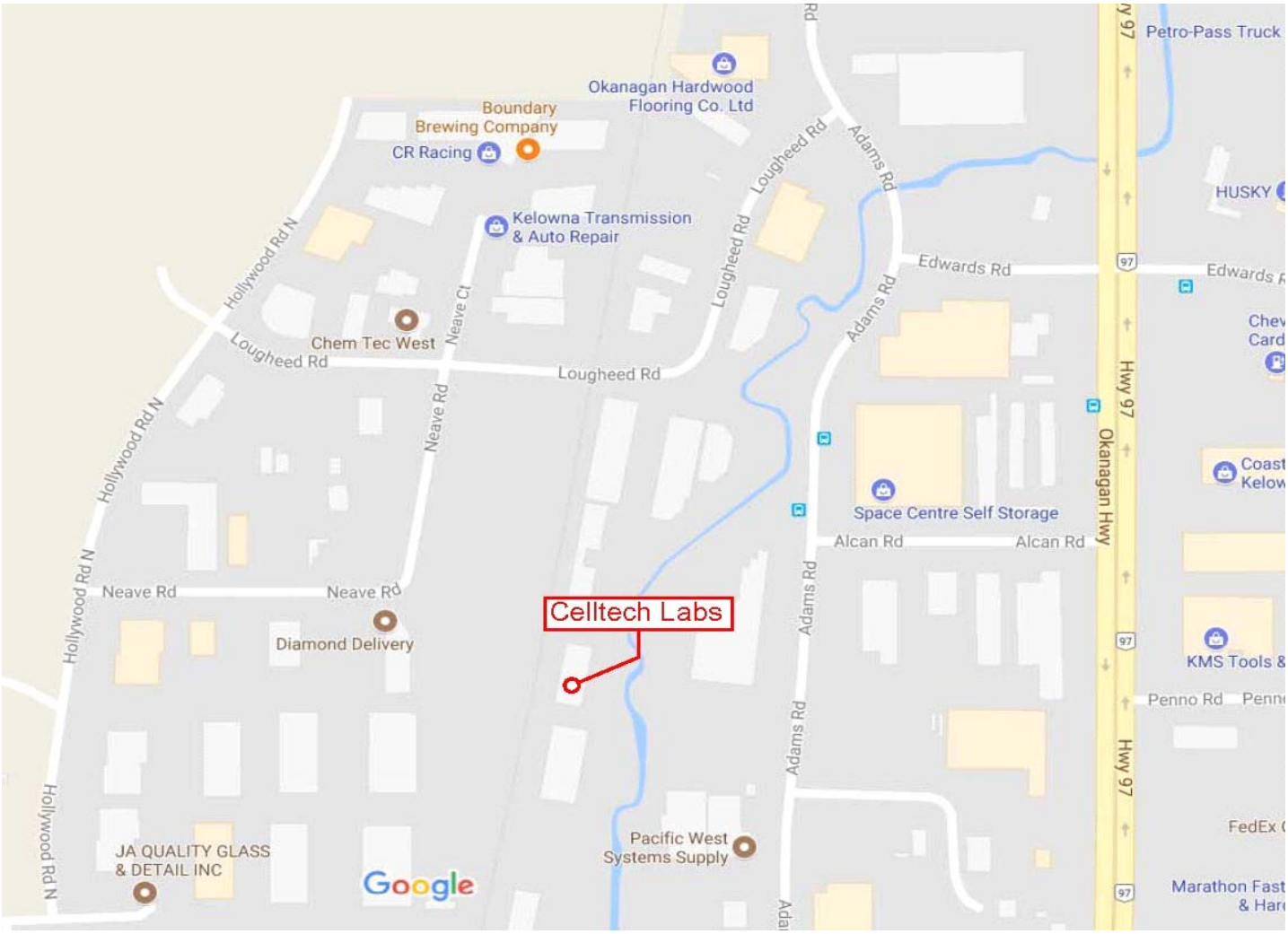
5.0 NORMATIVE REFERENCES

Normative References	
ISO/IEC 17025:2017	General requirements for the competence of testing and calibration laboratories
ANSI C63.4-2014	American National Standard of Procedures for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electric and Electronic Equipment in the Range of 9kHz to 40GHz
ANSI C63.10-2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
CFR Title 47: Part 2:	Code of Federal Regulations Telecommunication Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
CFR Title 47: Part 15: Sub Part C (15.247)	Code of Federal Regulations Telecommunication Radio Frequency Devices Intentional Radiators
ISED RSS-Gen Issue 5A1: March 2019	Innovation, Science and Economic Development Canada Spectrum Management and Telecommunications Radio Standards Specification General Requirements and Information for the Certification of Radiocommunication Equipment
ISED RSS-247 Issue 2: February 2017	Innovation, Science and Economic Development Canada Spectrum Management and Telecommunications Radio Standards Specification Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licensed-Exempt Local Area Network (LE_LAN) Devices
FCC KDB 558074 D01v05r02	OET Major Guidance Publications, Knowledge Data Base Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under Section 15.247

6.0 FACILITIES AND ACCREDITATIONS

Facility and Accreditation:

The facilities used to evaluate this device outlined in this report are located at 21-364 Lougheed Road, Kelowna, British Columbia, Canada V1X 7R8. The radiated emissions site (OATS) conforms to the requirements set forth in ANSI C63.4 and is filed and listed with the FCC under Test Firm Registration Number CA3874 and Innovation, Science and Economic Development Canada under Test Site File Number ISED 3874A-1. Celltech is accredited to ISO 17025, through accrediting body A2LA and with certificate 2470.01.



7.0 OCCUPIED BANDWIDTH

Test Procedure	
Normative Reference	FCC 47 CFR §2.1046, §15.247(b)(3), RSS-Gen (6.1.2), RSS-247 (5.4)(d), KDB 558074 (8.3.2.1), ANSI C63.10 (6.9.3)

General Procedure	
KDB 558074 (8.3.2.1)	**8.3.2.1 General** Section 15.247 permits the maximum conducted (average) output power to be measured as an alternative to the maximum peak conducted output power for demonstrating compliance to the limit. When this option is exercised, the measured power is to be referenced to the OBW rather than the DTS bandwidth.
C63.10 (6.9.3)	**6.9.3 Occupied bandwidth—power bandwidth (99%) measurement procedure** The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. The following procedure shall be used for measuring 99% power bandwidth: a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW. b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement. c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2. d) Step a) through step c) might require iteration to adjust within the specified range. e) Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used. f) Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.

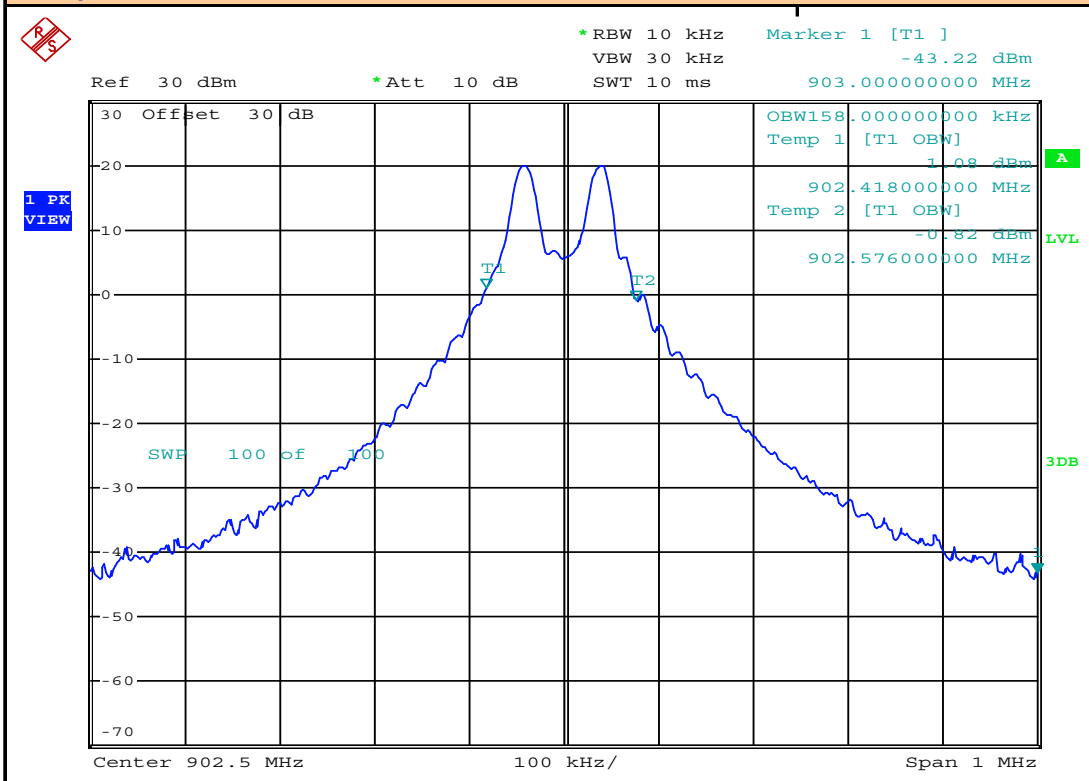
Test Setup	Appendix A - Figure A.1

Measurement Procedure

The DUT was connected to a Spectrum Analyzer (SA) via a 30dB attenuator connected to the DUT's antenna port. The SA was configured as described above using the 99% Occupied Bandwidth function. The output power of the DUT was set to the manufacturer's highest output power setting at the Low, Mid and High frequency channels as permitted by the device. The DUT was set to transmit at its maximum Duty Cycle. The 99% Occupied Bandwidth was measured and recorded and used for the basis for measuring the Conducted Output Power (See Section 10.0) and Power Spectral Density (See Section 11.0).

Plot 8.1 – Occupied Bandwidth, MESH, Ch 1

Occupied Bandwidth:

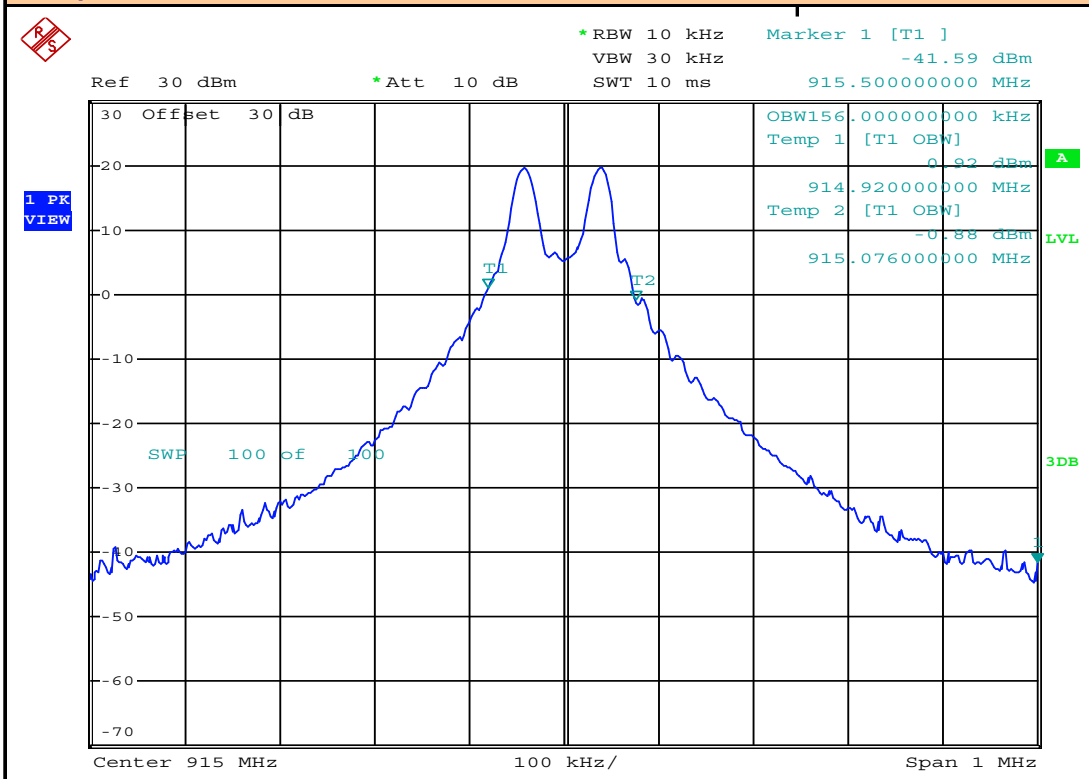


Date: 3.JUL.2021 12:08:28

Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	Occupied Bandwidth *(kHz)*
230kHz	1	902.5	MESH	FSK	158.0

Plot 8.2 – Occupied Bandwidth, MESH, Ch 26

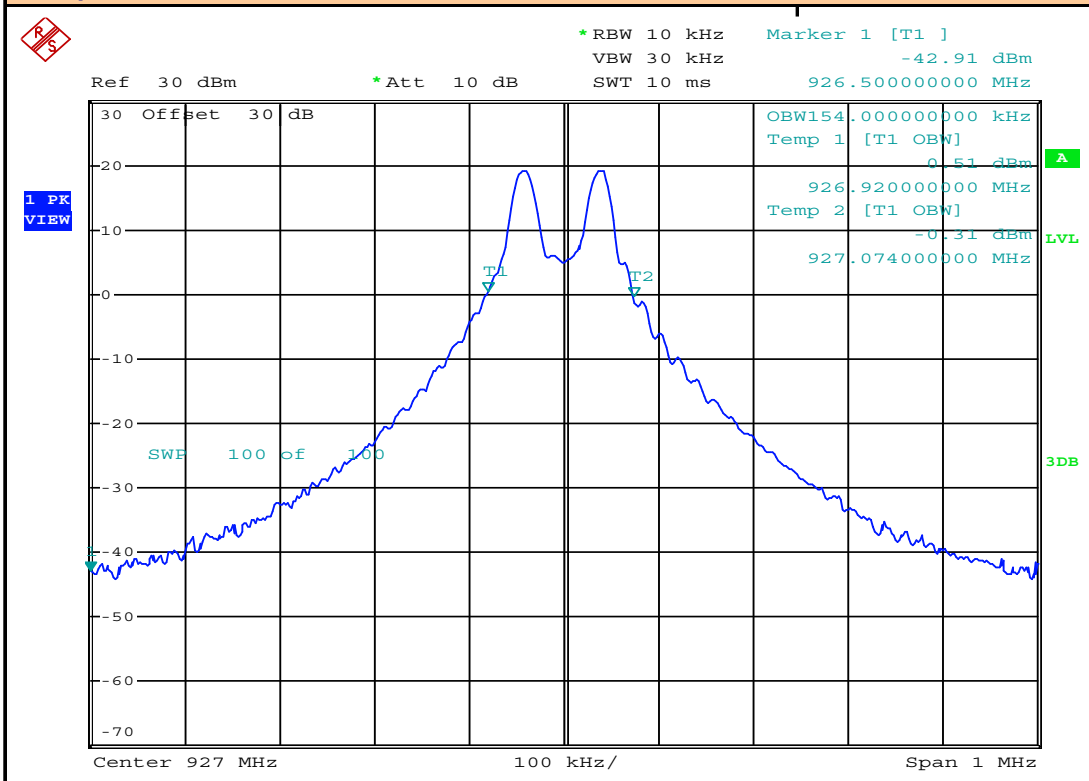
Occupied Bandwidth:



Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	Occupied Bandwidth *(kHz)*
230kHz	26	915	MESH	FSK	156.0

Plot 8.3 – Occupied Bandwidth, MESH, Ch 0

Occupied Bandwidth:

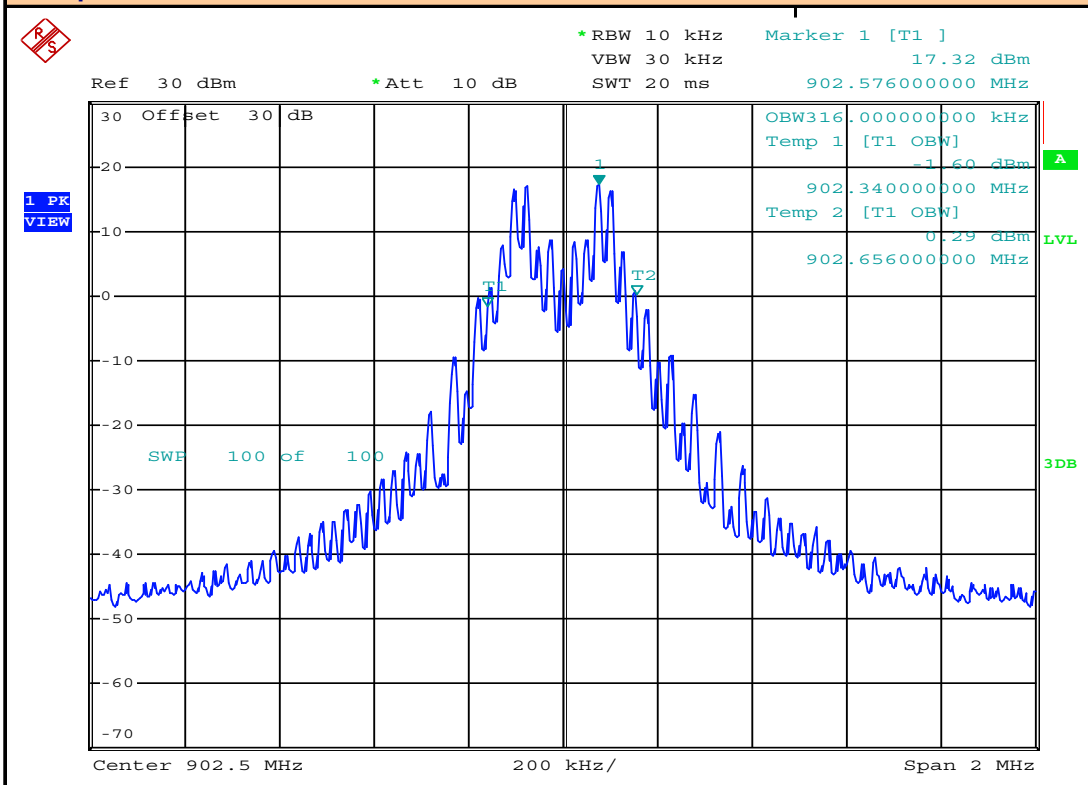


Date: 3.JUL.2021 12:07:16

Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	Occupied Bandwidth *(kHz)*
230kHz	0	927	MESH	FSK	154.0

Plot 8.4 – Occupied Bandwidth, Drive-By, Ch 1

Occupied Bandwidth:

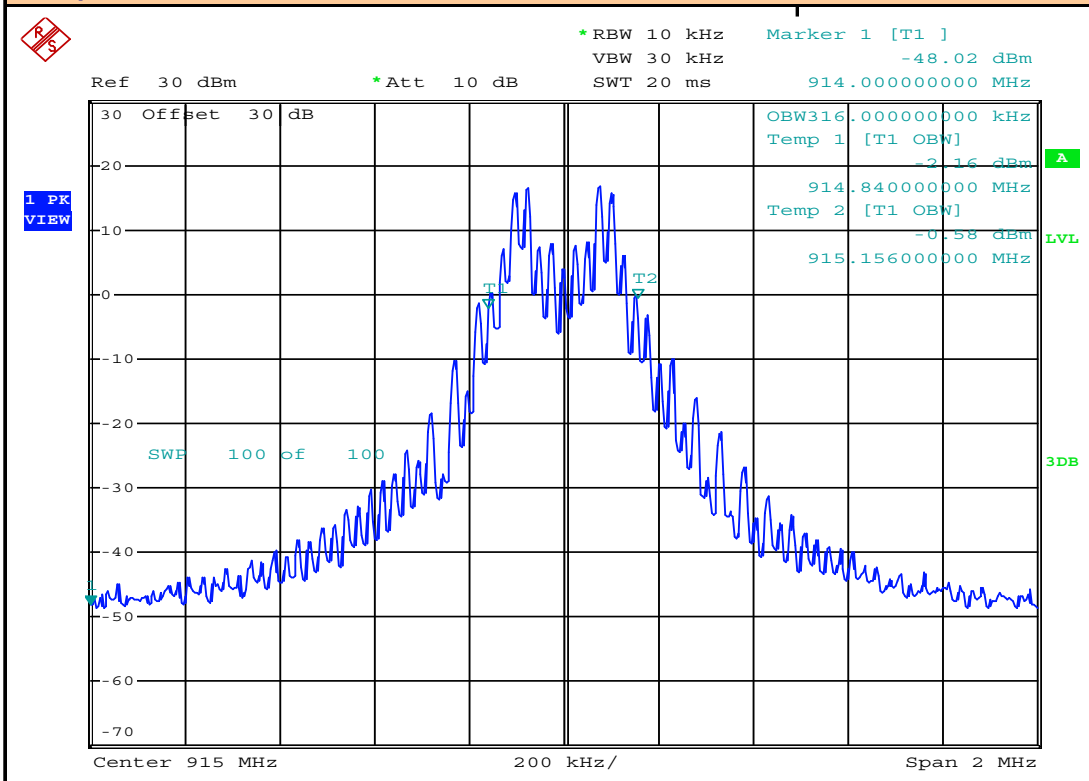


Date: 3.JUL.2021 12:02:35

Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	Occupied Bandwidth *(kHz)*
400kHz	1	902.5	Drive-By	FSK	316.0

Plot 8.5 – Occupied Bandwidth, Drive-By, Ch 26

Occupied Bandwidth:

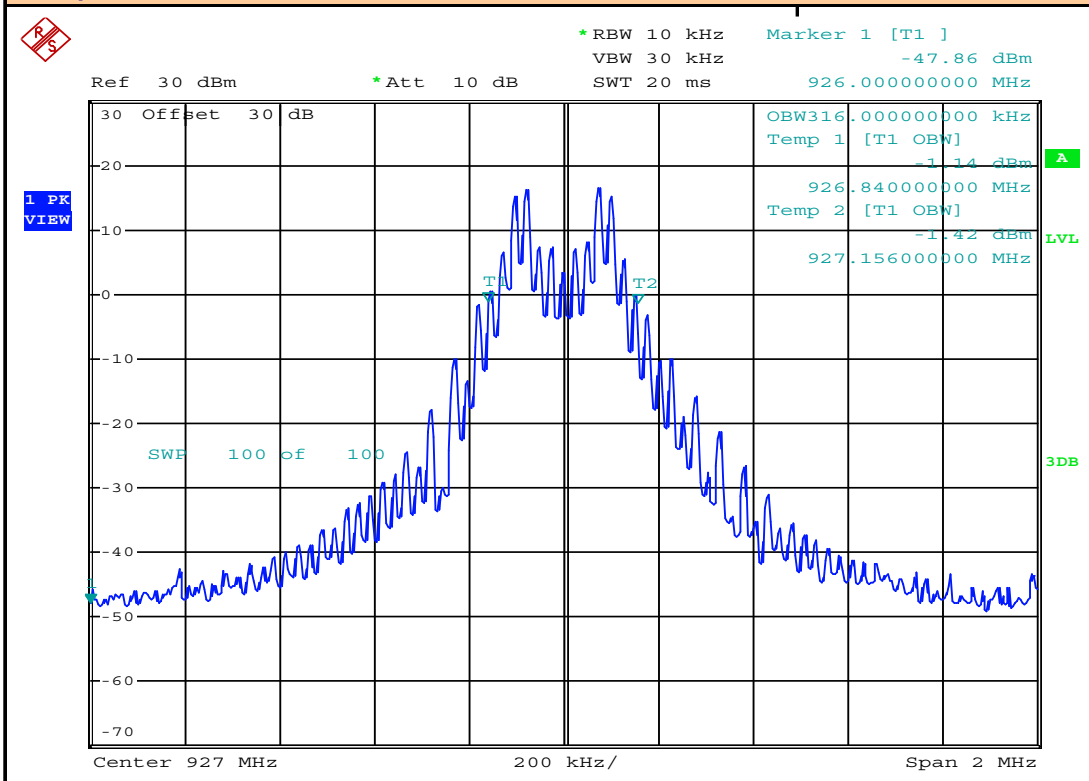


Date: 3.JUL.2021 12:03:34

Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	Occupied Bandwidth *(kHz)*
400kHz	26	915	Drive-By	FSK	316.0

Plot 8.6 – Occupied Bandwidth, Drive-By, Ch 0

Occupied Bandwidth:

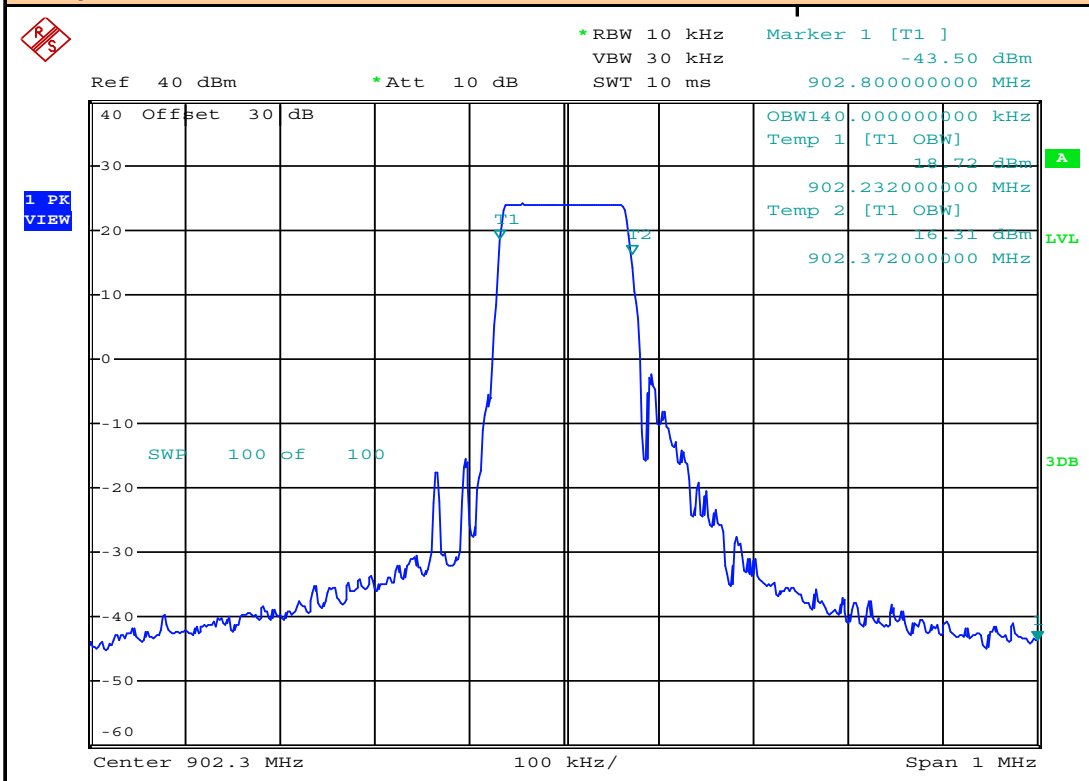


Date: 3.JUL.2021 12:04:41

Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	Occupied Bandwidth *(kHz)*
400kHz	0	927	Drive-By	FSK	316.0

Plot 8.7 – Occupied Bandwidth, LoRa (FHSS), Ch 0

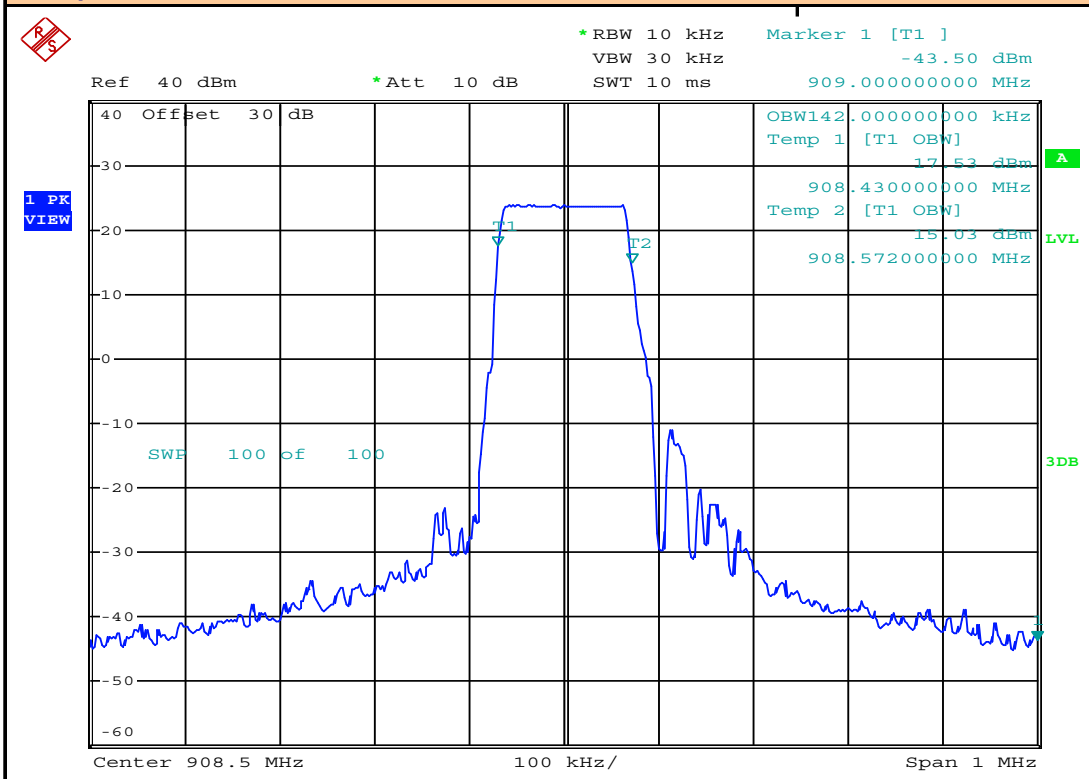
Occupied Bandwidth:



Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	Occupied Bandwidth *(kHz)*
150kHz	0	902.3	LoRa	FSK	140.0

Plot 8.8 – Occupied Bandwidth, LoRa (FHSS), Ch 31

Occupied Bandwidth:

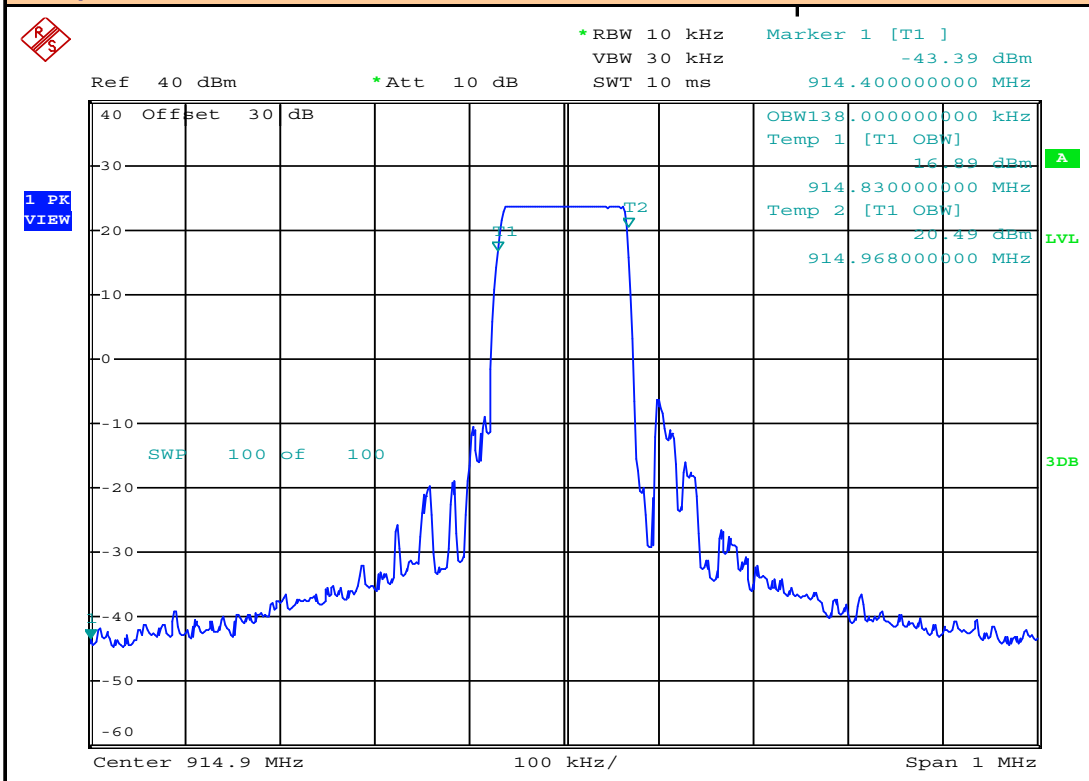


Date: 30.JUN.2021 13:32:40

Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	Occupied Bandwidth *(kHz)*
150kHz	31	908.5	LoRa	FSK	142.0

Plot 8.9 – Occupied Bandwidth, LoRa (FHSS), Ch 63

Occupied Bandwidth:

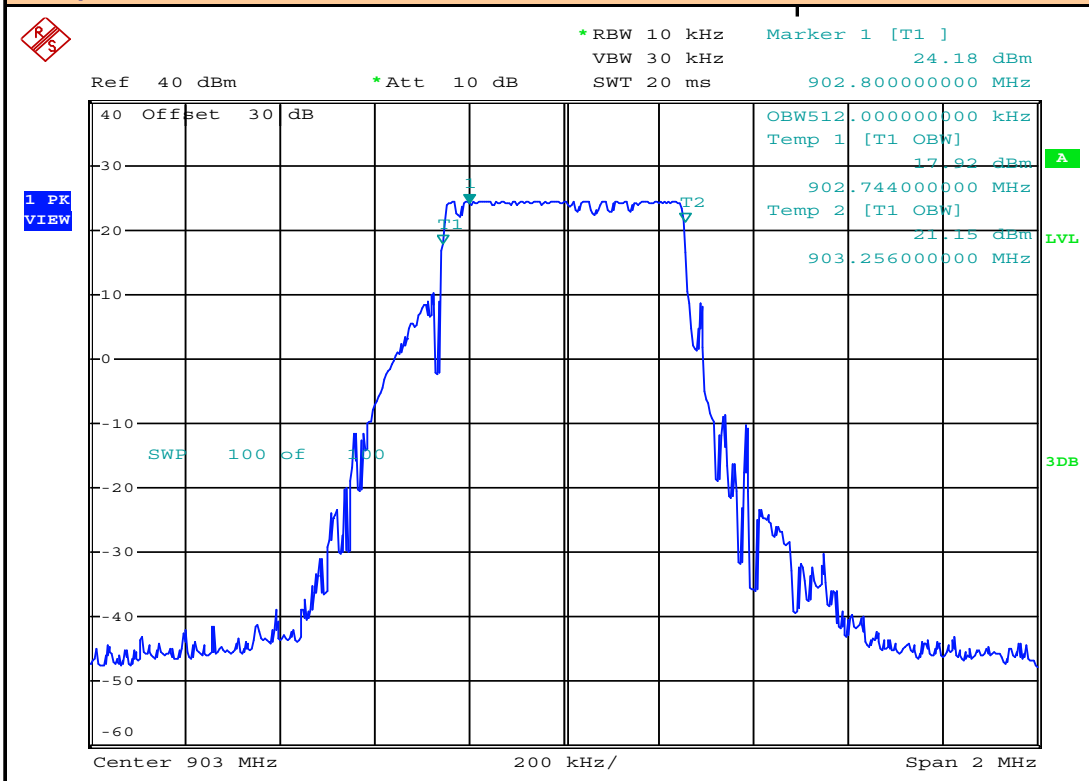


Date: 30.JUN.2021 13:30:10

Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	Occupied Bandwidth *(kHz)*
150kHz	63	908.5	LoRa	FSK	138.0

Plot 8.10 – Occupied Bandwidth, LoRa (DTS), Ch 0

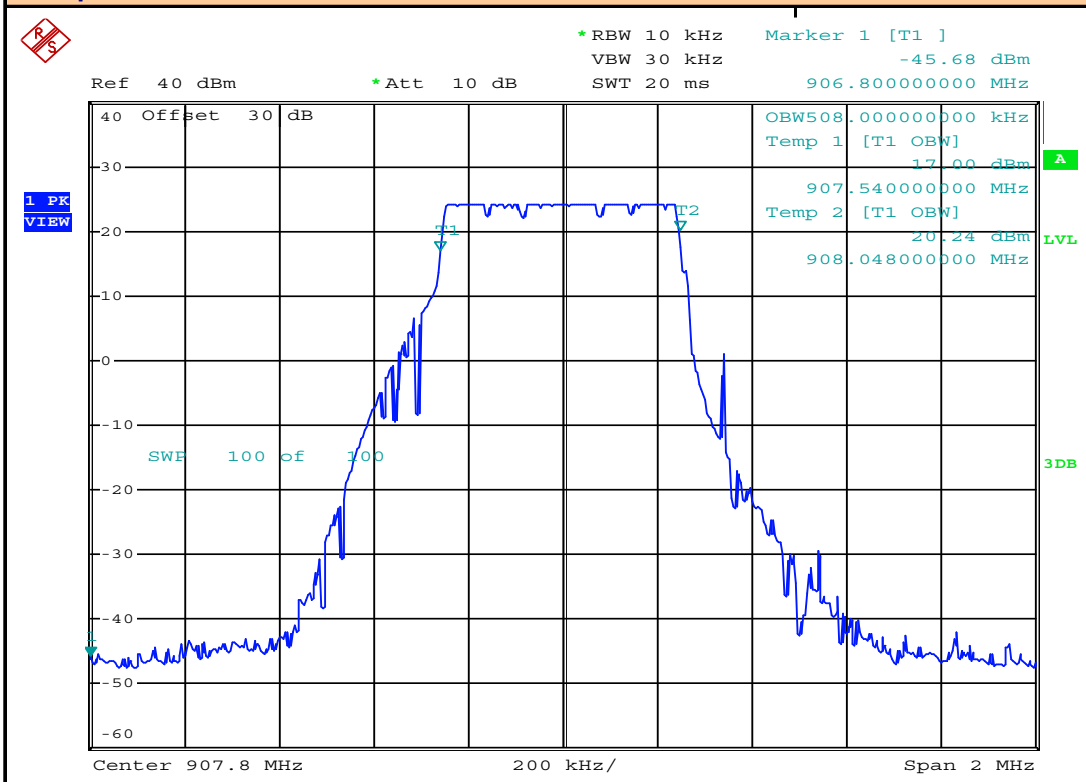
Occupied Bandwidth:



Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	Occupied Bandwidth *(kHz)*
500kHz	0	903	LoRa	FSK	512.0

Plot 8.11 – Occupied Bandwidth, LoRa (DTS), Ch 3

Occupied Bandwidth:

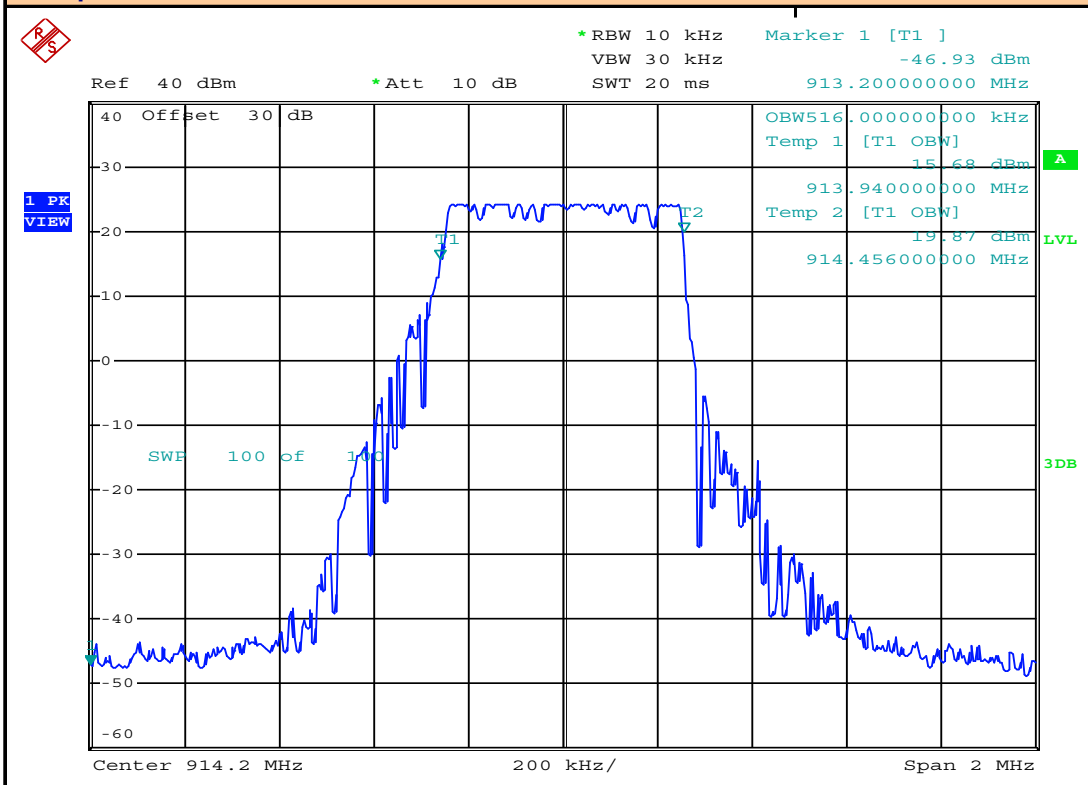


Date: 30.JUN.2021 13:42:41

Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	Occupied Bandwidth *(kHz)*
500kHz	3	907.8	LoRa	FSK	508.0

Plot 8.12 – Occupied Bandwidth, LoRa (DTS), Ch 7

Occupied Bandwidth:



Date: 30.JUN.2021 13:45:37

Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	Occupied Bandwidth *(kHz)*
500kHz	7	914.2	LoRa	FSK	516.0

Table 7.1 – Summary of Occupied Bandwidth Measurements (DTS)

Occupied Bandwidth Measurement Results:							
Mode	**Equipment Class**	**Channel Number**	**Channel Frequency (MHz)**	**Modulation**	**Nominal Channel Bandwidth (kHz)**	**Measured Occupied Bandwidth (kHz)**	**Emission Designator**
MESH	DSS	1	902.5	FSK	230kHz	158.0	158KF1D
		26	915.0			156.0	156KF1D
		0	927.0			154.0	154KF1D
Drive-By		1	902.5		400kHz	316.0	316KF1D
		26	915.0			316.0	316KF1D
		0	927.0			316.0	316KF1D
LoRa		0	902.3		150kHz	140.0	140KF1D
		31	908.5			142.0	142KF1D
		63	908.5			138.0	138KF1D
LoRa	DTS	0	903.0		500kHz	512.0	512KF1D
		3	907.8			508.0	508KF1D
		7	914.2			516.0	516KF1D
						Result:	**Complies**

8.0 DTS BANDWIDTH

Test Procedure	
Normative Reference	FCC 47 CFR §2.1049, §15.247(a)(2), RSS-Gen (6.7), RSS-247 (5.2)(a), KDB 558074 (8.2), ANSI C63.10 (11.8.2)

Limits	
47 CFR §15.247(a)(2)	(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions: (2) Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.
RSS-247 (5.2)(a)	**5.2 Digital transmission systems** DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400 - 2483.5 MHz: a) The minimum 6 dB bandwidth shall be 500 kHz.

General Procedure	
KDB 558074 (8.2) C63.10 (11.8.2)	**11.8.2 Option 2** The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥ 3 X RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

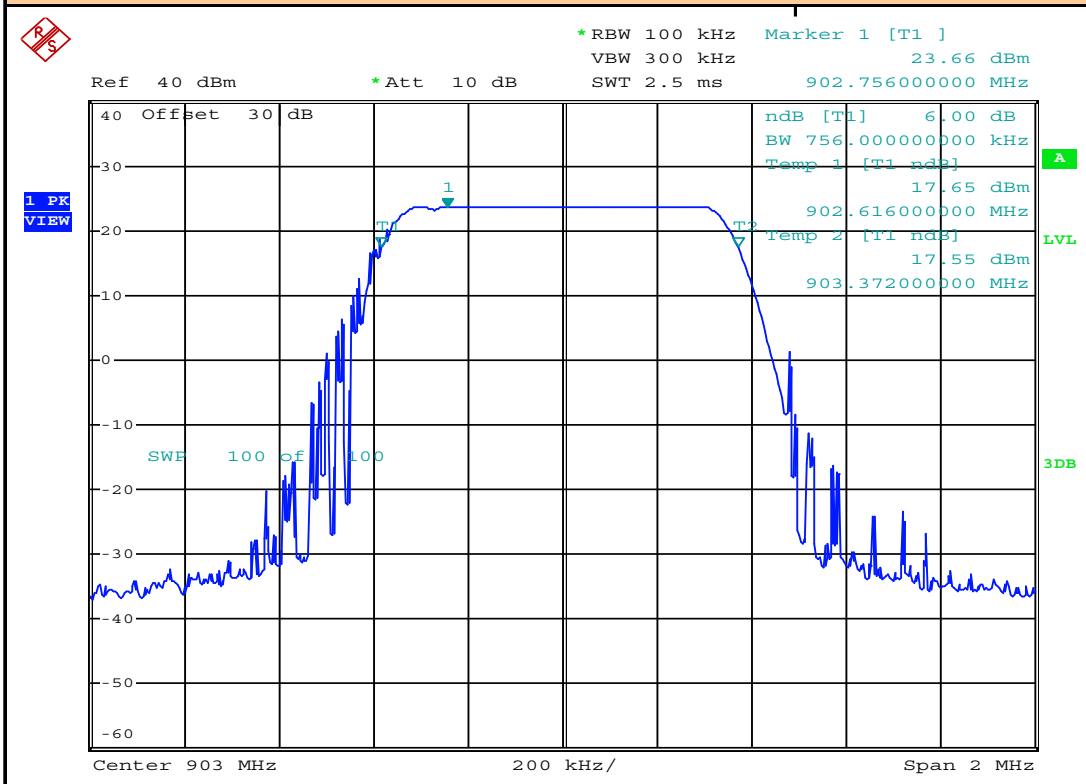
Test Setup	Appendix A - Figure A.1

Measurement Procedure

The DUT was connected to a Spectrum Analyzer (SA) via a 30dB attenuator connected to the DUT's antenna port. The SA was configured as above using the Automatic 6dB Cursor Bandwidth measurement. The output power of the DUT was set to the manufacturer's highest output power setting at the Low, Mid and High frequency channels as permitted by the device. The DUT was set to transmit at its maximum Duty Cycle.

Plot 8.1 – 6dB DTS Bandwidth, LoRa DTS Ch 0

DTS Bandwidth:

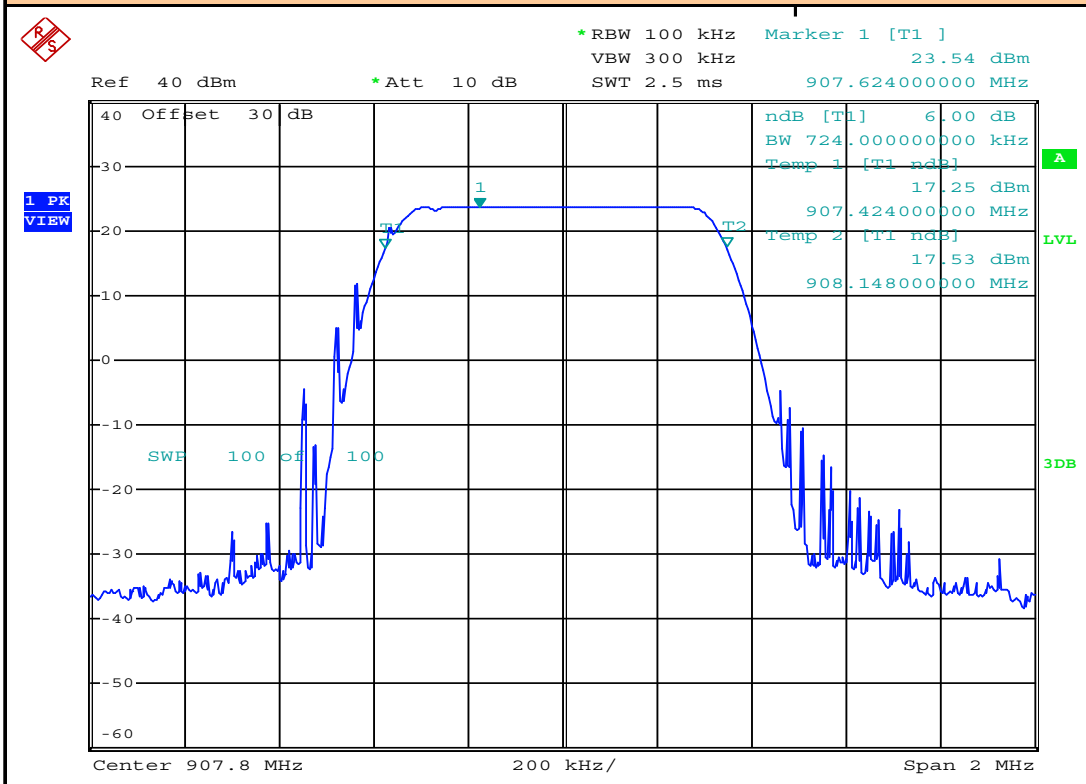


Date: 30.JUN.2021 13:52:04

Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	DTS Bandwidth *(kHz)*
500kHz	0	903	LoRa	FSK	756.0

Plot 8.2 – 6dB DTS Bandwidth, LoRa DTS Ch 3

DTS Bandwidth:

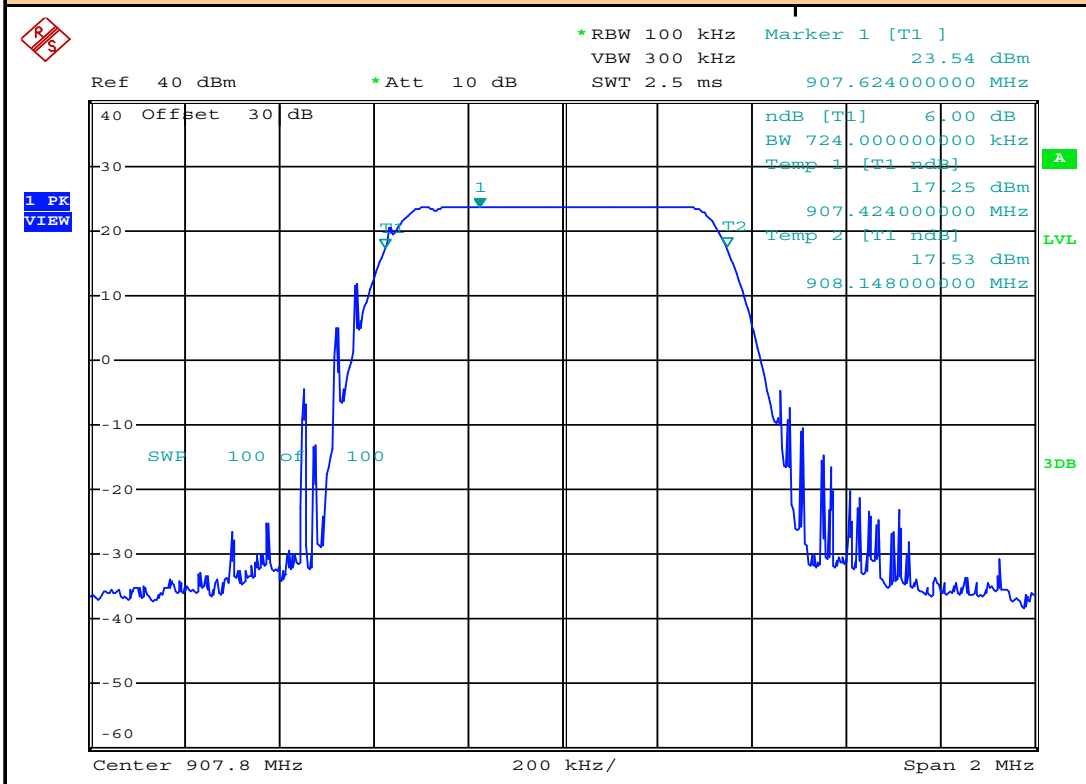


Date: 30.JUN.2021 13:49:31

Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	DTS Bandwidth *(kHz)*
500kHz	3	907.8	LoRa	FSK	724.0

Plot 8.3 – 6dB DTS Bandwidth, LoRa DTS Ch 7

DTS Bandwidth:



Date: 30.JUN.2021 13:49:31

Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	DTS Bandwidth *(kHz)*
500kHz	3	907.8	LoRa	FSK	724.0

Table 8.1 – Summary of 6dB DTS Bandwidth Measurements

DTS Bandwidth Measurement Results:						
Mode	Equipment Class	Channel Number	Channel Frequency (MHz)	Modulation	Nominal Channel Bandwidth (kHz)	Measured DTS Bandwidth (kHz)
LoRa	DTS	0	903.0	FSK	500kHz	756.0
		3	907.8			724.0
		7	914.2			764.0
					Result:	Complies

9.0 20DB BANDWIDTH

Test Procedure	
Normative Reference	FCC 47 CFR §2.1049, §15.247(a)(1)(i), RSS-Gen (6.7), RSS-247 (5.2)(c), KDB 558074 (8.2), ANSI C63.10 (11.8.2)

Limits	
§15.247(a)(1) (i)	(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions: (i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.
RSS-247 (5.2)(c)	**5.2 Digital transmission systems** DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400 - 2483.5 MHz: c) For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

General Procedure	
KDB 558074 (8.2) C63.10 (11.8.2)	**11.8.2 Option 2** The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥ 3 X RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

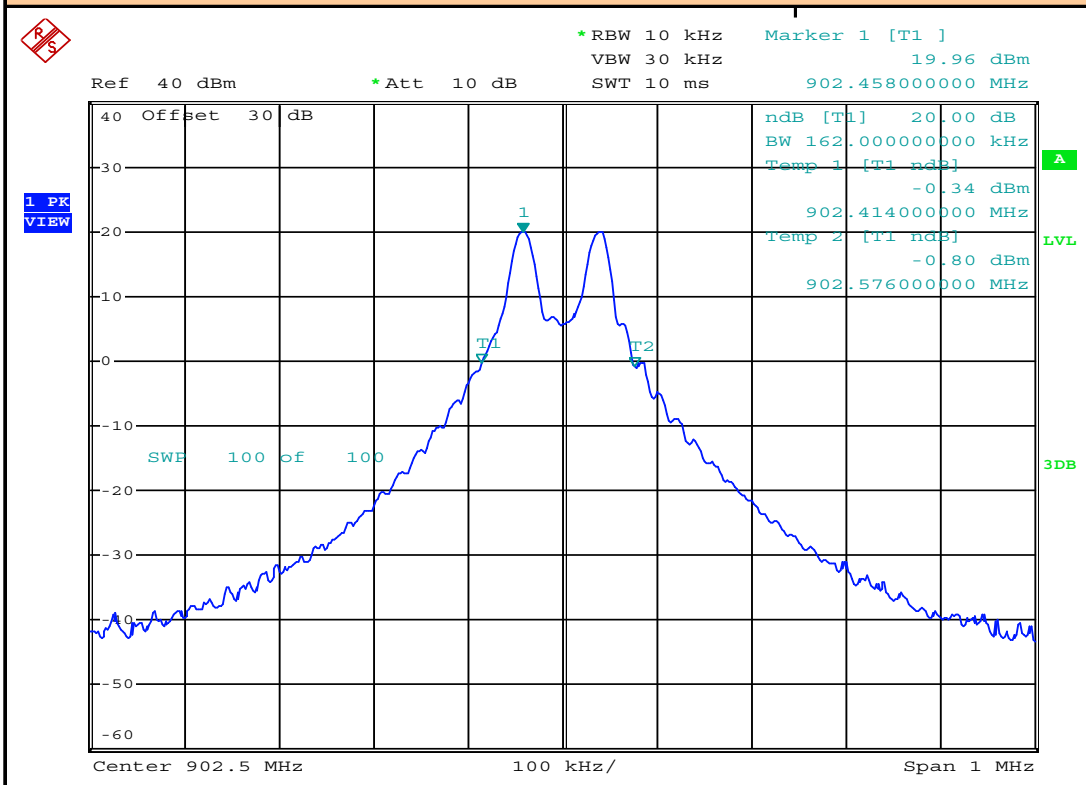
Test Setup	Appendix A - Figure A.1

Measurement Procedure

The DUT was connected to a Spectrum Analyzer (SA) via a 30dB attenuator connected to the DUT's antenna port. The SA was configured as above using the Automatic 6dB Cursor Bandwidth measurement. The output power of the DUT was set to the manufacturer's highest output power setting at the Low, Mid and High frequency channels as permitted by the device.

Plot 9.1 – 20dB Bandwidth, MESH Ch 1

20dB Bandwidth:

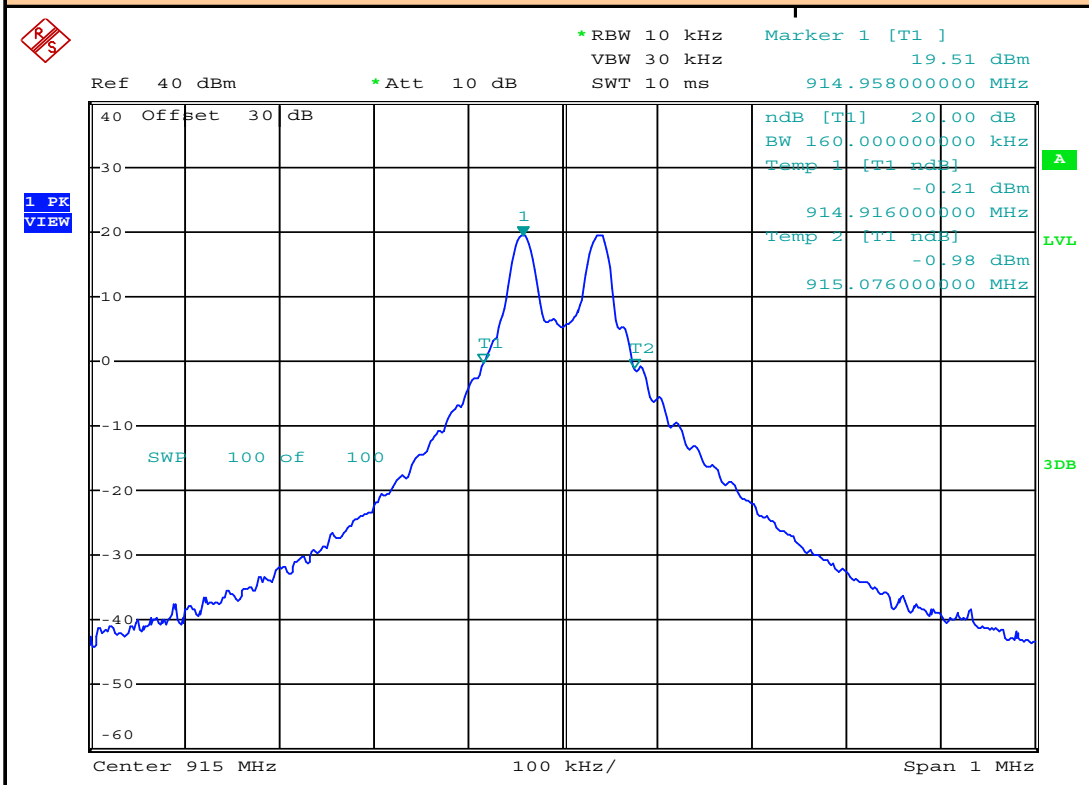


Date: 3.JUL.2021 12:12:12

Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	20dB Bandwidth *(kHz)*
230kHz	1	902.5	MESH	FSK	162.0

Plot 9.2 – 20dB Bandwidth, MESH Ch 26

20dB Bandwidth:

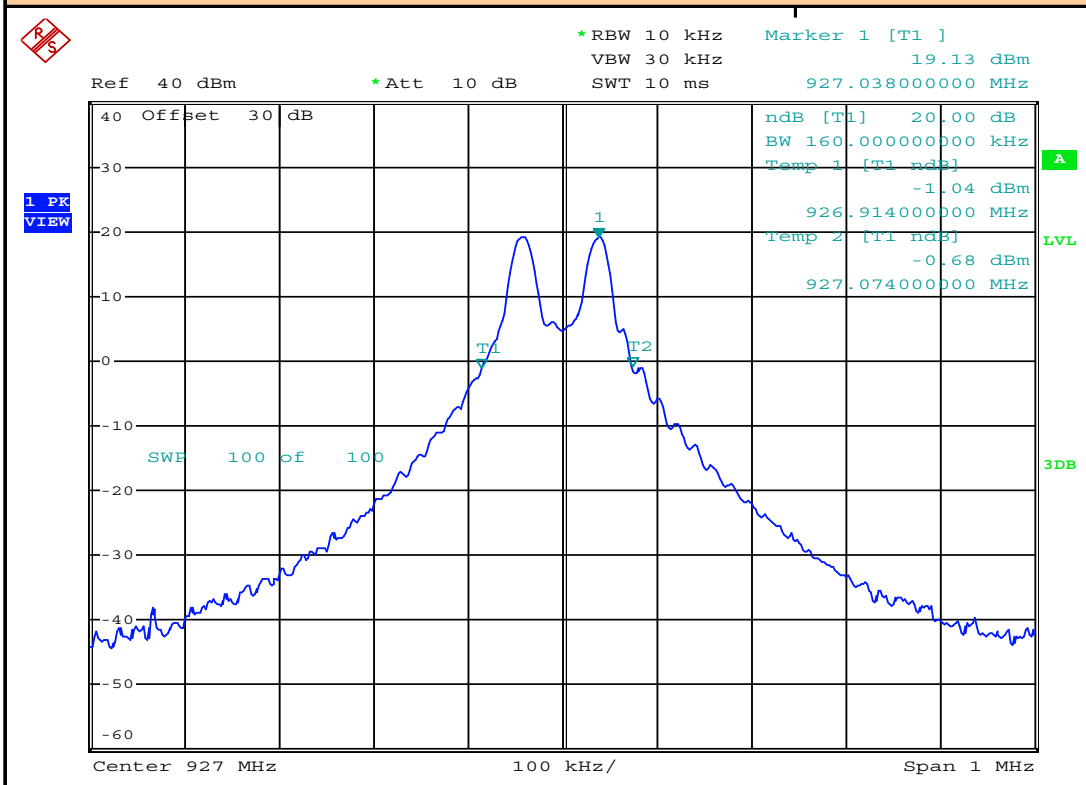


Date: 3.JUL.2021 12:13:03

Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	20dB Bandwidth *(kHz)*
230kHz	26	915	MESH	FSK	160.0

Plot 9.3 – 20dB Bandwidth, MESH Ch 0

20dB Bandwidth:

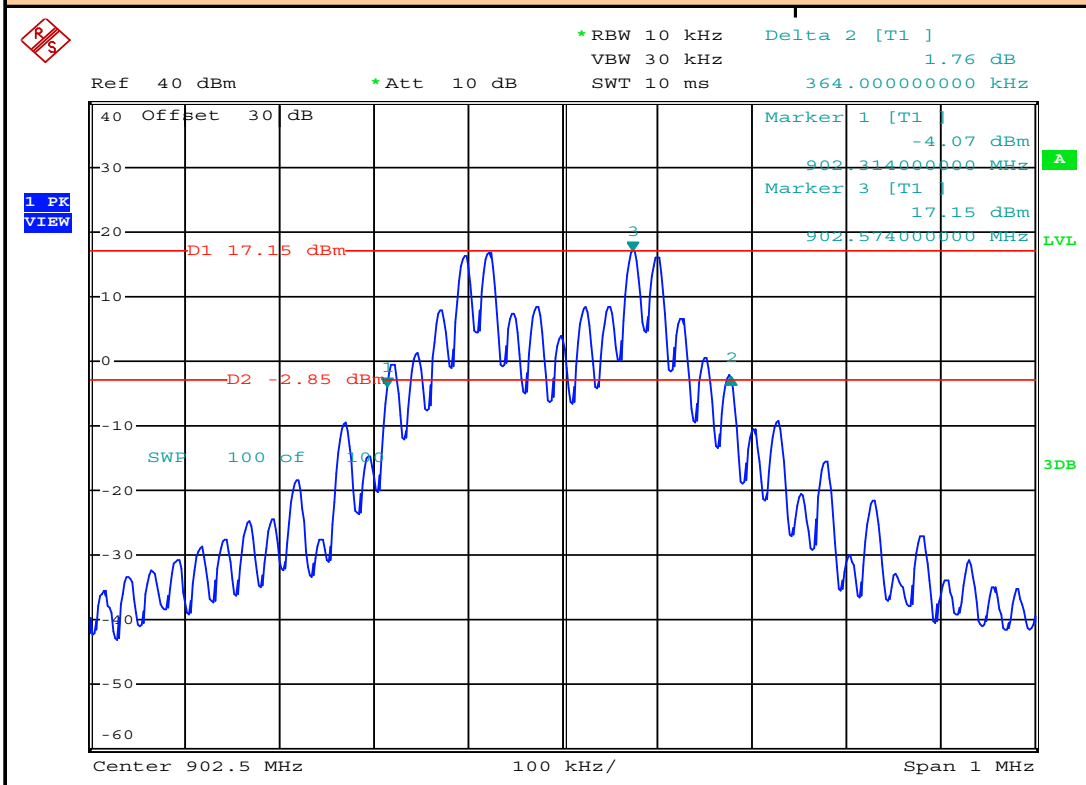


Date: 3.JUL.2021 12:13:58

Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	20dB Bandwidth *(kHz)*
230kHz	0	927	MESH	FSK	160.0

Plot 9.4 – 20dB Bandwidth, Drive-By Ch 1

20dB Bandwidth:

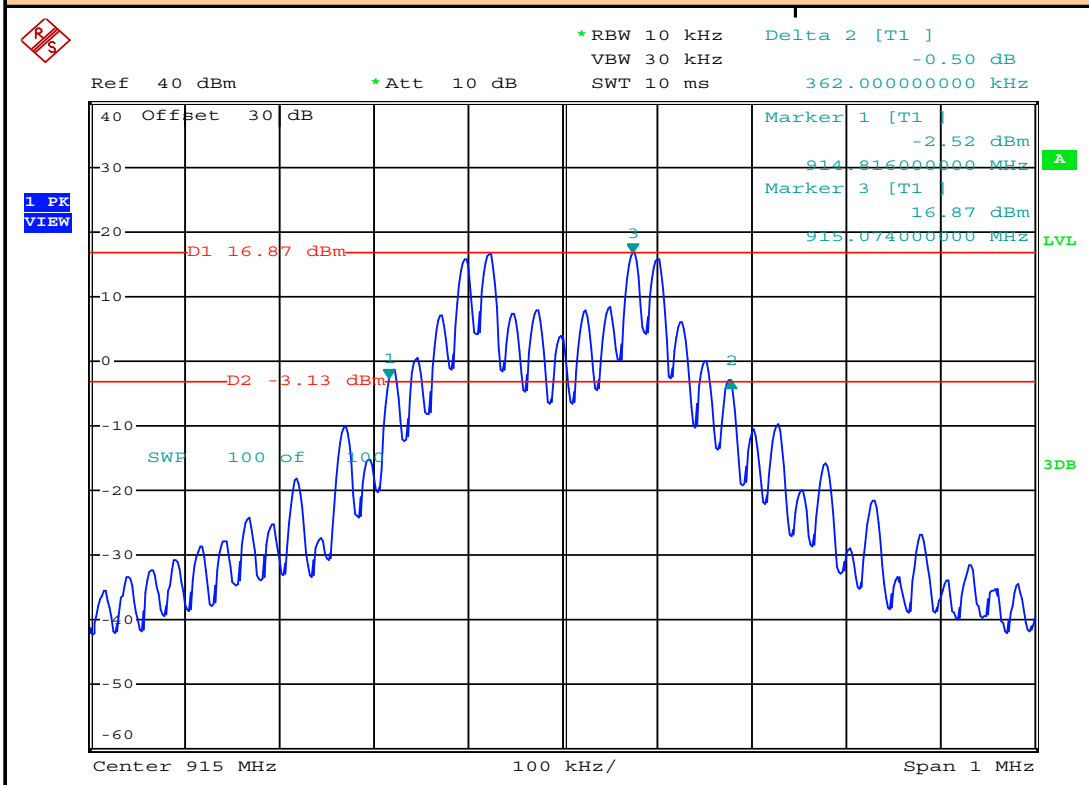


Date: 3.JUL.2021 12:20:45

Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	20dB Bandwidth *(kHz)*
400kHz	1	902.5	Drive-By	FSK	364.0

Plot 9.5 – 20dB Bandwidth, Drive-By Ch 26

20dB Bandwidth:

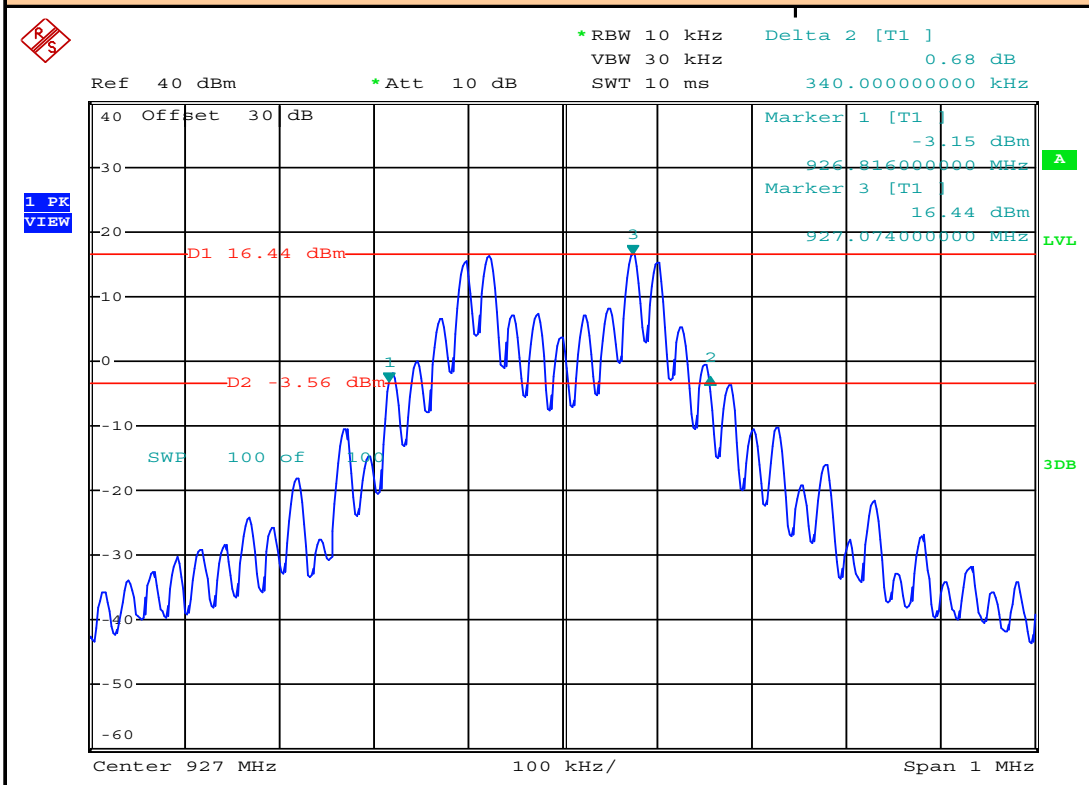


Date: 3.JUL.2021 12:19:11

Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	20dB Bandwidth *(kHz)*
400kHz	26	915	Drive-By	FSK	362.0

Plot 9.6 – 20dB Bandwidth, Drive-By Ch 0

20dB Bandwidth:

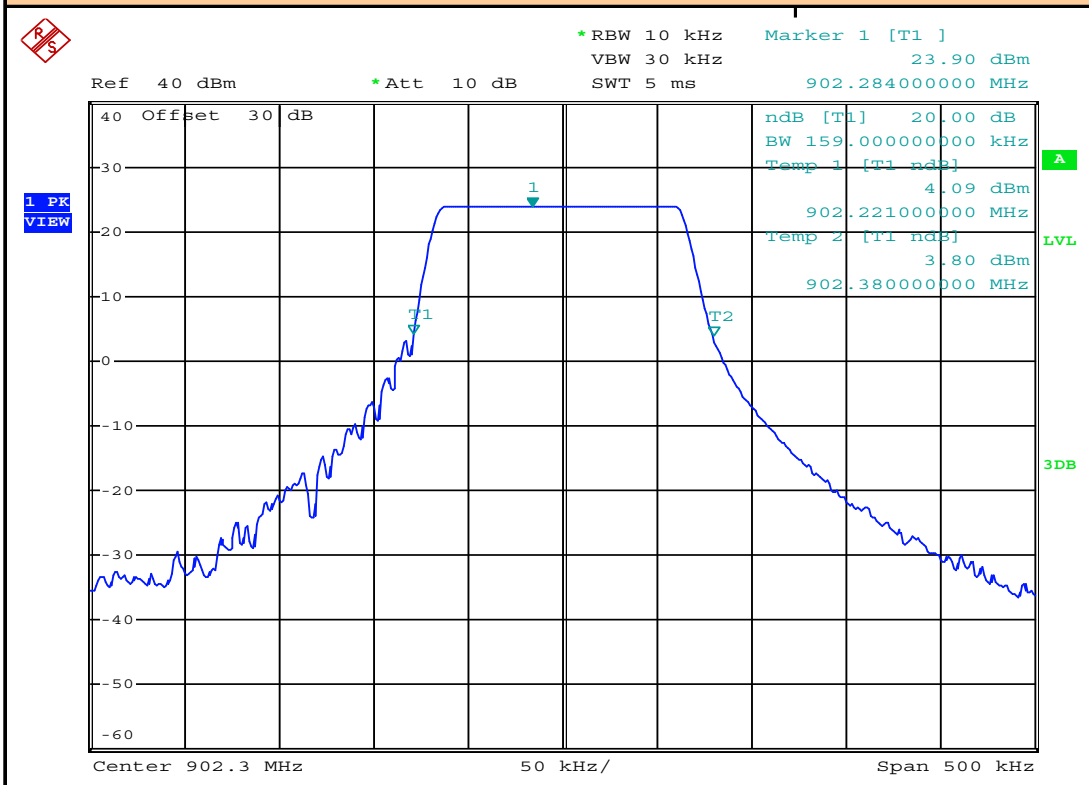


Date: 3.JUL.2021 12:17:10

Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	20dB Bandwidth *(kHz)*
400kHz	0	927	Drive-By	FSK	340.0

Plot 9.7 – 20dB Bandwidth, Lora (FHSS) Ch 0

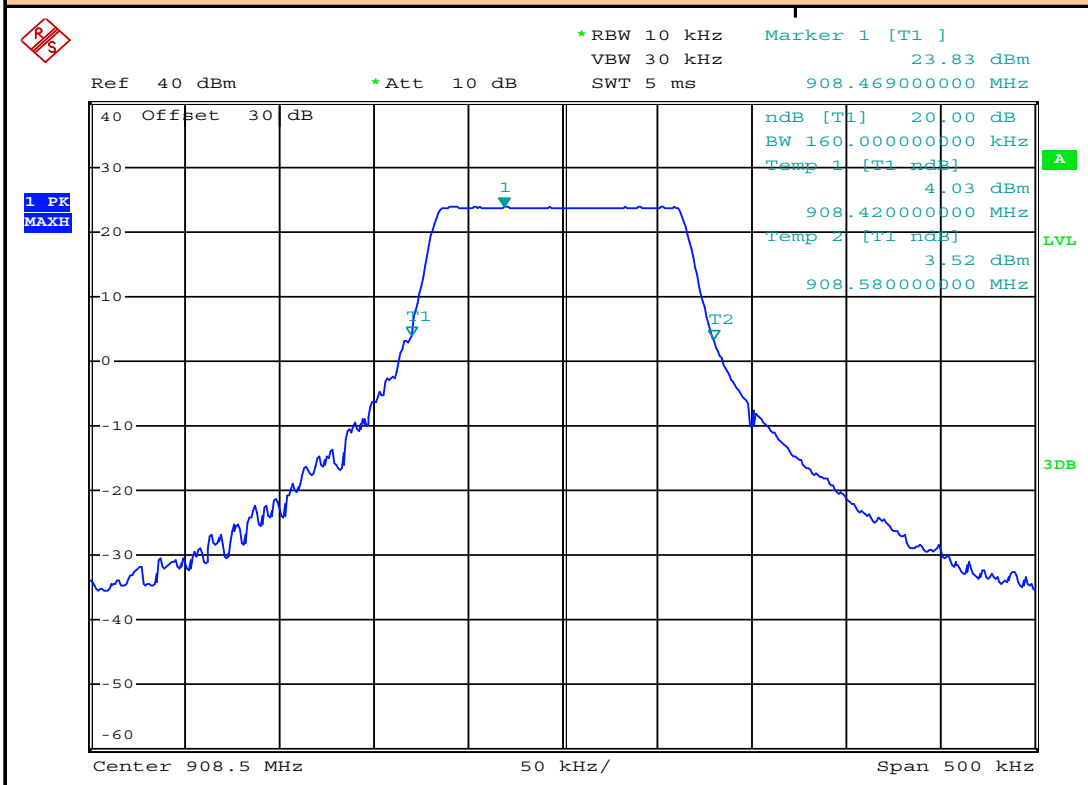
20dB Bandwidth:



Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	20dB Bandwidth *(kHz)*
150kHz	0	902.3	LoRa	FSK	159.0

Plot 9.8 – 20dB Bandwidth, Lora (FHSS) Ch 31

20dB Bandwidth:

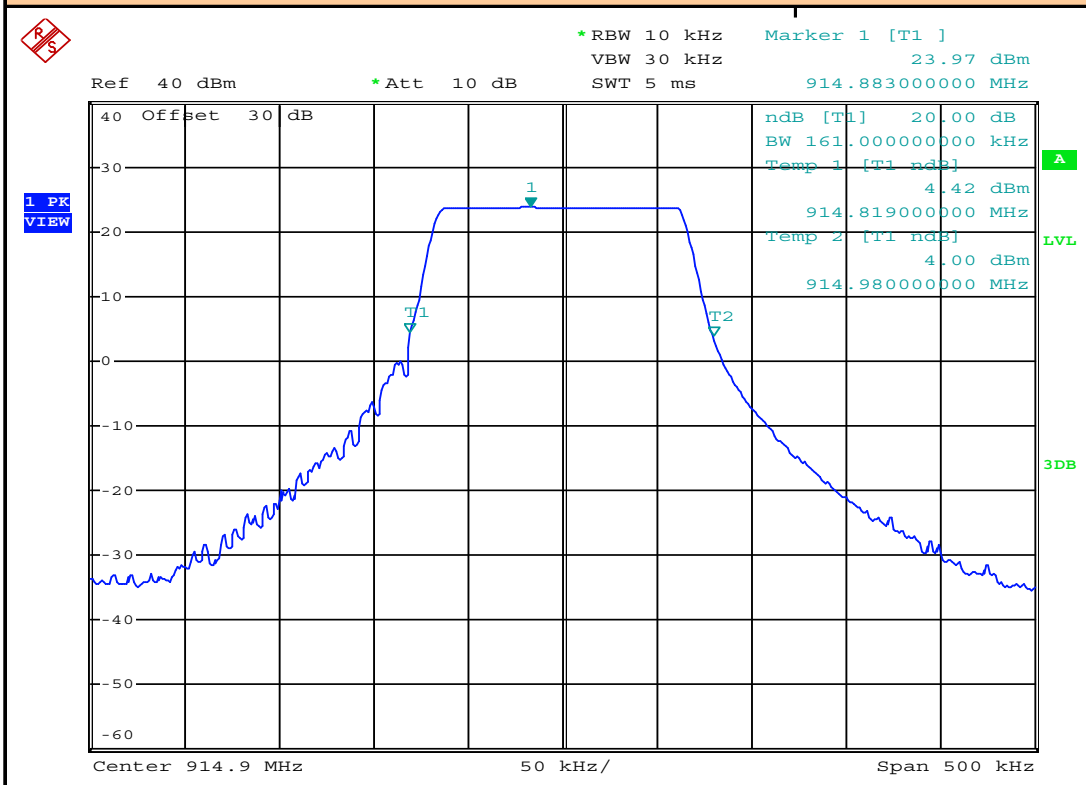


Date: 13.JUL.2021 15:41:14

Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	20dB Bandwidth *(kHz)*
150kHz	31	908.5	LoRa	FSK	160.0

Plot 9.9 – 20dB Bandwidth, Lora (FHSS) Ch 63

20dB Bandwidth:



Date: 13.JUL.2021 15:45:18

Nominal Channel Bandwidth	Channel Number	Channel Frequency *(MHz)*	Mode	Modulation	20dB Bandwidth *(kHz)*
150kHz	63	908.5	LoRa	FSK	161.0

Table 9.1 – Summary of 20dB Bandwidth Measurements,

20dB Bandwidth Measurement Results:						
Mode	**Equipment Class**	**Channel Number**	**Channel Frequency (MHz)**	**Modulation**	**Nominal Channel Bandwidth (kHz)**	**Measured 20dB Bandwidth (kHz)**
MESH	DSS	1	902.5	FSK	230kHz	162.0
		26	915.0			160.0
		0	927.0			160.0
Drive-By		1	902.5		400kHz	364.0
		26	915.0			362.0
		0	927.0			340.0
LoRa		0	902.3		150kHz	159.0
		31	908.5			160.0
		63	908.5			161.0
					Result:	**Complies**

10.0A ANTENNA PORT CONDUCTED POWER, (DTS)

Test Procedure	
Normative Reference	FCC 47 CFR §2.1046, §15.247(b)(3), RSS-Gen (6.1.2), RSS-247 (5.4)(d), KDB 558074 (8.3.2), ANSI C63.10 (11.9.2.2.2)

Limits	
47 CFR §15.247(b)(3)	(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following: (3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power.
RSS-247 (5.4)(d)	**5.4 Transmitter output power and equivalent isotropically radiated power (e.i.r.p.)** Devices shall comply with the following requirements, where applicable: d) For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e). As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power.

Test Procedure	
Normative Reference	FCC 47 CFR §2.1046, §15.247(b)(3), RSS-Gen (6.1.2), RSS-247 (5.4)(d),
	KDB 558074 (8.3.2), ANSI C63.10 (11.9.2.2.2)

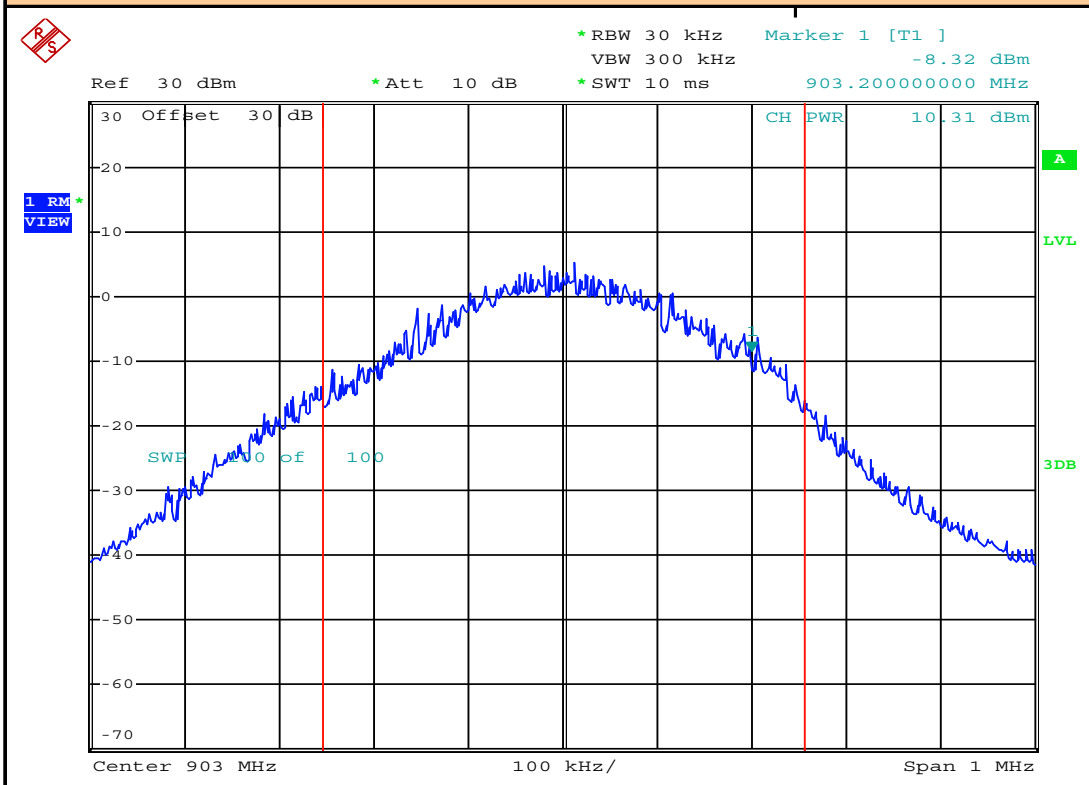
General Procedure	
KDB 558074 (8.3.2.1)	**8.3.2.1 General** Section 15.247 permits the maximum conducted (average) output power to be measured as an alternative to the maximum peak conducted output power for demonstrating compliance to the limit. When this option is exercised, the measured power is to be referenced to the OBW rather than the DTS bandwidth.
C63.10 (11.9.2.2.2)	**Method AVGSA-1** (trace averaging with the EUT transmitting at full power throughout each a) Set span to at least 1.5 X OBW. b) Set RBW = 1 % to 5 % of the OBW, not to exceed 1 MHz. c) Set VBW ≥ 3 X RBW. d) Number of points in sweep ≥ 2 X span / RBW. e) Sweep time = auto. f) Detector = RMS g) If the EUT transmits continuously (i.e., with no off intervals) or at duty cycle ≥ 98 %, and if each transmission is entirely at the maximum power control level, then the trigger shall be set to “free run”. h) Trace average at least 100 traces in power averaging i) Compute power by integrating the spectrum across the OBW of the signal using the instrument’s band power measurement function, with band limits set equal to the OBW band edges.

Test Setup	Appendix A - Figure A.1

Measurement Procedure
The DUT was connected to a Spectrum Analyzer (SA) via a 30dB attenuator connected to the DUT’s antenna port. The SA was configured as described above. Number of Sweep Points ≥ 2 X Span / RBW = 2 X (4MHz / 30kHz) = 267, the SA was configured for 501 Points. The output power of the DUT was set to the manufacturer’s highest output power setting at the Low, Mid and High frequency channels as permitted by the device. The DUT was set to transmit at 100% Duty Cycle. The Channel Bandwidth was set to the measured 99% Occupied Bandwidth (See Section 9.0). The Band Channel Power was measured and recorded.

Plot 10A.1 – Conducted Power, Lora (DTS) Ch 0

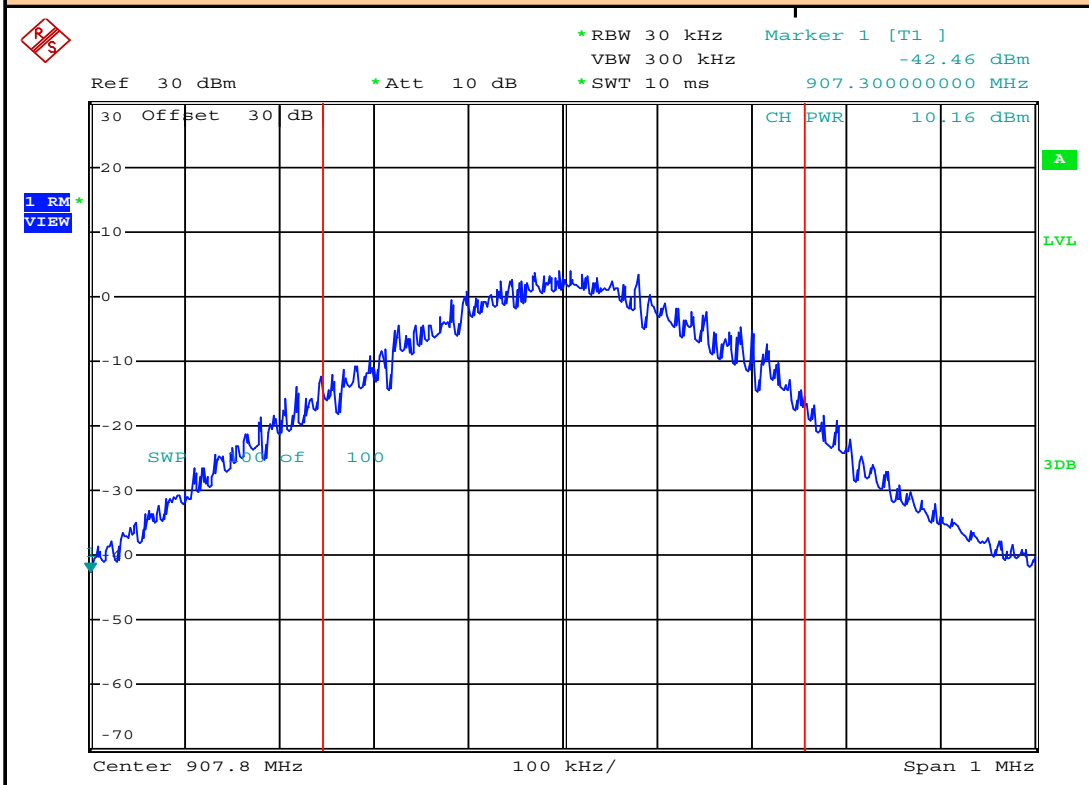
Conducted Power:



Channel Number	Channel Frequency (MHz)	Mode	Modulation	Conducted Power (dBm)
0	903	LoRa	FSK	10.31

Plot 10A.2 – Conducted Power, Lora (DTS) Ch 3

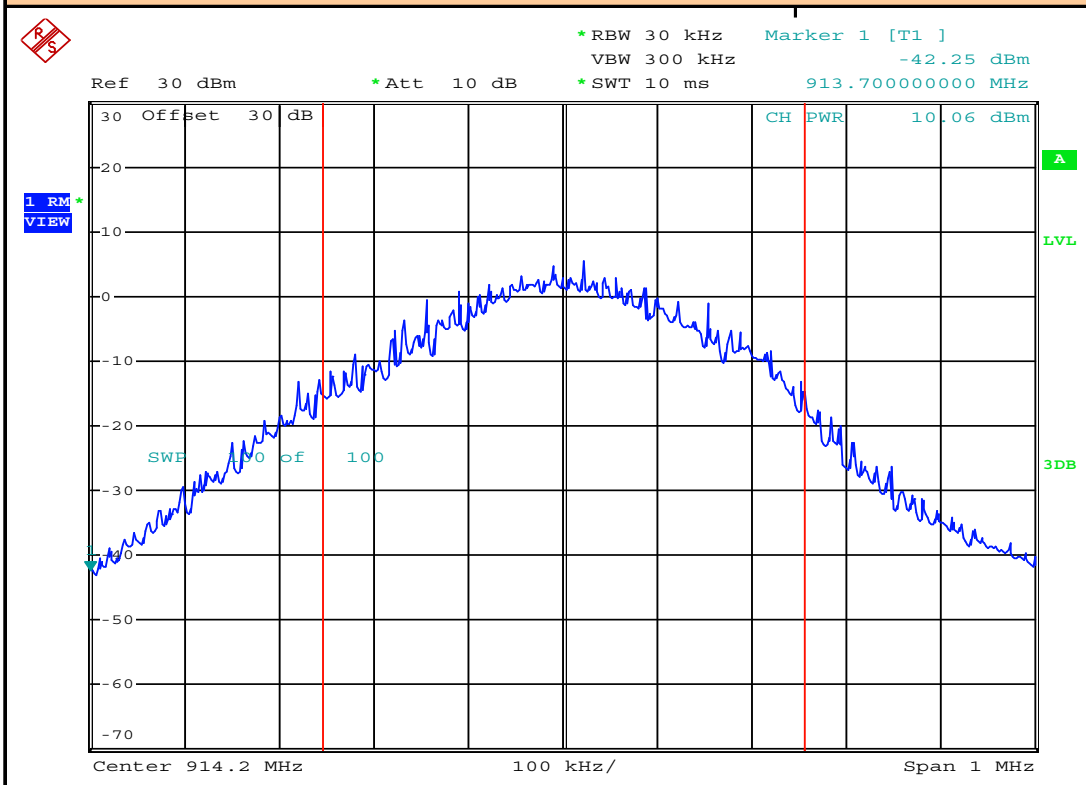
Conducted Power:



Channel Number	Channel Frequency (MHz)	Mode	Modulation	Conducted Power (dBm)
3	907.8	LoRa	FSK	10.16

Plot 10A.3 – Conducted Power, Lora (DTS) Ch 7

Conducted Power:



Date: 4.JUL.2021 12:24:27

Channel Number	Channel Frequency (MHz)	Mode	Modulation	Conducted Power (dBm)
7	914.2	LoRa	FSK	10.06

Table 10A.1 – Summary of Conducted Power Measurements

Conducted Power Measurement Results:											
Mode	Channel Number	Frequency (MHz)	Equipment Class	Modulation	Measured Power [P_{Meas}] (dBm)	Conducted Limit [P_{Lim}] (dBm)	Conducted Margin (dB)	Antenna Gain (dBi)	EIRP [E_{Meas}] (dBm)	EIRP Limit [E_{Lim}] (dBm)	EIRP Margin (dB)
LoRa	0	903.00	DTS	FSK	10.310	30	19.7	0	10.31	36	25.7
	3	907.80			10.160		19.8		10.16		25.8
	7	914.20			10.060		19.9		10.06		25.9
										Result:	Complies

Conducted Margin = P_{Limit} - P_{Meas}

EIRP Margin = E_{Limit} - E_{Meas}

10.0B ANTENNA PORT CONDUCTED POWER, (DSS)

Test Procedure	
Normative Reference	FCC 47 CFR §2.1046, §15.247(b)(2), RSS-Gen (6.1.2), RSS-247 (5.4)(d), KDB 558074 (8.3.2), ANSI C63.10 (11.9.1.1)

Limits	
47 CFR §15.247(b)(2)	(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following: (2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.
RSS-247 (5.4)(d)	**5.4 Transmitter output power and equivalent isotropically radiated power (e.i.r.p.)** Devices shall comply with the following requirements, where applicable: a) For FHSs operating in the band 902-928 MHz, the maximum peak conducted output power shall not exceed 1.0 W, and the e.i.r.p. shall not exceed 4 W if the hopset uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W and the e.i.r.p. shall not exceed 1 W if the hopset uses less than 50 hopping channels.

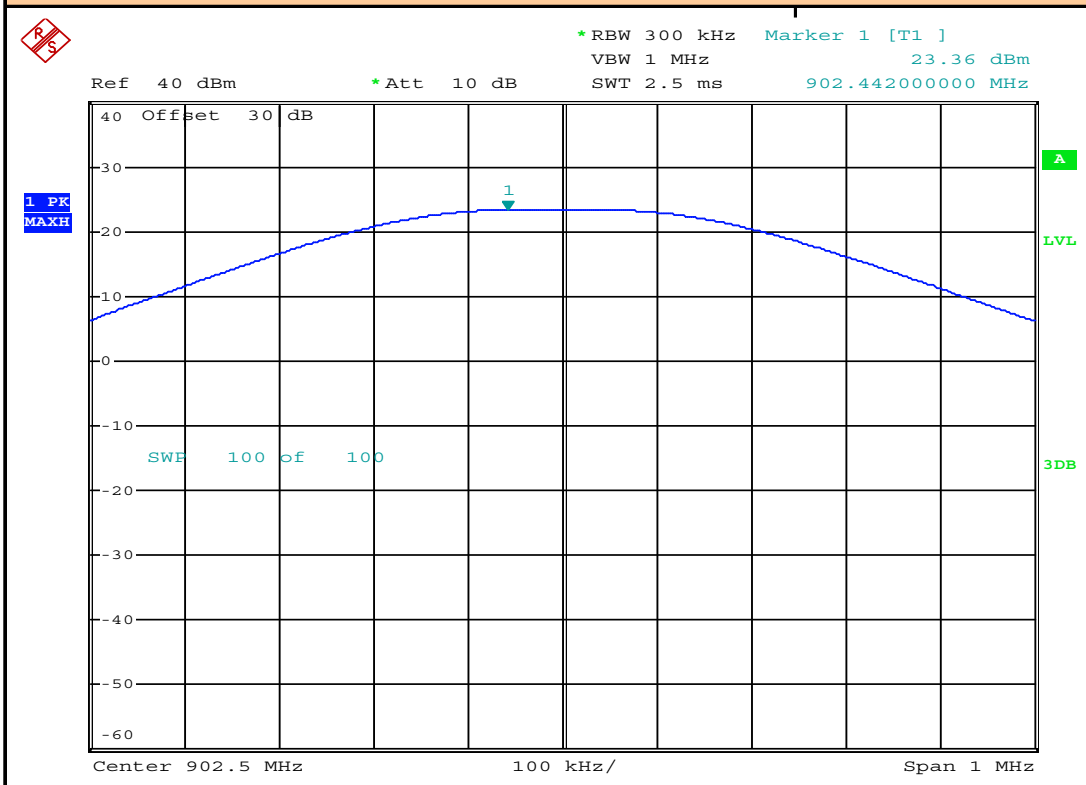
General Procedure	
KDB 558074 (8.3.2.1)	**8.3.2.1 General** Section 15.247 permits the maximum conducted (average) output power to be measured as an alternative to the maximum peak conducted output power for demonstrating compliance to the limit. When this option is exercised, the measured power is to be referenced to the OBW rather than the DTS bandwidth.
C63.10 (11.9.1.1)	**11.9.1.1** RBW ≥ DTS bandwidth The following procedure shall be used when an instrument with a resolution bandwidth that is greater than the DTS bandwidth is available to perform the measurement: a) Set the RBW ≥ DTS bandwidth. b) Set VBW ≥ [3 × RBW]. c) Set span ≥ [3 × RBW]. d) Sweep time = auto couple. e) Detector = peak. f) Trace mode = max hold. g) Allow trace to fully stabilize. h) Use peak marker function to determine the peak amplitude level.

Test Setup	Appendix A - Figure A.1

Measurement Procedure
The DUT was connected to a Spectrum Analyzer (SA) via a 30dB attenuator connected to the DUT's antenna port. The SA was configured as described above. The Power was measured and recorded.

Plot 10B.1 – Conducted Power, MESH Ch 1

Conducted Power:

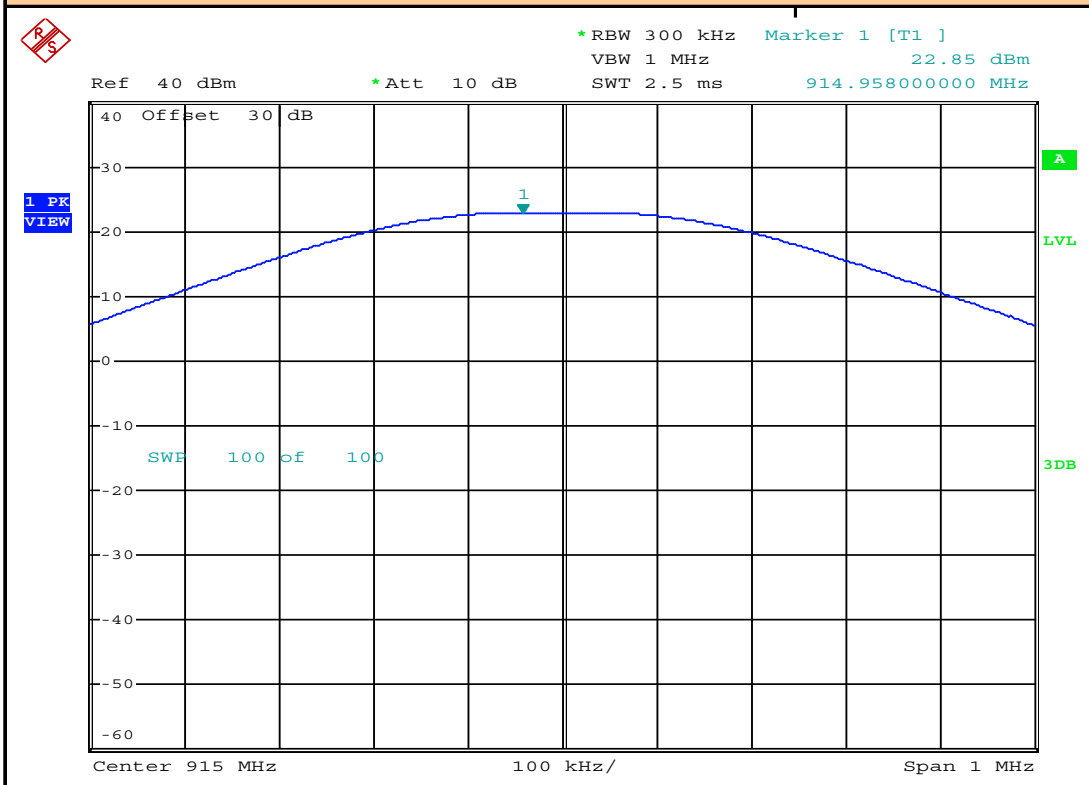


Date: 3.JUL.2021 12:35:06

Channel Number	Channel Frequency (MHz)	Mode	Modulation	Conducted Power (dBm)
1	902.5	MESH	FSK	23.36

Plot 10B.2 – Conducted Power, MESH Ch 26

Conducted Power:

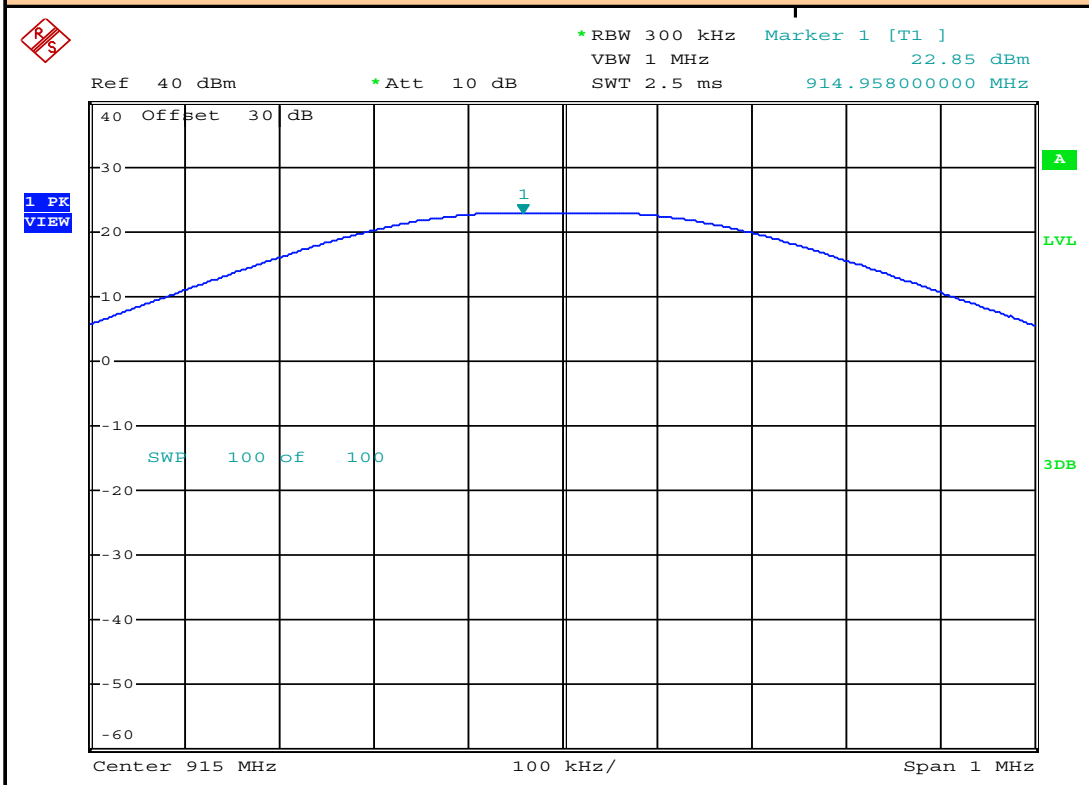


Date: 3.JUL.2021 12:36:07

Channel Number	Channel Frequency (MHz)	Mode	Modulation	Conducted Power (dBm)
26	915	MESH	FSK	22.85

Plot 10B.3 – Conducted Power, MESH Ch 0

Conducted Power:

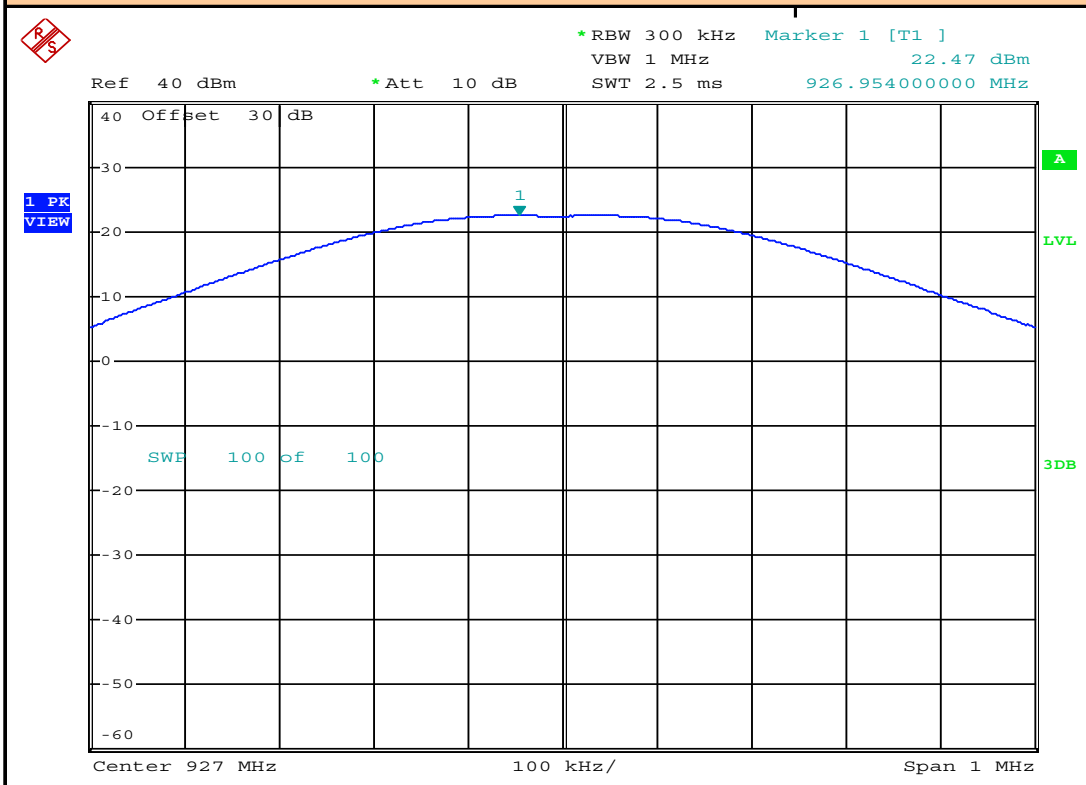


Date: 3.JUL.2021 12:36:07

Channel Number	Channel Frequency (MHz)	Mode	Modulation	Conducted Power (dBm)
26	915	MESH	FSK	22.85

Plot 10B.3 – Conducted Power, MESH Ch 0

Conducted Power:

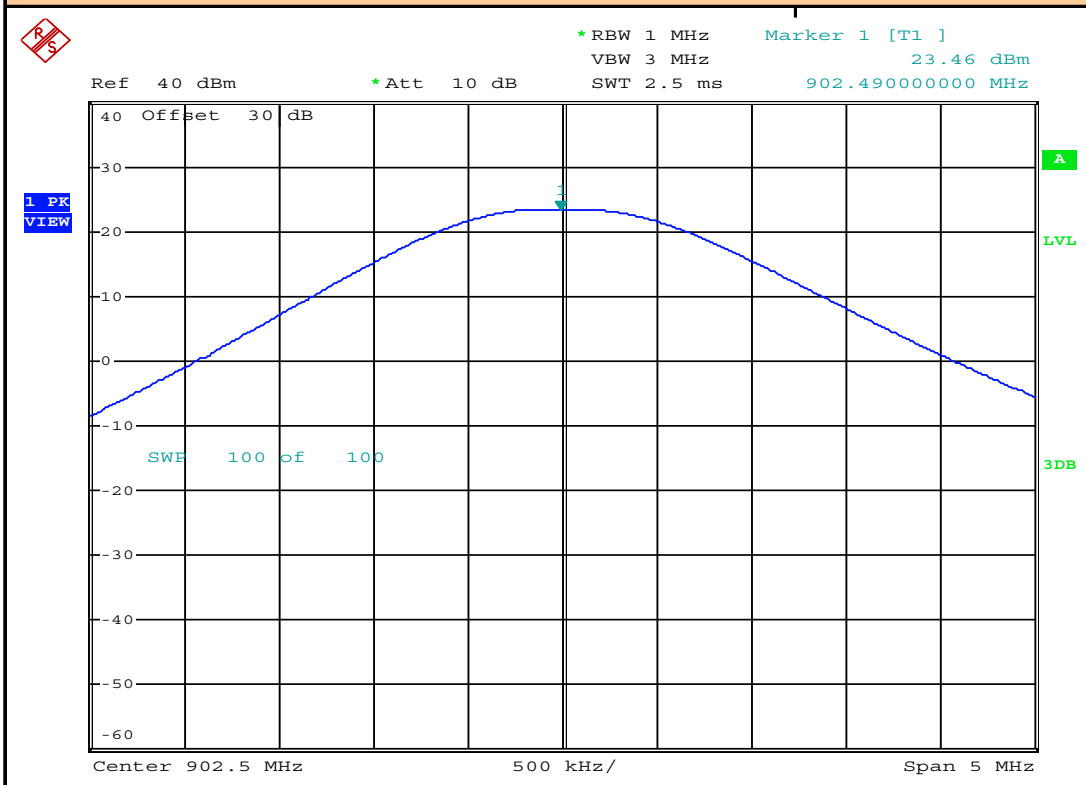


Date: 3.JUL.2021 12:36:37

Channel Number	Channel Frequency (MHz)	Mode	Modulation	Conducted Power (dBm)
0	927	MESH	FSK	22.47

Plot 10B.4 – Conducted Power, Drive-By Ch 1

Conducted Power:

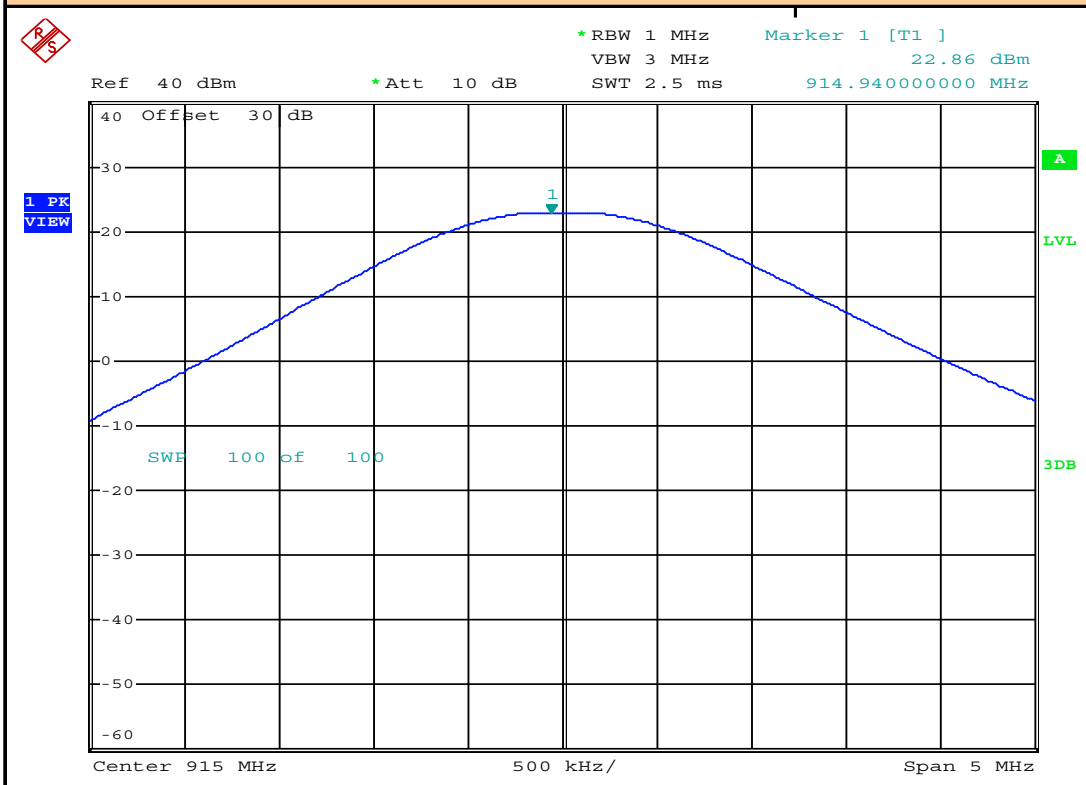


Date: 3.JUL.2021 12:39:12

Channel Number	Channel Frequency (MHz)	Mode	Modulation	Conducted Power (dBm)
1	902.5	Drive-By	FSK	23.46

Plot 10B.5 – Conducted Power, Drive-By Ch 26

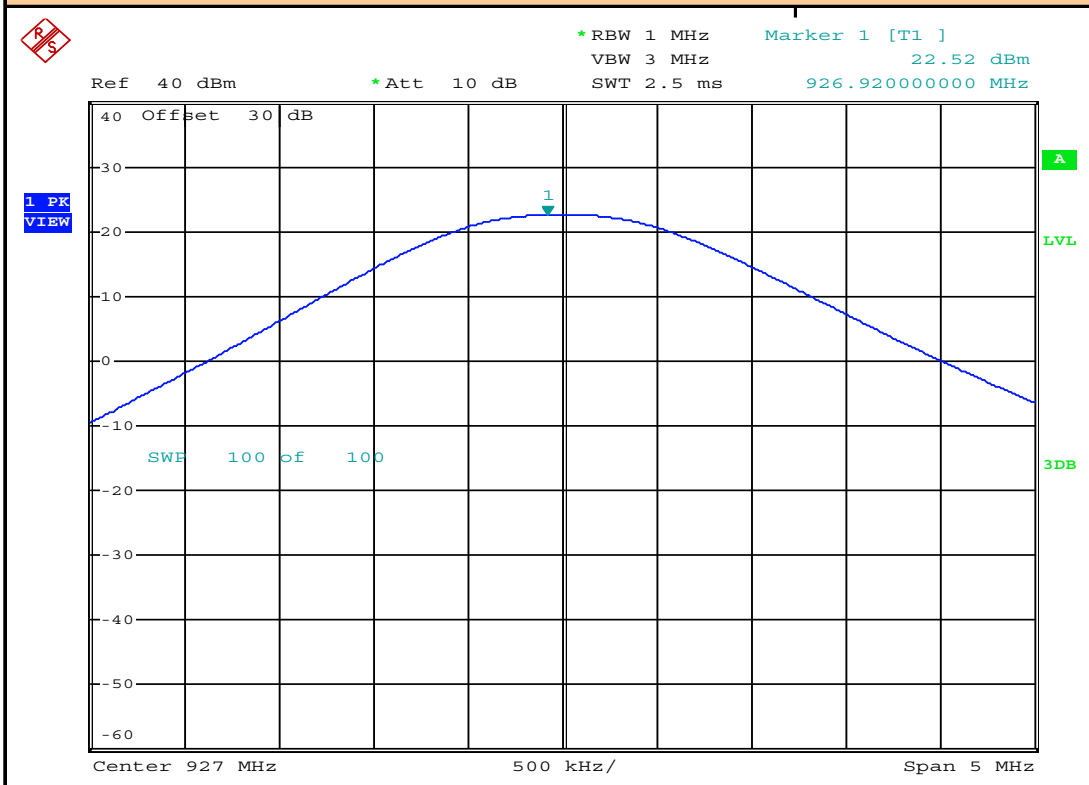
Conducted Power:



Channel Number	Channel Frequency (MHz)	Mode	Modulation	Conducted Power (dBm)
26	915	Drive-By	FSK	22.86

Plot 10B.6 – Conducted Power, Drive-By Ch 0

Conducted Power:



Channel Number	Channel Frequency (MHz)	Mode	Modulation	Conducted Power (dBm)
0	927	Drive-By	FSK	22.52

Table 10B.1 – Summary of Conducted Power Measurements, (DSS)

Conducted Power Measurement Results:											
Mode	**Channel Number**	**Frequency (MHz)**	**Equipment Class**	**Modulation**	**Measured Power [P_{Meas}] (dBm)**	**Conducted Limit [P_{Lim}] (dBm)**	**Conducted Margin (dB)**	**Antenna Gain (dBi)**	**EIRP [E_{Meas}] (dBm)**	**EIRP Limit [E_{Lim}] (dBm)**	**EIRP Margin (dB)**
MESH	1	902.50	DSS	FSK	23.360	30	6.6	0	23.36	36	12.6
	26	915.00			22.850		7.2		22.85		13.2
	0	927.00			22.470		7.5		22.47		13.5
Drive-By	1	902.50			23.460		6.5		23.46		12.5
	26	915.00			22.860		7.1		22.86		13.1
	0	927.00			22.520		7.5		22.52		13.5
LoRa	0	902.30			23.580		6.4		23.58		12.4
	31	908.50			23.390		6.6		23.39		12.6
	63	908.50			23.270		6.7		23.27		12.7
										Result:	**Complies**

Conducted Margin = P_{Limit} - P_{Meas}

EIRP Margin = E_{Limit} - E_{Meas}

11.0 POWER SPECTRAL DENSITY

Test Procedure	
Normative Reference	FCC 47 CFR §15.247(e), RSS-247 (5.2)(b),
	KDB 558074 (10.3), ANSI C63.10 (11.10.3)

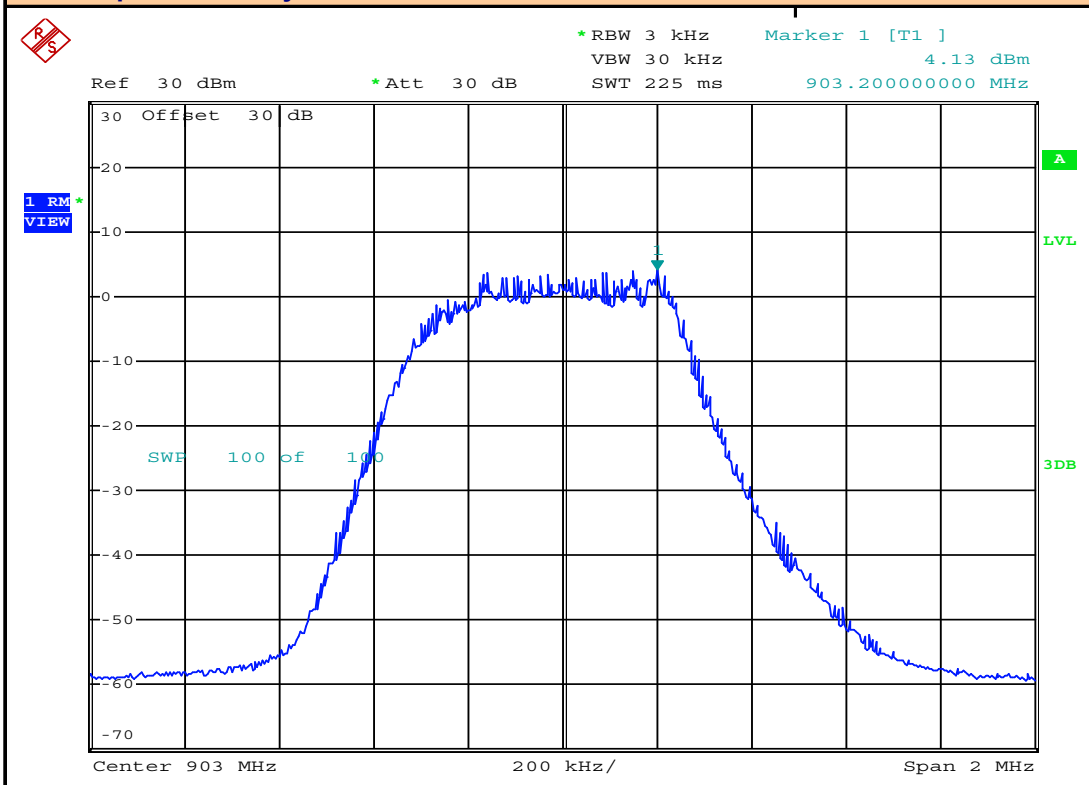
Limits	
47 CFR §15.247(e)	(e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance 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.
RSS-247 (5.2)(b)	b) The transmitter power spectral density conducted from the transmitter 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 section 5.4(d), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).
KDB 558074 (10.3) C63.10 (11.10.3)	**Method AVGPSD-1** (trace averaging with EUT transmitting at full power throughout each sweep) This procedure may be used when the maximum (average) conducted output power was used to demonstrate compliance to the output power limit. This is the baseline method for determining the maximum (average) conducted PSD level. If the instrument has an RMS power averaging detector, it must be used; otherwise, use the sample detector. The EUT must be configured to transmit continuously (duty cycle ≥ 98 %); otherwise sweep triggering/signal gating must be implemented to ensure that measurements are made only when the EUT is transmitting at its maximum power control level (no transmitter off time is to be considered). a) Set instrument center frequency to DTS channel center frequency. b) Set span to at least 1.5 X OBW. c) Set RBW to: 3 kHz ≤ RBW ≤ 100 kHz. . d) Set VBW ≥ 3 X RBW. e) Detector = RMS f) Ensure that the number of measurement points in the sweep ≥ 2 X span/RBW. g) Sweep time = auto couple. h) Employ trace averaging (RMS) mode over a minimum of 100 traces. i) Use the peak marker function to determine the maximum amplitude level. j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span in order to meet the minimum measurement point requirement as the RBW is reduced).
Test Setup	**Appendix A Figure A.1**

Measurement Procedure

The DUT was connected to a Spectrum Analyzer (SA) via a 30dB attenuator connected to the DUT's antenna port. The SA was configured as described above. Number of Sweep Points ≥ 2 X Span / RBW = 2 X (1.5MHz / 3kHz) = 1000, the SA was configured for 1001 Points. The output power of the DUT was set to the manufacturer's highest output power setting at the Low, Mid and High frequency channels as permitted by the device. The DUT was set to transmit at 100% Duty Cycle. The Power Spectral Density was measured and recorded.

Plot 11.1 – Power Spectral Density, LoRa (DTS) Ch 0

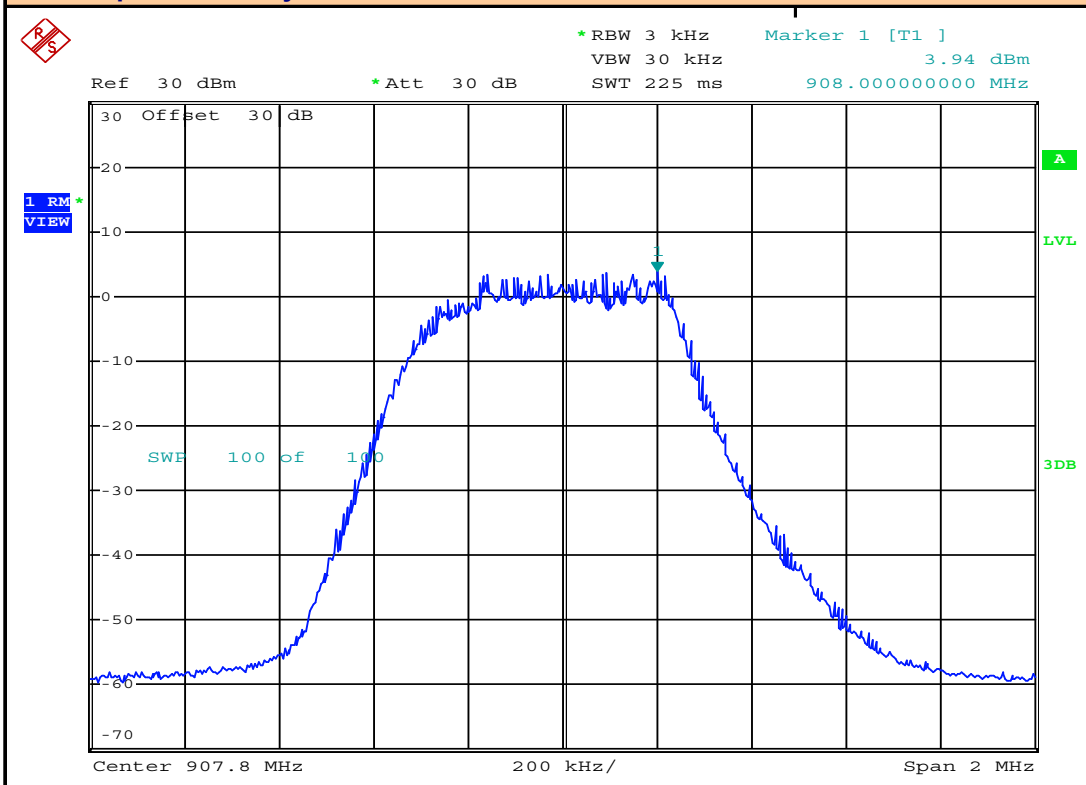
Power Spectal Density:



Channel Number	Channel Frequency (MHz)	Mode	Modulation	Measured PSD (dBm)
0	903	LoRa	FSK	4.13

Plot 11.2 – Power Spectral Density, LoRa (DTS) Ch 3

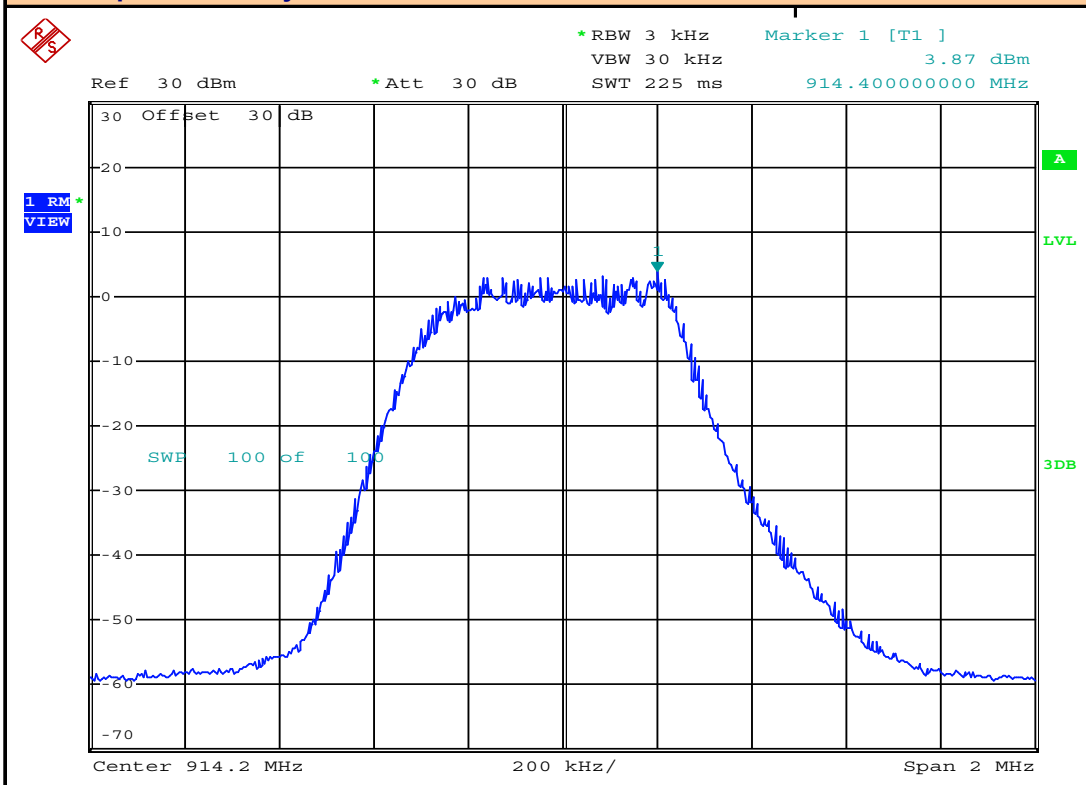
Power Spectal Density:



Channel Number	Channel Frequency (MHz)	Mode	Modulation	Measured PSD (dBm)
3	907.8	LoRa	FSK	3.94

Plot 11.3 – Power Spectral Density, LoRa (DTS) Ch 7

Power Spectal Density:



Channel Number	Channel Frequency (MHz)	Mode	Modulation	Measured PSD (dBm)
7	914.2	LoRa	FSK	3.87

Table 11.1 – Summary of Power Spectral Density Measurements, (DTS)

Power Spectral Density Measurement Results: DTS						
Mode	**Channel Number**	**Frequency (MHz)**	**Modulation**	**Measured PSD [P_{Meas}] (dBm)**	**PSD Limit [P_{Lim}] (dBm)**	**Conducted Margin (dB)**
Lora	0	903	FSK	4.13	8	3.9
	3	907.8		3.94	8	4.1
	7	914.2		3.87	8	4.1
				Result:	**Complies**	

Margin = P_{Limit} - P_{Meas}

12.0 FHSS NUMBER OF HOPPING CHANNELS

Test Procedure	
Normative Reference	FCC 47 CFR §2.1049, §15.247(a)(1)(i), RSS-Gen (6.7), RSS-247 (5.2)(c), KDB 558074 (8.2), ANSI C63.10 (11.8.2)

Limits	
§15.247(a)(1) (i)	(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions: (i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.
RSS-247 (5.2)(c)	**5.2 Digital transmission systems** DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400 - 2483.5 MHz: c) For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

General Procedure	
KDB 558074 (8.2) C63.10 (11.8.2)	**11.8.2 Option 2** The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥ 3 X RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

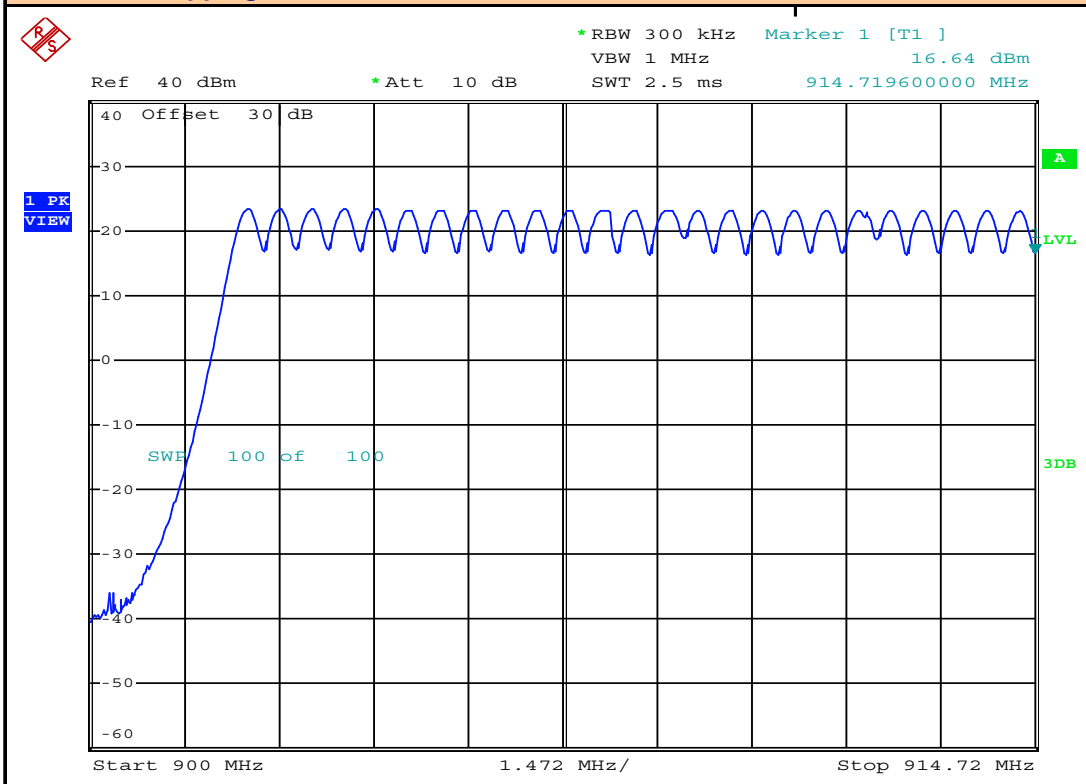
Test Setup	Appendix A - Figure A.1

Measurement Procedure

The DUT was connected to a Spectrum Analyzer (SA) via a 30dB attenuator connected to the DUT's antenna port. The SA was configured as above using the Automatic 6dB Cursor Bandwidth measurement. The output power of the DUT was set to the manufacturer's highest output power setting at the Low, Mid and High frequency channels as permitted by the device.

Plot 12.1 – Number of Hopping Channels, MESH, Part 1

Number of Hopping Channels:

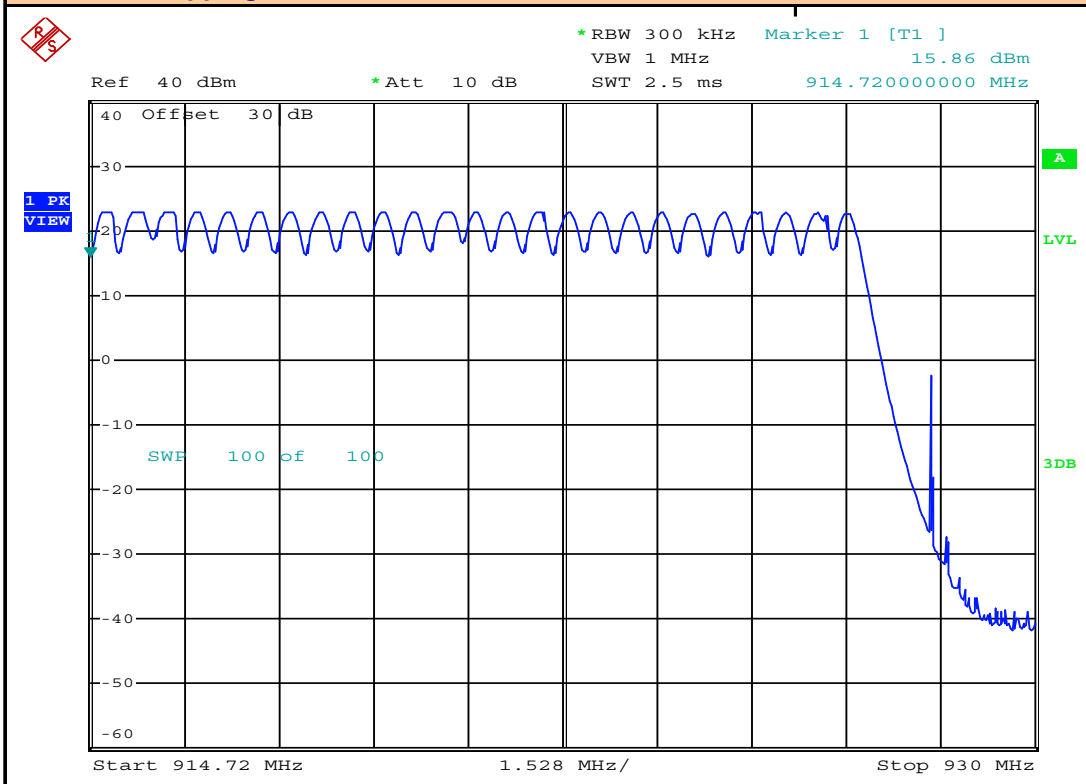


Date: 30.JUN.2021 15:32:04

Start Frequency *(MHz)*	Stop Frequency *(MHz)*	Mode	Modulation	Hopping Channels
900	914.72	MESH	FSK	25

Plot 12.2 – Number of Hopping Channels, MESH, Part 2

Number of Hopping Channels:

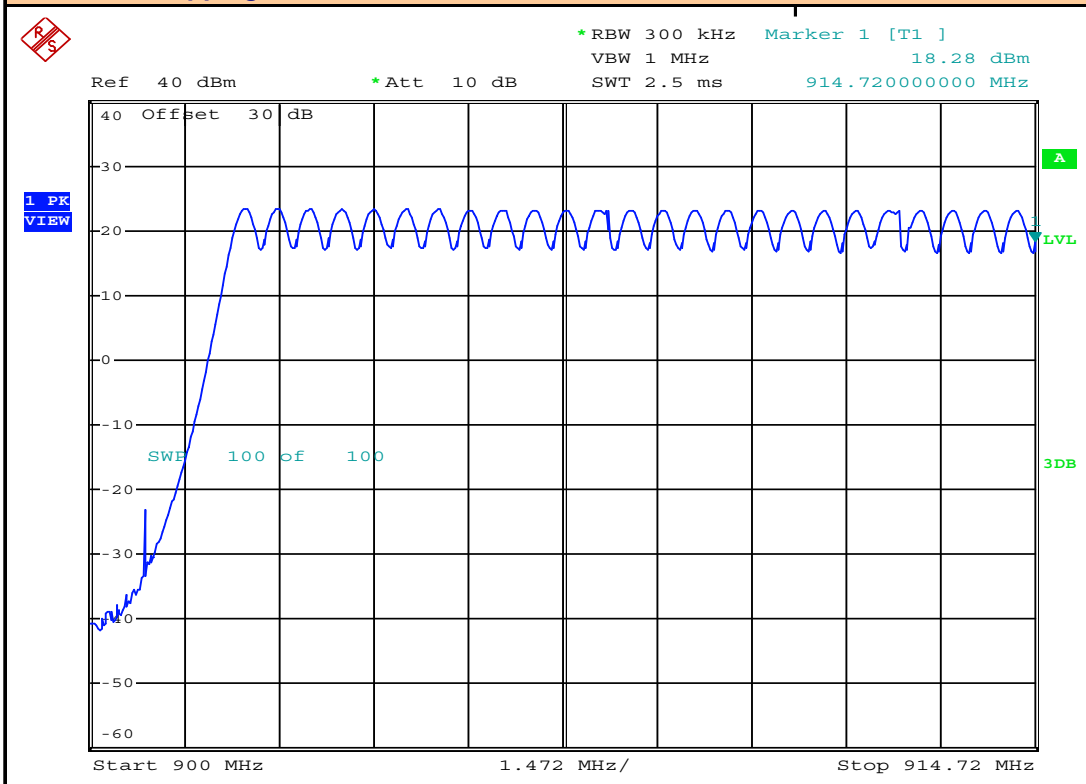


Date: 30.JUN.2021 15:33:01

Start Frequency *(MHz)*	Stop Frequency *(MHz)*	Mode	Modulation	Hopping Channels
914.72	930	MESH	FSK	25

Plot 12.3 – Number of Hopping Channels, Drive-By, Part 1

Number of Hopping Channels:

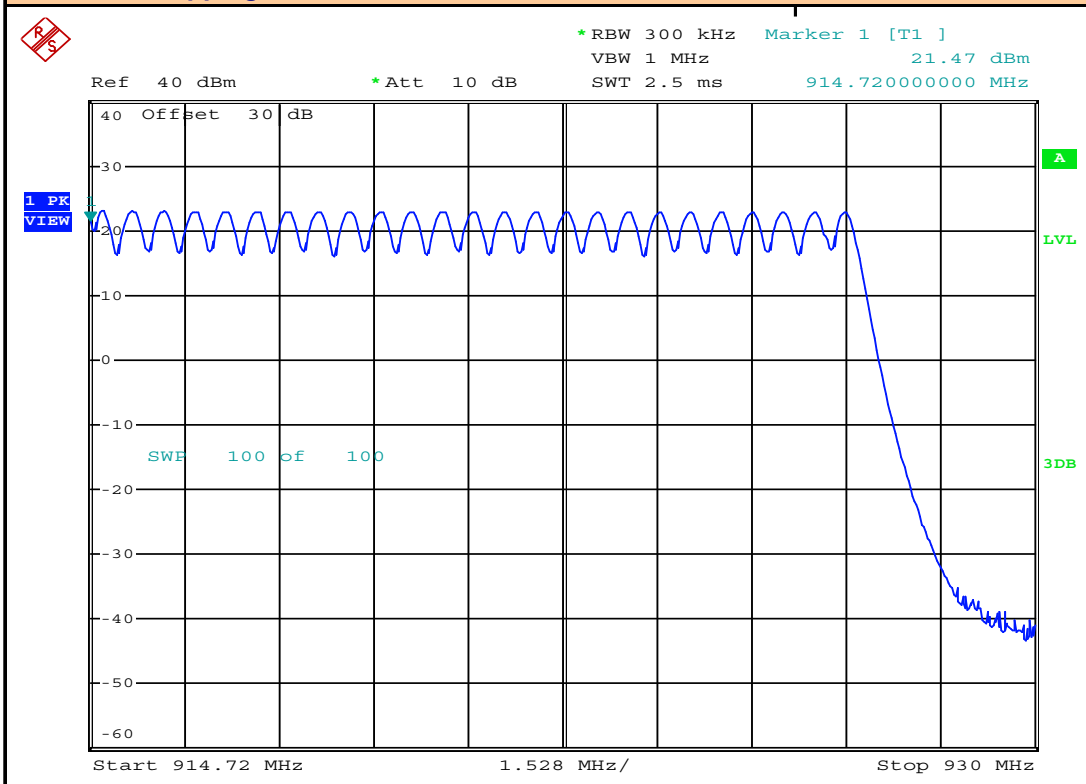


Date: 30.JUN.2021 15:35:12

Start Frequency *(MHz)*	Stop Frequency *(MHz)*	Mode	Modulation	Hopping Channels
900	914.72	Drive-By	FSK	25

Plot 12.4 – Number of Hopping Channels, Drive-By, Part 2

Number of Hopping Channels:

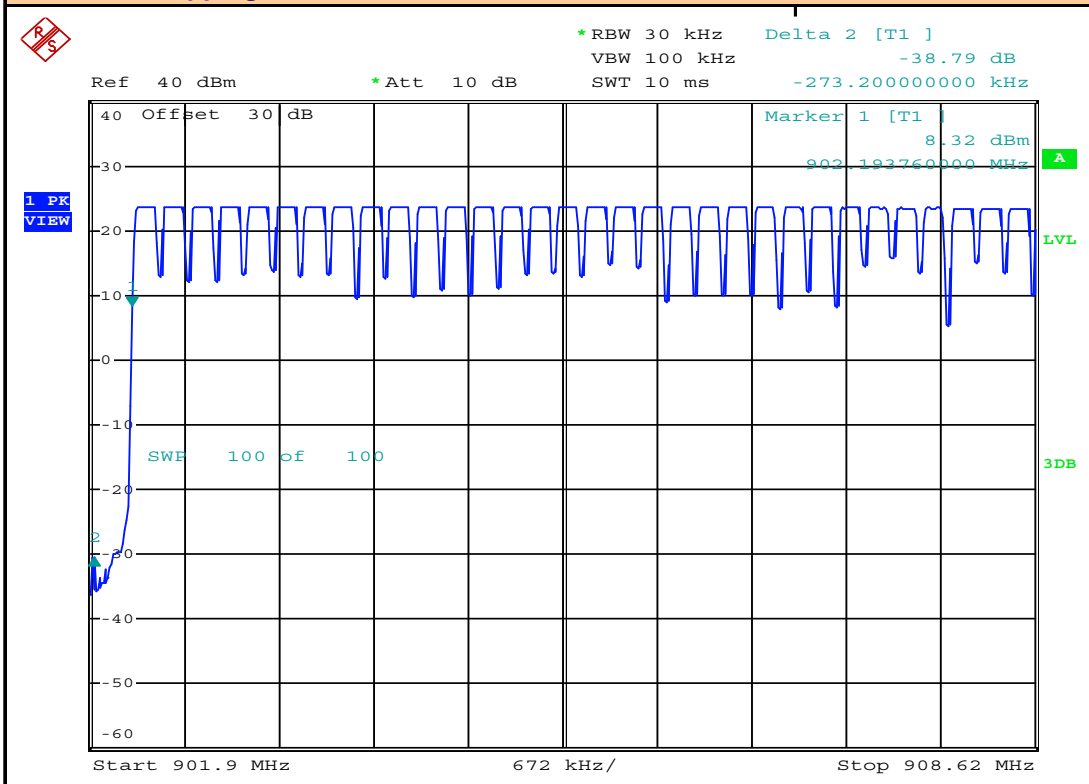


Date: 30.JUN.2021 15:34:32

Start Frequency *(MHz)*	Stop Frequency *(MHz)*	Mode	Modulation	Hopping Channels
914.72	930	Drive-By	FSK	25

Plot 12.5 – Number of Hopping Channels, LoRa (DSS), Part 1

Number of Hopping Channels:

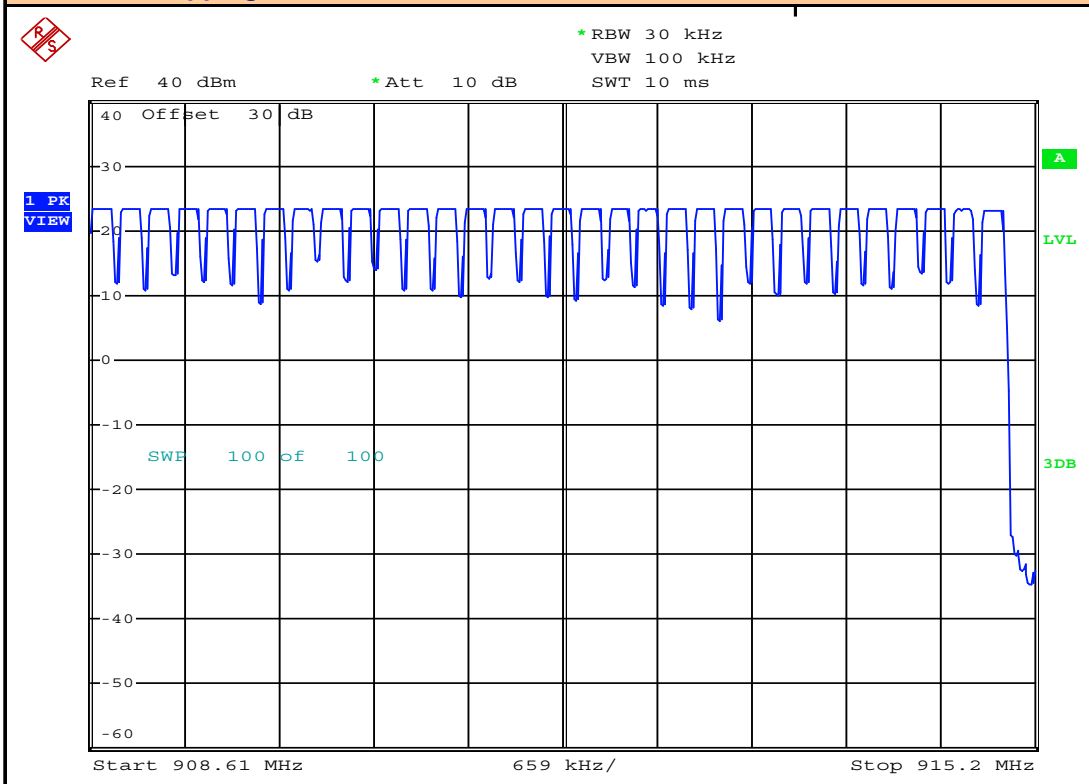


Date: 4.JUL.2021 11:51:25

Start Frequency *(MHz)*	Stop Frequency *(MHz)*	Mode	Modulation	Hopping Channels
901.9	908.62	LoRa	FSK	32

Plot 12.6 – Number of Hopping Channels, LoRa (DSS), Part 2

Number of Hopping Channels:



Start Frequency *(MHz)*	Stop Frequency *(MHz)*	Mode	Modulation	Hopping Channels
908.61	915.2	LoRa	FSK	32

Table 12.2 – Summary of FHSS Number of Hopping Channels

Hopping Channel Results DSS			
Frequency Range (MHz)	**Mode**	**Modulation**	**Number of Hopping Channels**
900-914.7	MESH	FSK	25
914.7-930			25
		Total:	**50**
900-914.7	Drive-By	FSK	25
914.7-930			25
		Total:	**50**
901.9-908.6	LoRa	FSK	32
908.6-915			32
		Total:	**64**
		Result:	**Complies**

13.0 FHSS CHANNEL SEPARATION

Test Procedure	
Normative Reference	FCC 47 CFR §2.1049, §15.247(a)(1)(i), RSS-Gen (6.7), RSS-247 (5.2)(c), KDB 558074 (8.2), ANSI C63.10 (11.8.2)

Limits	
§15.247(a)(1) (i)	(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions: (i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.
RSS-247 (5.2)(c)	**5.2 Digital transmission systems** DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400 - 2483.5 MHz: c) For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

General Procedure	
KDB 558074 (8.2) C63.10 (11.8.2)	**11.8.2 Option 2** The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥ 3 X RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

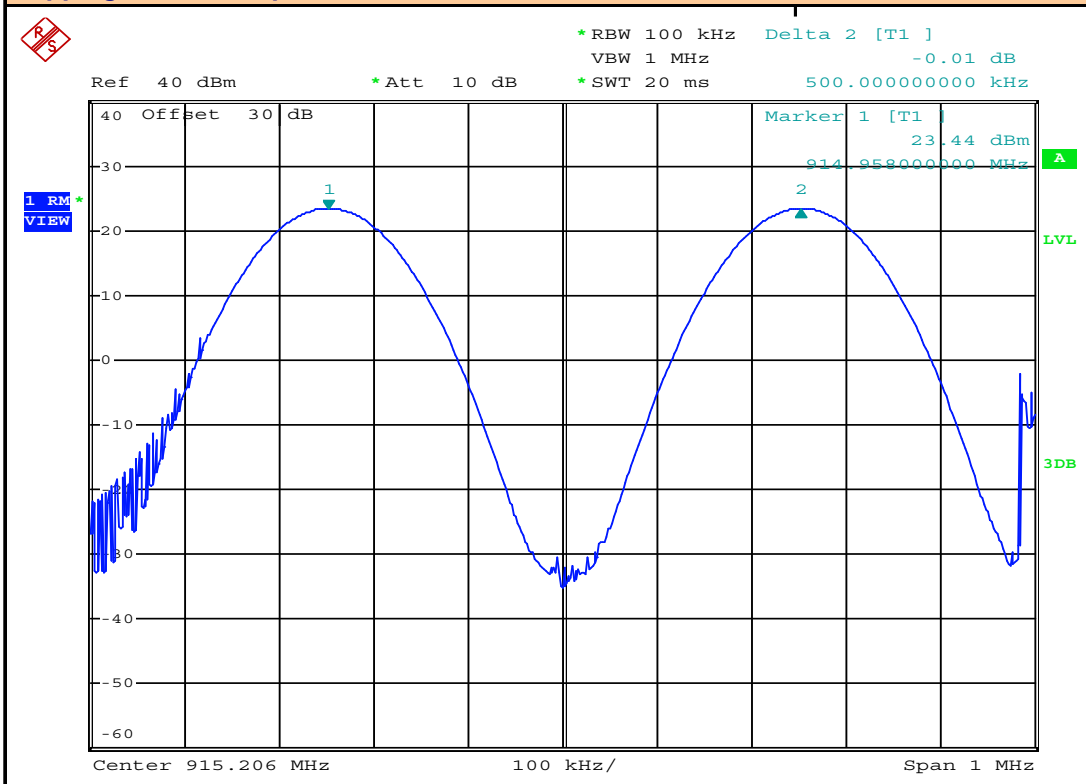
Test Setup	Appendix A - Figure A.1

Measurement Procedure

The DUT was connected to a Spectrum Analyzer (SA) via a 30dB attenuator connected to the DUT's antenna port. The SA was configured as above using the Automatic 6dB Cursor Bandwidth measurement. The output power of the DUT was set to the manufacturer's highest output power setting at the Low, Mid and High frequency channels as permitted by the device.

Plot 13.1 – Channel Separation, MESH

Hopping Channel Separation:

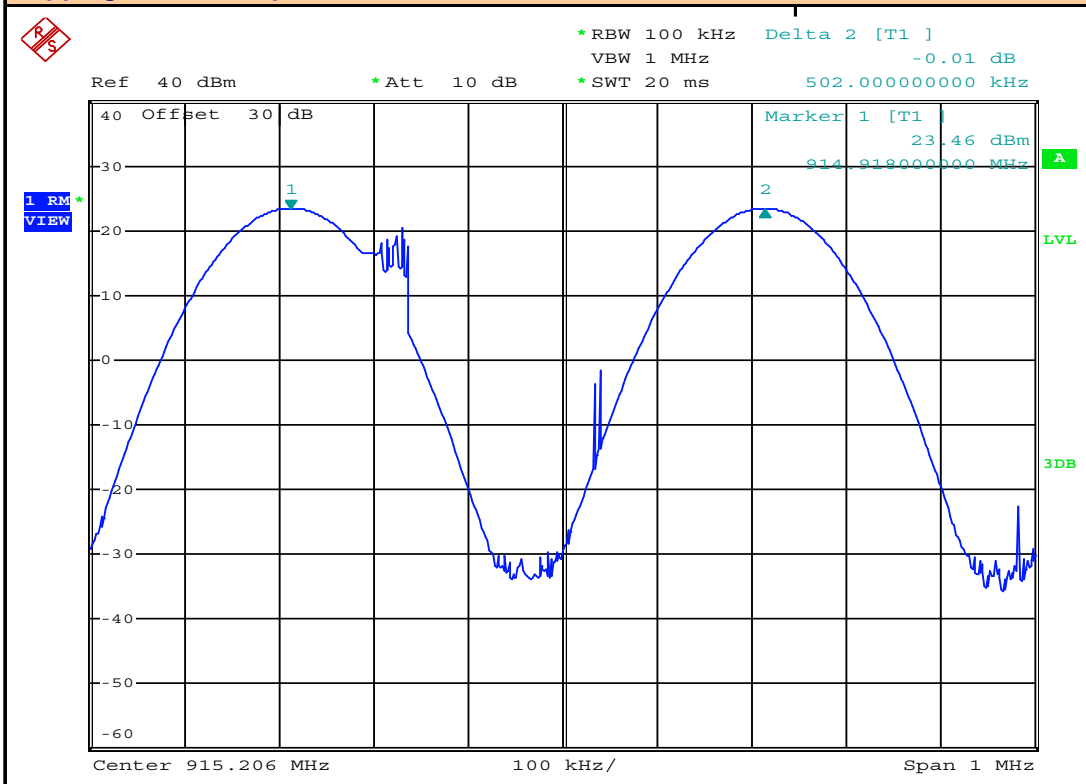


Date: 13.JUL.2021 14:35:59

Mode	Modulation	20dB Bandwidth (kHz)	Channel Separation (kHz)
MESH	FSK	162	500

Plot 13.2 – Channel Separation, Drive-By

Hopping Channel Separation:

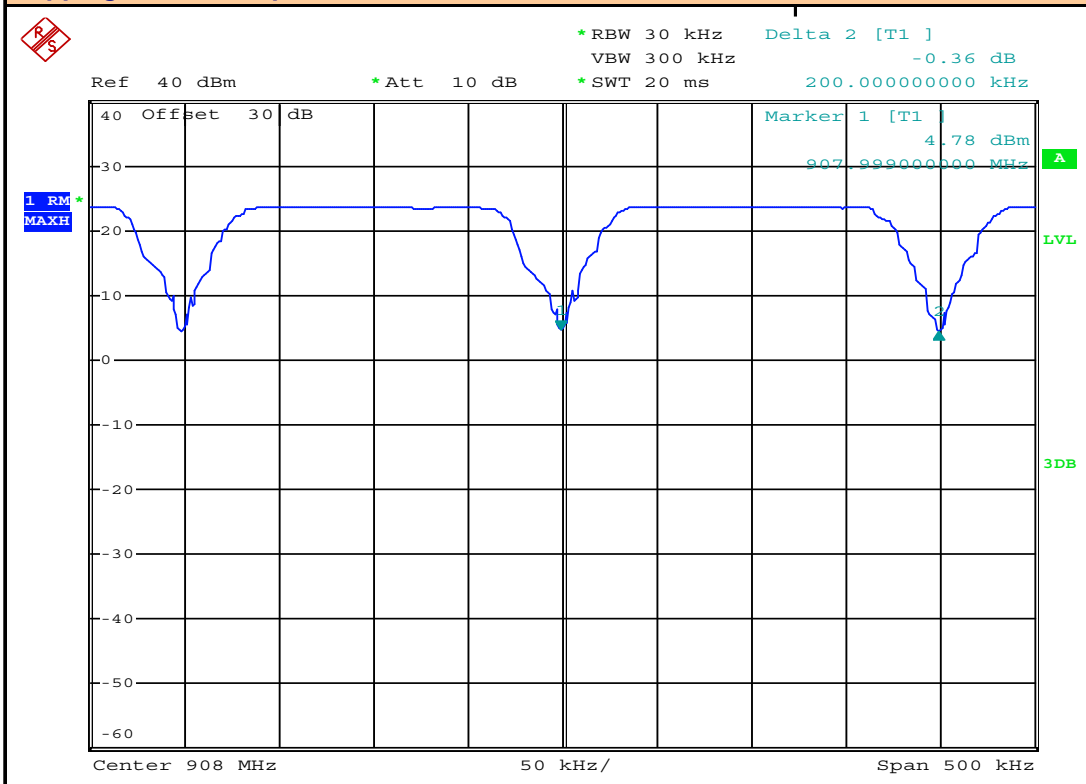


Date: 13.JUL.2021 14:37:35

Mode	Modulation	20dB Bandwidth (kHz)	Channel Separation (kHz)
Drive-By	FSK	364	502

Plot 13.3 – Channel Separation, LoRa (DSS)

Hopping Channel Separation:



Date: 13.JUL.2021 15:28:49

Mode	Modulation	20dB Bandwidth (kHz)	Channel Separation (kHz)
LoRa	FSK	161	200

Table 13.1 – Summary of FHSS Channel Separation

Hopping Channel Separation Results DSS				
Mode	**Modulation**	**Channel Separation *(kHz)***	**20dB BW *(kHz)***	**Margin *(kHz)***
MESH	FSK	500	162.000	338.000
Drive-By		502	364.000	138.000
Lora		200	161.000	39.000
			Result:	**Complies**

Margin = Channel Separation - Minimum Bandwidth

14.0 FHSS TIME OF OCCUPANCY

Test Procedure	
Normative Reference	FCC 47 CFR §2.1049, §15.247(a)(1)(i), RSS-Gen (6.7), RSS-247 (5.2)(c), KDB 558074 (8.2), ANSI C63.10 (11.8.2)

Limits	
§15.247(a)(1) (i)	(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions: (i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.
RSS-247 (5.2)(c)	**5.2 Digital transmission systems** DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400 - 2483.5 MHz: c) For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

General Procedure	
KDB 558074 (8.2) C63.10 (11.8.2)	**11.8.2 Option 2** The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥ 3 X RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

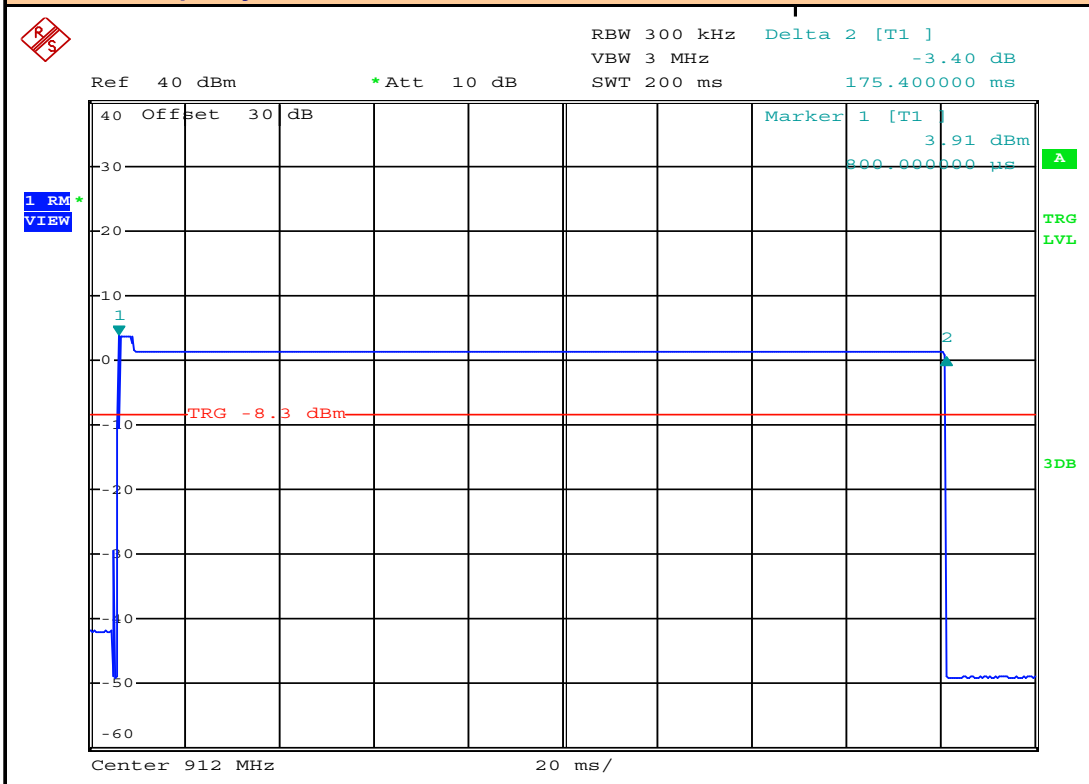
Test Setup	Appendix A - Figure A.1

Measurement Procedure

The DUT was connected to a Spectrum Analyzer (SA) via a 30dB attenuator connected to the DUT's antenna port. The SA was configured as above using the Automatic 6dB Cursor Bandwidth measurement. The output power of the DUT was set to the manufacturer's highest output power setting at the Low, Mid and High frequency channels as permitted by the device.

Plot 14.1 – Time of Occupancy, Dwell Time, MESH

Time of Occupancy: Dwell Time

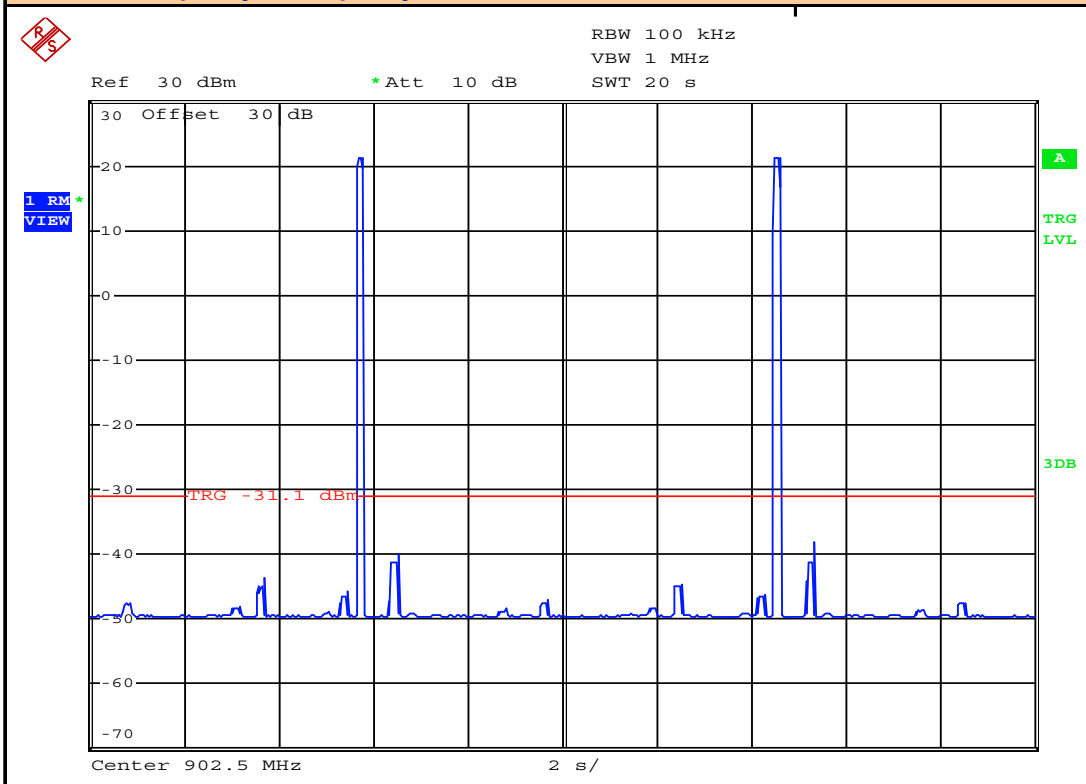


Date: 2.JUL.2021 14:02:39

Mode	Modulation	Dwell Time (mSec)
MESH	FSK	175.4

Plot 14.2 – Time of Occupancy, Occupancy, MESH

Time of Occupancy: Occupancy Time

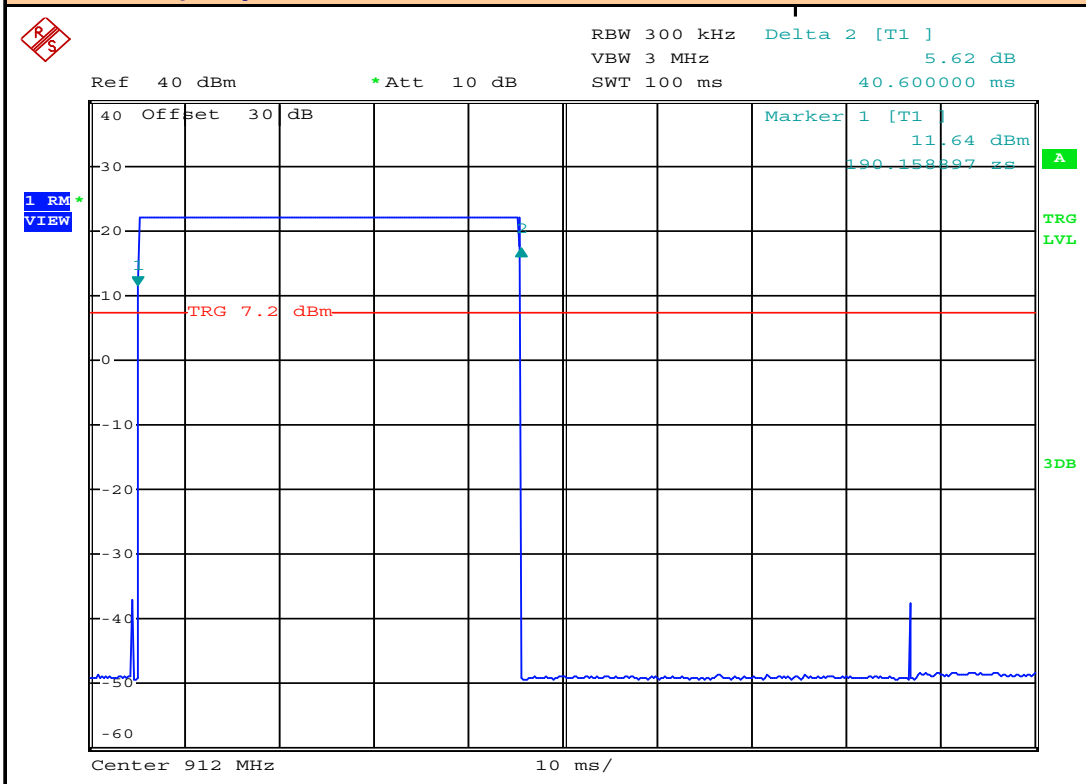


Date: 3.JUL.2021 11:49:58

Mode	Modulation	Dwell Time (mSec)	Occupancy Time (mSec)
MESH	FSK	175.4	350.8

Plot 14.3 – Time of Occupancy, Dwell Time, Drive-By

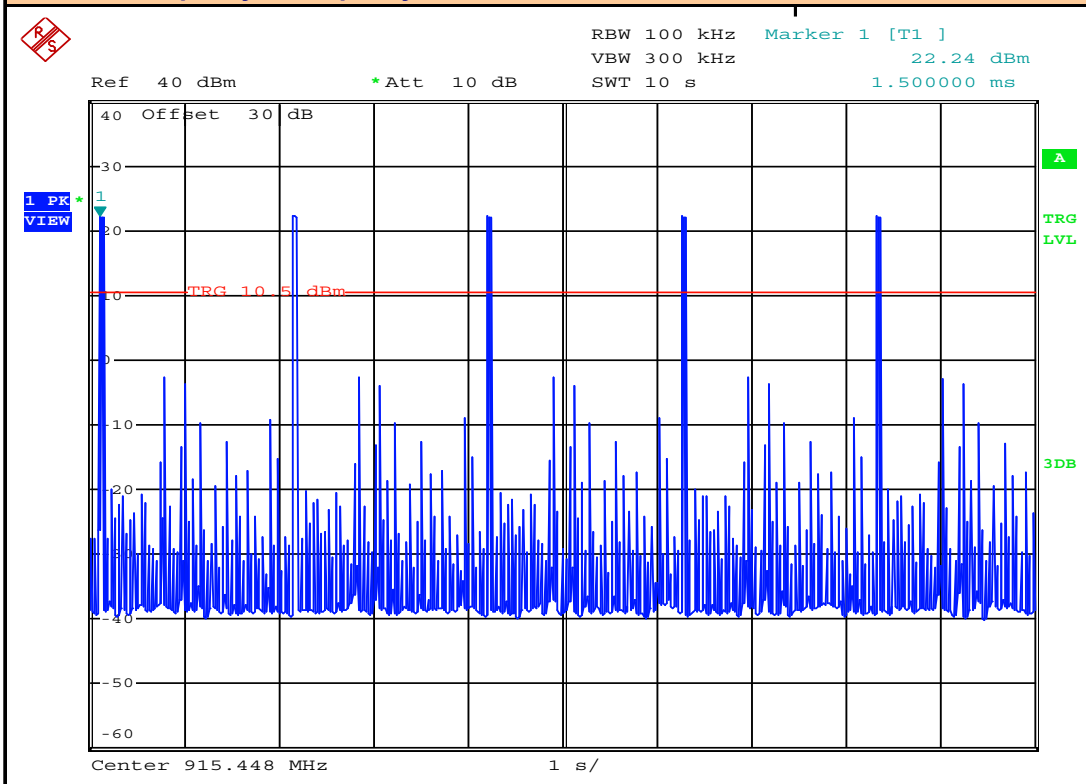
Time of Occupancy: Dwell Time



Mode	Modulation	Dwell Time (mSec)
Drive-By	FSK	40.6

Plot 14.4 – Time of Occupancy, Occupancy, Drive-By

Time of Occupancy: Occupancy Time

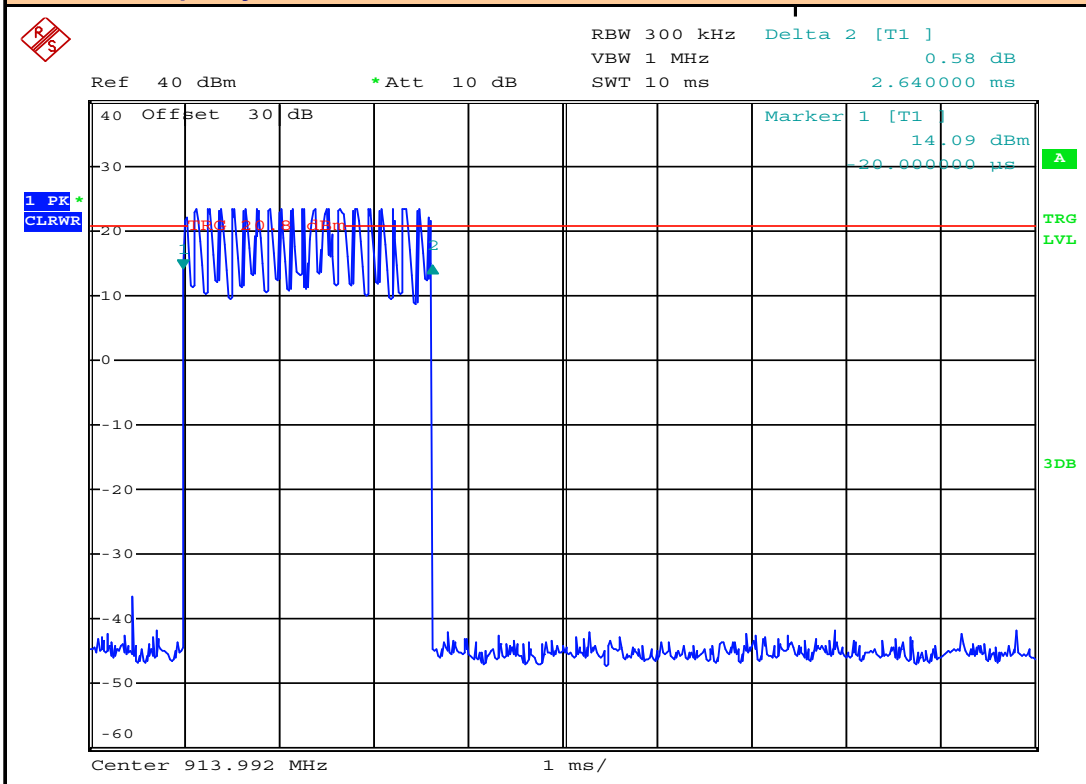


Date: 4.JUL.2021 11:25:36

Mode	Modulation	Dwell Time (mSec)	Occupancy Time (mSec)
Drive-By	FSK	40.6	203.0

Plot 14.5 – Time of Occupancy, Dwell Time, LoRa (DSS)

Time of Occupancy: Dwell Time

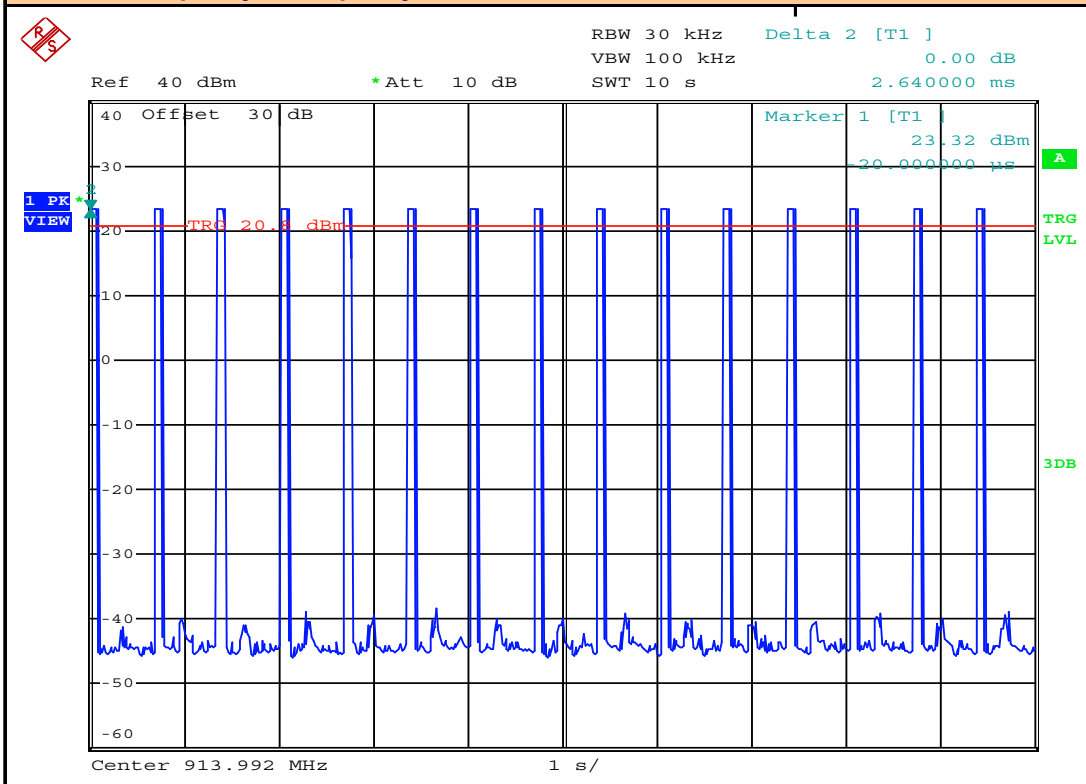


Date: 3.JUL.2021 13:17:22

Mode	Modulation	Dwell Time (mSec)
Lora	FSK	2.64

Plot 14.6 – Time of Occupancy, Occupancy, LoRa (DSS)

Time of Occupancy: Occupancy Time



Date: 3.JUL.2021 13:23:44

Mode	Modulation	Dwell Time (mSec)	Occupancy Time (mSec)
Lora	FSK	2.64	39.6

Table 14.1 – Summary of FHSS Time of Occupancy

Hopping Channel Time of Occupancy DSS										
Mode	**Modulation**	**Channel On Time (Dwell) [t_{on}] (mSec)**	**Number of Period Transmits [N_{Period}]**	**Observation Period [T_{Period}] (Sec)**	**Time of Period Occupancy [T_{Occ}] (mSec)**	**Total Observation Period [TT_{Period}] (mSec)**	**Accumulated Time of Occupancy [TT_{Occ}] (mSec)**	**Number of Hopping Channels [N_{Hop}]**	**Limit [Limit] (mSec)**	**Margin (mSec)**
MESH	FSK	175.4	2	20	350.8	20	350.80	50	400	49
Drive-By		40.6	5	10	203.0	10	203.00	50	400	197
LoRa		2.6	15	10	39.6	20	79.20	64	400	321
									Result:	**Complies**

Time of Occupancy within the measurement (Observation) period [T_{Occ}] = On Time [T_{on}] X Number of Transmits within the Observation Period [N_{period}]

Total Observation Period [TT_{Period}] = 15mSec X Number of Hopping Channels = 15mSec X [N_{Hop}]

Accumulated Time of Occupancy [TT_{Occ}] = Time of Occupancy [T_{Occ}] X Total Observation Peroid [TT_{Period}] / Observation Period [T_{Period}]

Margin = Limit - TT_{Occ}

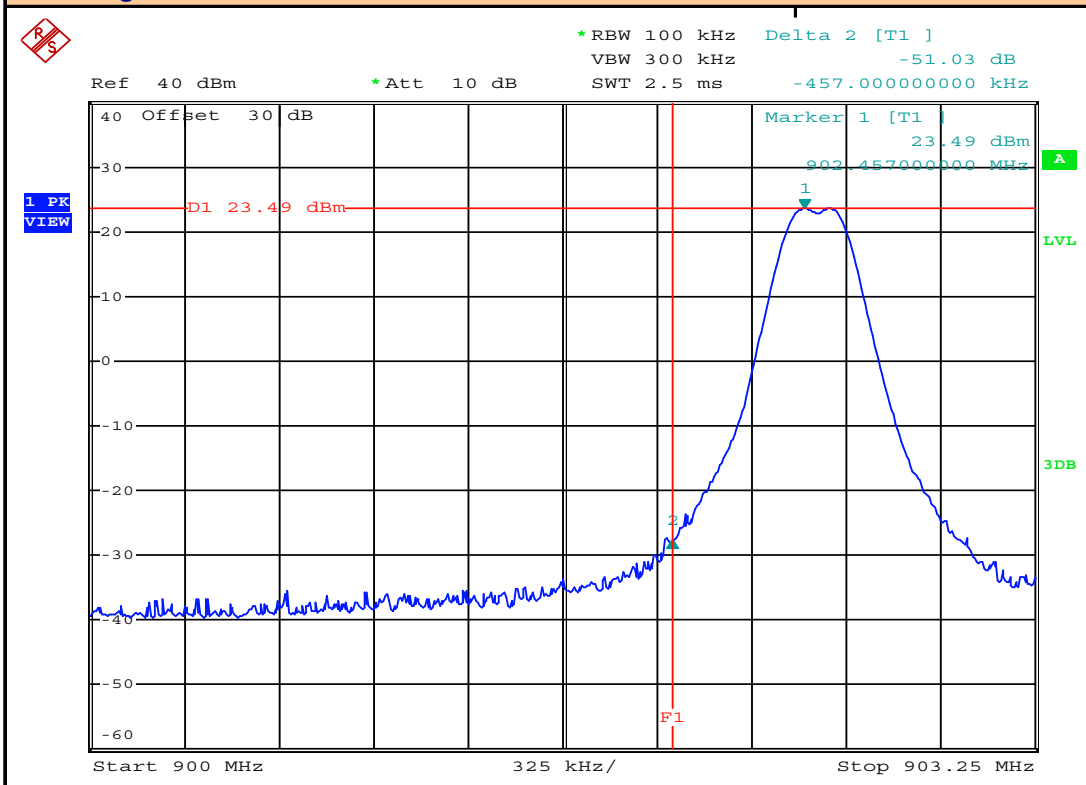
15.0 CONDUCTED SPURIOUS EMISSIONS -BAND EDGE

Test Procedure	
Normative Reference	FCC 47 CFR §2.1051, §15.247(d), RSS-Gen (6.13), RSS-247 (5.5),
	KDB 558074 (11.3), ANSI C63.10 (11.11.3)

Limits	
47 CFR §15.247(d)	(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.
RSS-247 (5.5)	**5.5 Unwanted emissions** In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required. d) For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e). As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power.
KDB 558074 (11.3) C63.10 (11.11.3)	**11.1 General** The DTS rules specify that in any 100 kHz bandwidth outside of the authorized frequency band, the power shall be attenuated according to the following conditions: b) If maximum conducted (average) output power was used to demonstrate compliance as described in 9.2, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 30 dBc). **11.2 Reference level measurement** a) Set instrument center frequency to DTS channel center frequency. b) Set the span to ≥ 1.5 X *DTS bandwidth.* c) Set the RBW = 100 kHz. d) Set the VBW ≥ 3 X RBW. e) Detector = peak. f) Sweep time = auto couple. g) Trace mode = max hold. h) Allow trace to fully stabilize. i) Use the peak marker function to determine the maximum PSD level. Note that the channel found to contain the maximum PSD level can be used to establish the reference

Plot 15.1 – Conducted Spurious Emissions, Lower Band Edge, MESH Ch1

Band Edge: Lower

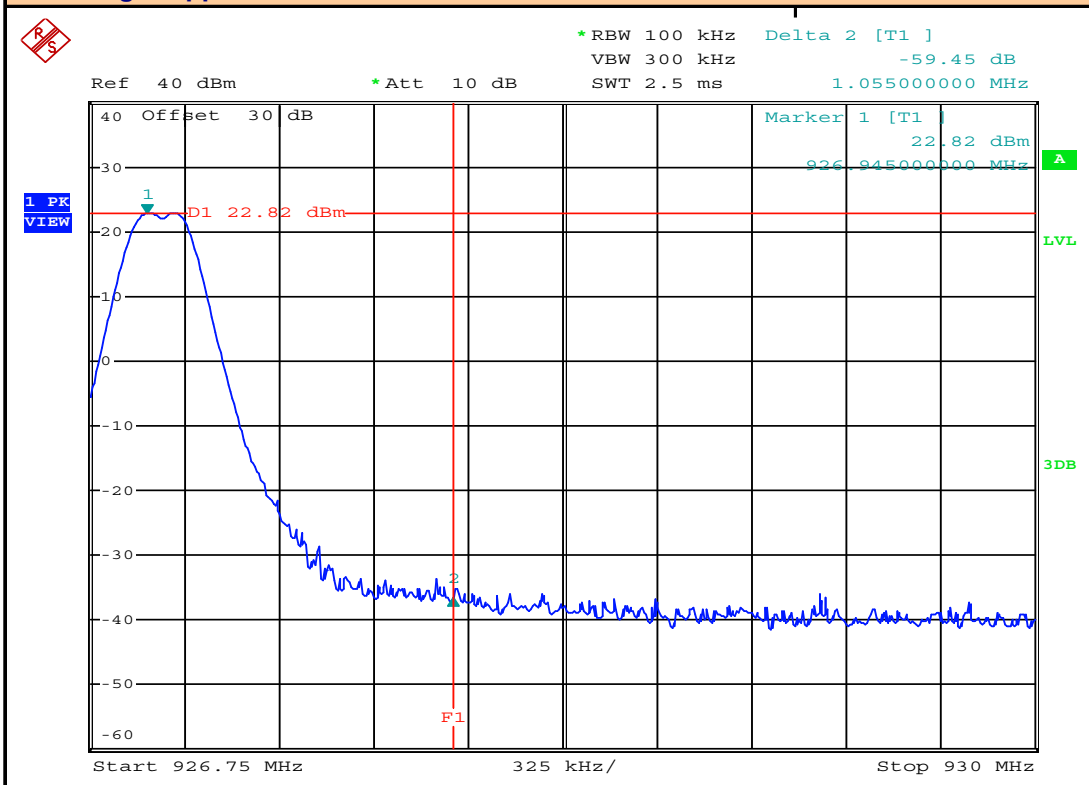


Date: 4.JUL.2021 13:54:54

Equipment Class	Channel Number	Channel Frequency (MHz)	Mode	Modulation	Fund. Power (dBm)	Emission Frequency (MHz)	Measured Emission (dBm)
DSS	1	902.5	MESH	FSK	23.49	902.00	-27.54

Plot 15.2 – Conducted Spurious Emissions, Upper Band Edge, MESH Ch0

Band Edge: Upper

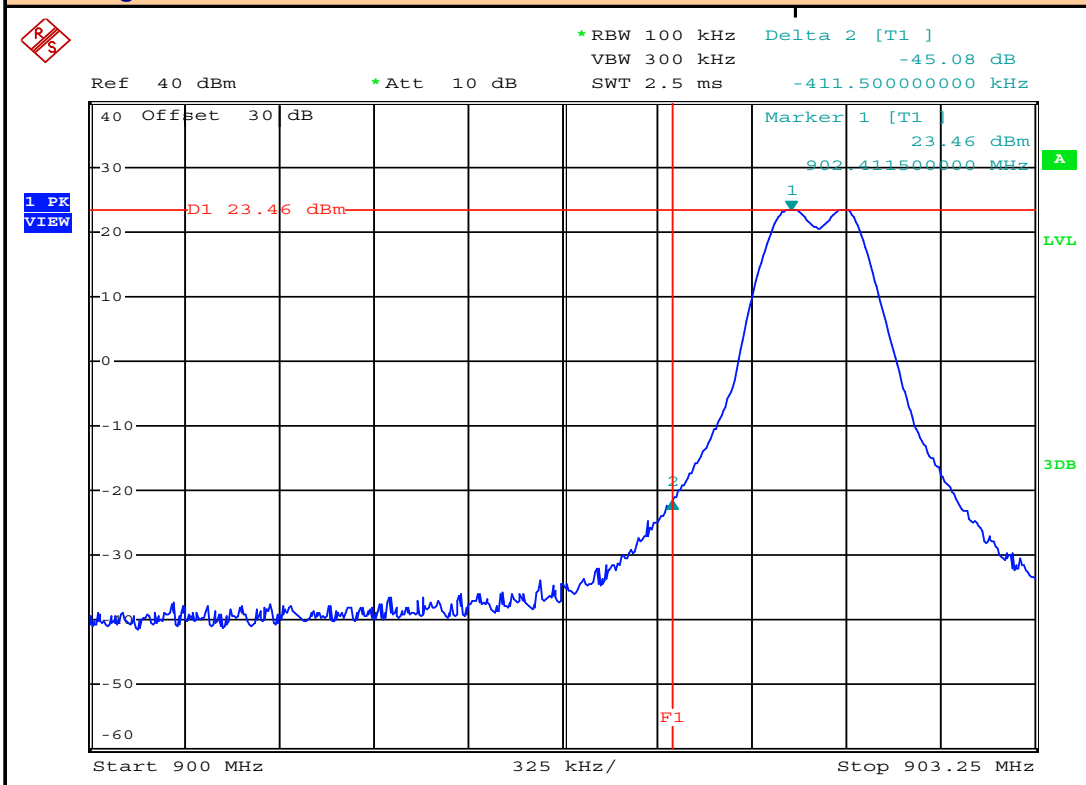


Date: 4.JUL.2021 13:57:12

Equipment Class	Channel Number	Channel Frequency (MHz)	Mode	Modulation	Fund. Power (dBm)	Emission Frequency (MHz)	Measured Emission (dBm)
DSS	0	927	MESH	FSK	22.82	928.00	-36.63

Plot 15.3 – Conducted Spurious Emissions, Lower Band Edge, Drive-By Ch1

Band Edge: Lower

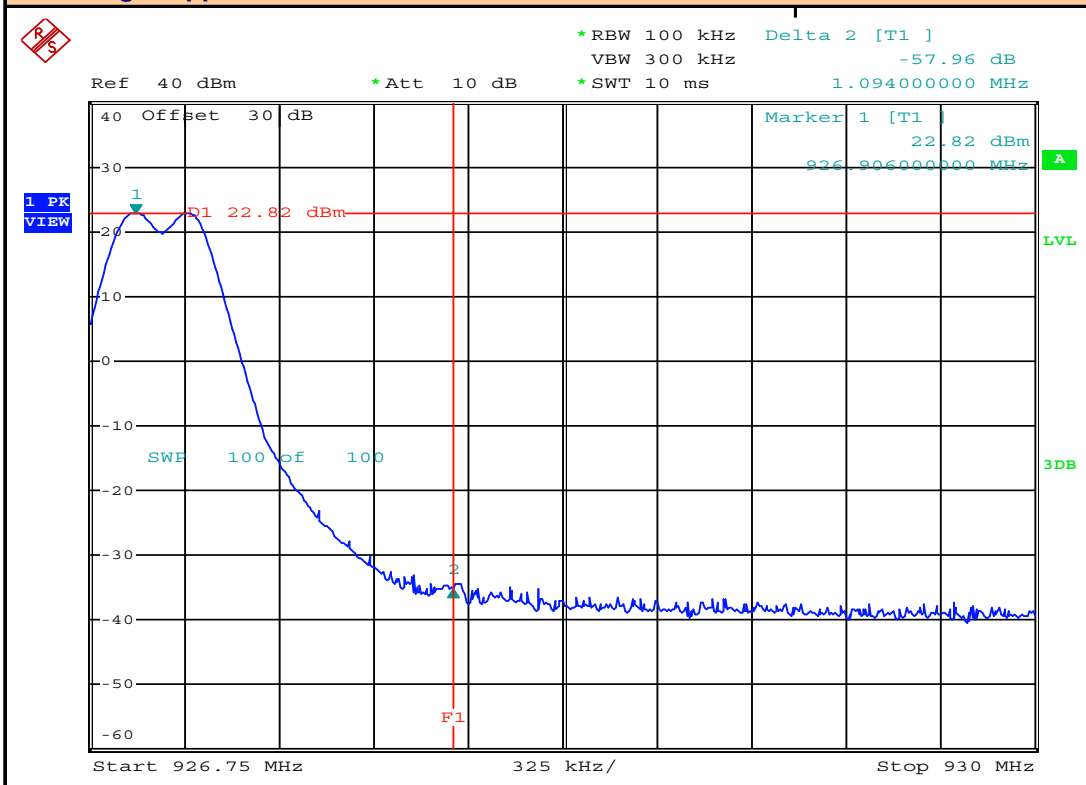


Date: 4.JUL.2021 13:52:45

Equipment Class	Channel Number	Channel Frequency (MHz)	Mode	Modulation	Fund. Power (dBm)	Emission Frequency (MHz)	Measured Emission (dBm)
DSS	1	902.5	Drive-By	FSK	23.46	902.00	-21.62

Plot 15.4 – Conducted Spurious Emissions, Upper Band Edge, Drive-By Ch0

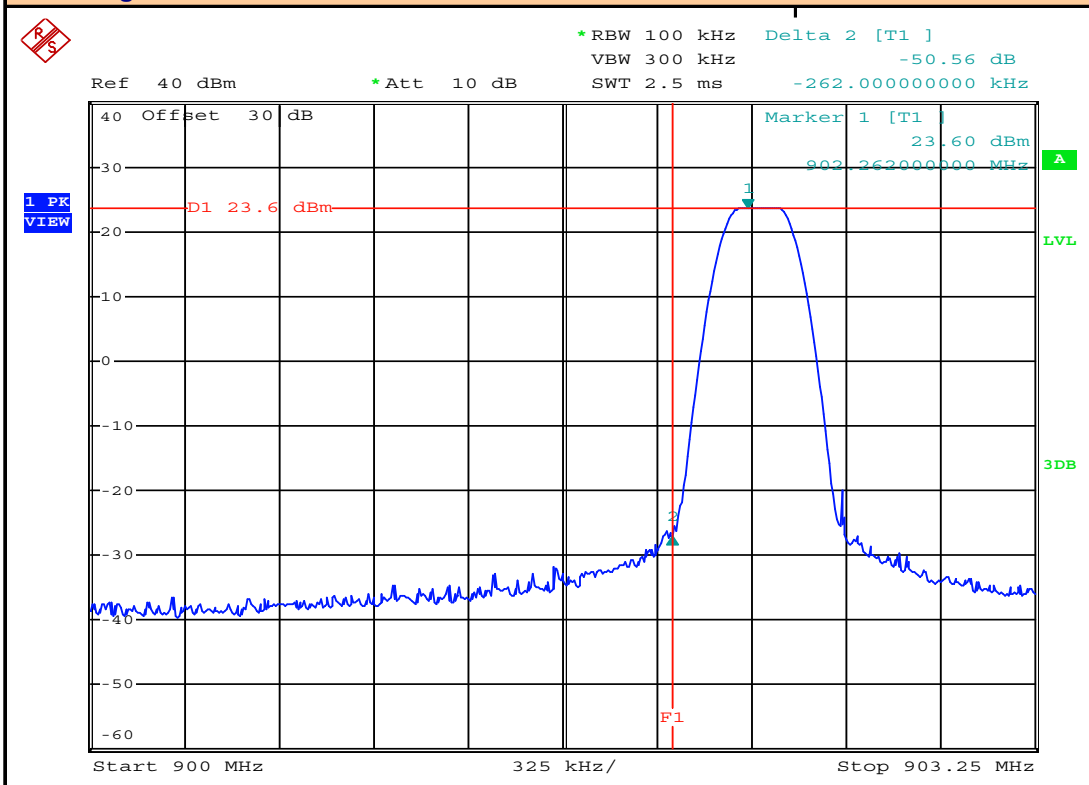
Band Edge: Upper



Equipment Class	Channel Number	Channel Frequency (MHz)	Mode	Modulation	Fund. Power (dBm)	Emission Frequency (MHz)	Measured Emission (dBm)
DSS	0	927	Drive-By	FSK	22.82	928.00	-35.14

Plot 15.5 – Conducted Spurious Emissions, Lower Band Edge, Lora (DSS) Ch0

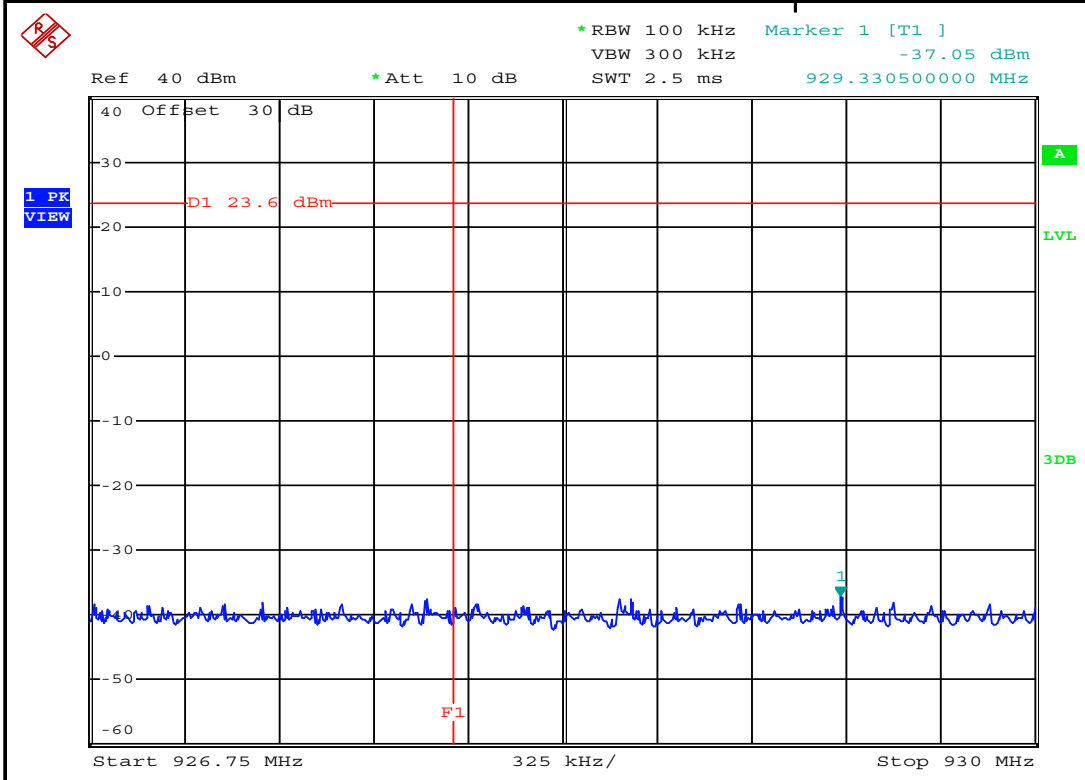
Band Edge: Lower



Equipment Class	Channel Number	Channel Frequency (MHz)	Mode	Modulation	Fund. Power (dBm)	Emission Frequency (MHz)	Measured Emission (dBm)
DSS	0	902.3	LoRa	FSK	23.6	902.00	-26.96

Plot 15.6 – Conducted Spurious Emissions, Upper Band Edge, Lora (DSS) Ch63

Band Edge: Upper

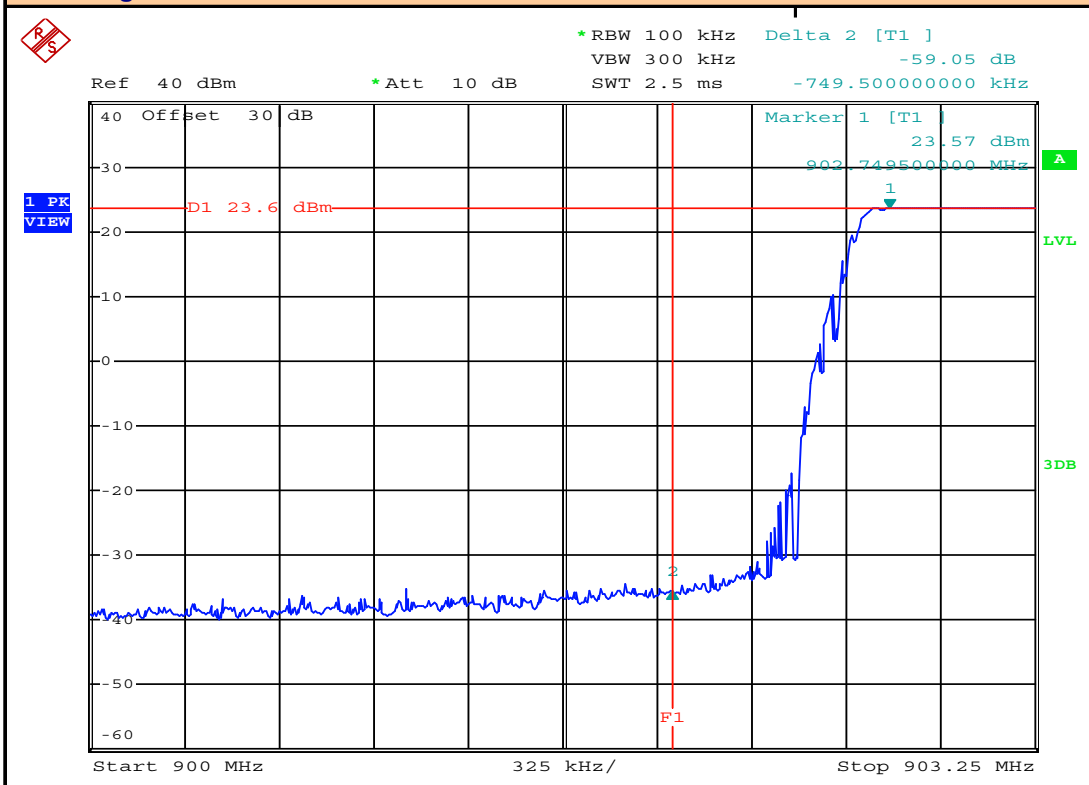


Date: 4.JUL.2021 14:06:08

Equipment Class	Channel Number	Channel Frequency (MHz)	Mode	Modulation	Fund. Power (dBm)	Emission Frequency (MHz)	Measured Emission (dBm)
DSS	63	908.5	LoRa	FSK	23.6	929.30	-37.05

Plot 15.7 – Conducted Spurious Emissions, Lower Band Edge, LoRa (DTS) Ch0

Band Edge: Lower

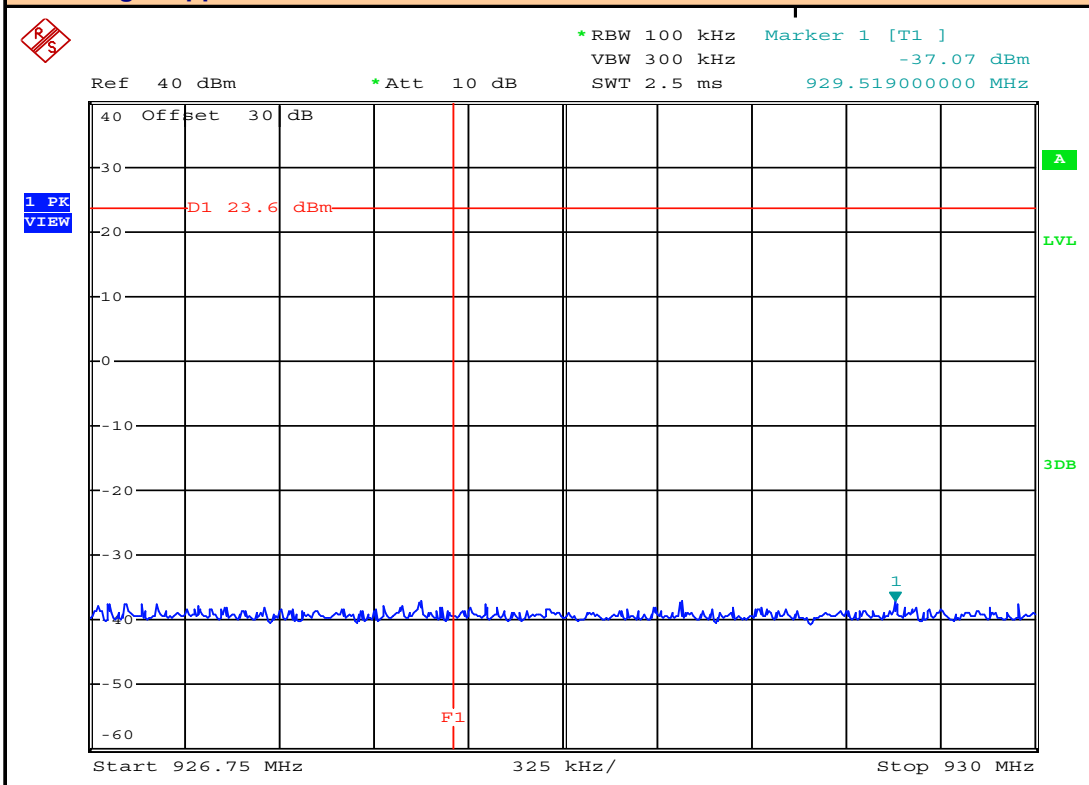


Date: 4.JUL.2021 14:10:47

Equipment Class	Channel Number	Channel Frequency (MHz)	Mode	Modulation	Fund. Power (dBm)	Emission Frequency (MHz)	Measured Emission (dBm)
DTS	0	903	LoRa	FSK	23.6	902.00	-35.48

Plot 15.8 – Conducted Spurious Emissions, Upper Band Edge, LoRa (DTS) Ch7

Band Edge: Upper



Date: 4.JUL.2021 14:12:27

Equipment Class	Channel Number	Channel Frequency (MHz)	Mode	Modulation	Fund. Power (dBm)	Emission Frequency (MHz)	Measured Emission (dBm)
DTS	7	914.2	LoRa	FSK	23.6	929.51	-37.07

Table 15.1 – Summary of Conducted Spurious Emission Measurements – Band Edge,

Unwanted Emissons Measurement Results: Band Edge										
Mode	**Channel Number**	**Frequency (MHz)**	**Equipment Class**	**Modulation**	**Fundamental Power [P_{Fund}] (dBm)**	**Emission Frequency (MHz)**	**Measured Emission [P_{Meas}] (dBm)**	**Attenuation [Att] (dBm)**	**Limit (dB)**	**Margin (dB)**
MESH	1	902.5	DSS	FSK	23.49	902.0	-27.54	51.03	30.0	21.0
	0	927.0			22.82	928.0	-36.63	59.45		29.5
Drive-By	1	902.5			23.46	902.0	-21.62	45.08		15.1
	0	927.0			22.82	928.0	-35.14	57.96		28.0
LoRa	0	902.3			23.60	902.0	-26.96	50.56		20.6
	63	908.5			23.60	929.3	-37.05	60.65		30.7
LoRa	0	903.0	DTS		23.60	902.0	-35.48	59.08		29.1
	7	914.2			23.60	929.5	-37.07	60.67		30.7
									Result:	**Complies**

Attenuation [Att] = Fundamental Power [Pf_{und}] - Measured Emission [P_{meas}]

Margin = [Att] - Limit

16.0 CONDUCTED SPURIOUS EMISSIONS

Test Procedure	
Normative Reference	FCC 47 CFR §2.1051, §15.247(d), RSS-Gen (6.13), RSS-247 (5.5), KDB 558074 (11.3), ANSI C63.10 (11.11.3)

Limits	
47 CFR §15.247(d)	(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.
RSS-247 (5.5)	**5.5 Unwanted emissions** In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required. d) For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e). As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power.
KDB 558074 (11.3) C63.10 (11.11.3)	**11.1 General** The DTS rules specify that in any 100 kHz bandwidth outside of the authorized frequency band, the power shall be attenuated according to the following conditions: b) If maximum conducted (average) output power was used to demonstrate compliance as described in 9.2, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 30 dBc). **11.2 Reference level measurement** a) Set instrument center frequency to DTS channel center frequency. b) Set the span to ≥ 1.5 X *DTS bandwidth.* c) Set the RBW = 100 kHz. d) Set the VBW ≥ 3 X RBW. e) Detector = peak. f) Sweep time = auto couple. g) Trace mode = max hold. h) Allow trace to fully stabilize. i) Use the peak marker function to determine the maximum PSD level. Note that the channel found to contain the maximum PSD level can be used to establish the reference

Table 16.1 – Summary of Conducted Spurious Emissions, (DTS)

See Appendix D for Measurement Plots

Conducted Spurious Emissons Measurement Results:

Mode	Channel Number	Frequency (MHz)	Equipment Class	Modulation	Fundamental Power [P_{Fund}] (dBm)	Emission Frequency (MHz)	Measured Emission [P_{Meas}] (dBm)	Attenuation [Att] (dBm)	Limit (dB)	Margin (dB)
MESH	0	927.0	DSS	FSK	22.82	944.4	-37.16	59.98	30.0	30.0
					22.82	1216.0	-37.07	59.89		29.9
					22.82	9244.0	-36.52	59.34		29.3
Drive-By	0	927.0			22.82	951.7	-37.06	59.88		29.9
					22.82	1856.0	-37.04	59.86		29.9
					22.82	3840.0	-35.90	58.72		28.7
LoRa	63	908.5			23.60	987.4	-37.57	61.17		31.2
					23.60	2952.0	-36.93	60.53		30.5
					23.60	3168.0	-36.12	59.72		29.7
LoRa	7	914.2	DTS		23.60	988.4	-37.17	60.77		30.8
					23.60	2420.0	-36.92	60.52		30.5
					23.60	3000.0	-38.15	61.75		31.8
									Result:	Complies

Attenuation [Att] = Fundamental Power [Pf_{und}] - Measured Emission [P_{meas}]
Margin = [Att] - Limit

17.0 RADIATED TX SPURIOUS EMISSIONS, RESTRICTED BAND

Test Procedure	
Normative Reference	FCC 47 CFR §2.1051, §15.247(d), §15.205(a), §15.205(c), §15.209(a)
	KDB 558074 (8.6), ANSI C63.10 (11.12)

Limits

47 CFR §15.247(d)

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

47 CFR §15.209(a)

§15.209 Radiated emission limits; general requirements.

(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (microvolts/meter)
0.009 - 0.490	2400/F (kHz) @300m
0.490 - 1.705	24000/F (kHz) @30m
1.705 - 30	30 @ 30m
30 - 88	100 @3m
88 - 216	150 @3m
216 - 960	200 @3m
Above 960	500 @3m

Table 17.1 – Summary of Radiated Tx Spurious Emissions, Restricted Band

See Appendix E for Measurement Plots

Summary of Radiated Tx Emissions (Restricted Band)										
Measured Frequency Range (MHz)	Channel Frequency (MHz)	Antenna Polarization	Emission Frequency	Measured Emission [E_{Meas}] (dBuV)	Antenna ACF [ACF] (dB)	Cable Loss [L_C] (dB)	Amplifier Gain [G_A] (dB)	Corrected Emission [E_{Corr}] (dBuV/m)	Limit (dBuV)	Margin (dB)
9kHz - 30MHz	916.0	Front	ND	ND (1)	0.00	0.00	0.00 (3)	ND (2)	n/a	**n/a**
9kHz - 30MHz	916.0	Side	ND	ND (1)	0.00	0.00	0.00 (3)	ND (2)	n/a	**n/a**
30-1000MHz	916.0	Horizontal	750.1MHz	39.2	0.00	0.00	0.00 (3)	39.2 (2)	56.9	**17.7**
30-1000MHz	916.0	Horizontal	854.4MHz	40.2	0.00	0.00	0.00 (3)	40.2 (2)	56.9	**16.7**
30-1000MHz	916.0	Vertical	729.4MHz	40.4	0.00	0.00	0.00 (3)	40.4 (2)	56.9	**16.5**
30-1000MHz	916.0	Vertical	755.7MHz	40.5	0.00	0.00	0.00 (3)	40.5 (2)	56.9	**16.4**
30-1000MHz	916.0	Vertical	852.3MHz	40.9	0.00	0.00	0.00 (3)	40.9 (2)	56.9	**16.0**
1 - 3GHz	916.0	Horizontal	ND	ND (1)	27.40	4.58	0.00 (3)	ND	60.0	**n/a**
1 - 3GHz	916.0	Vertical	ND	ND (1)	27.40	4.58	0.00 (3)	ND	60.0	**n/a**
3-10GHz	916.0	Horizontal	ND	ND (1)	36.76	9.86	0.00 (3)	ND	60.0	**n/a**
3-10GHz	916.0	Vertical	ND	ND (1)	36.76	9.86	0.00 (3)	ND	60.0	**n/a**
								Results:	**Complies**	

(1) No Emissions Detected (ND) above ambient or within 20dB of the limit
(2) Antenna ACF, Cable Loss and Amplifier Gain corrected in Spectrum Analyzer Transducer Factor
(3) External Amplier not used

$E_{Corr} = E_{Meas} + ACF + L_C - G_A$

18.0 RADIATED RX SPURIOUS EMISSIONS

Test Procedure	
Normative Reference	**FCC 47 CFR §15.109, ICES-003(6.2)** **ANSI C63.4:2014**

Limits	
47 CFR §15.109	(a) Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values: 30-88MHz: 40dBuV/m 88-216MHz: 43.5dBuV/m 216-960MHz: 46dBuV/m > 960MHz: 54dBuV/m
ICES-003(6.2.1)	6.2.1 - Radiated Emissions Limits Below 1 GHz Class B: ITE that does not meet the conditions for Class A operation shall comply with the Class B radiated limits set out in Table 5 determined at a distance of 3 metres. 30-88MHz: 40dBuV/m 88-216MHz: 43.5dBuV/m 216-960MHz: 46dBuV/m > 960MHz: 54dBuV/m

Test Setup	Appendix A Figure A.2

Measurement Procedure
The DUT was set up as per ANSI C63.4:2014. Emissions were scanned between 30MHz and 1000MHz. The turntable was rotated 360 degrees and the antenna was elevated to 4m to optimize the measured emissions.

Table 19.1 – Summary of Radiated Rx Spurious Emissions

See Appendix F for Measurement Plots

Measurement Results				
Frequency Range	**Antenna Polarization**	**Measured Emission [E_{Meas}] (dBm)**	**Limit e.r.p./e.r.i.p. [A_L] (dBuV/m)**	**Margin (dB)**
30-1000MHz	Horizontal	ND	49.5	**n/a**
1 - 3GHz		ND	60.0	**n/a**
3 - 10GHz		ND	60.0	**n/a**
30-1000MHz	Vertical	ND	49.5	**n/a**
1 - 3GHz		ND	60.0	**n/a**
3 - 10GHz		ND	60.0	**n/a**
		Results:	**Complies**	

ND: No emissions detected above ambient or within 20dB of the limit

APPENDIX A – TEST SETUP DRAWINGS

Table A.1 – Conducted Measurement Setup

Equipment List				
Asset Number	**Manufacturer**	**Model Number**	**Serial Number**	**Description**
00241	R&S	FSU40	100500	Spectrum Analyzer
00263	Koaxis	KP10-1.00M-TD	263	1m Armoured Cable

Figure A.1 – Test Setup – Conducted Measurements

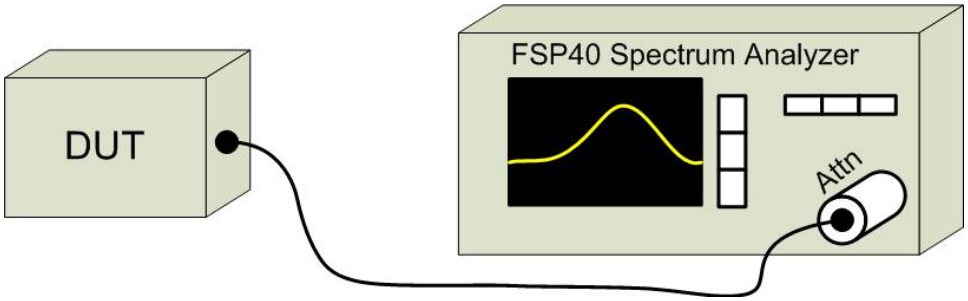


Table A.2 – Radiated Emissions Measurement Equipment

Equipment List				
Asset Number	**Manufacturer**	**Model Number**	**Serial Number**	**Description**
00050	Chase	CBL-6111A	1607	Bilog Antenna
00034	ETS	3115	6267	Double Ridged Guide Horn
00035	ETS	3115	6276	Double Ridged Guide Horn
00085	EMCO	6502	9203-2724	Loop Antenna
00161	Waveline Inc.	889		Standard Gain Horn 18-26GHz
00162	Waveline Inc.	889		Standard Gain Horn 18-26GHz
00165	Waveline Inc.	801-KF		Waveguide Adapter 18-26GHz
00166	Waveline Inc.	801-KF		Waveguide Adapter 18-26GHz
00333	HP	85685A	3010A01095	RF Preselector
00049	HP	85650A	2043A00162	Quasi-peak Adapter
00051	HP	8566B	2747A05510	Spectrum Analyzer
00241	R&S	FSU40	100500	Spectrum Analyzer
00265	Miteq	JS32-00104000-58-5P	1939850	Microwave L/N Amplifier
00071	EMCO	2090	9912-1484	Multi-Device Controller
00072	EMCO	2075	0001-2277	Mini-mast
00073	EMCO	2080	0002-1002	Turn Table
00263	Koaxis	KP10-1.00M-TD	263	1m Armoured Cable
00263B	Koaxis	KP10-1.00M-TD	263B	1m Armoured Cable
00275	TMS	LMR400	n/a	25m Cable
00278	TILE	34G3	n/a	TILE Test Software

Figure A.2 – Test Setup Radiated Measurements 9kHzMHz – 30MHz

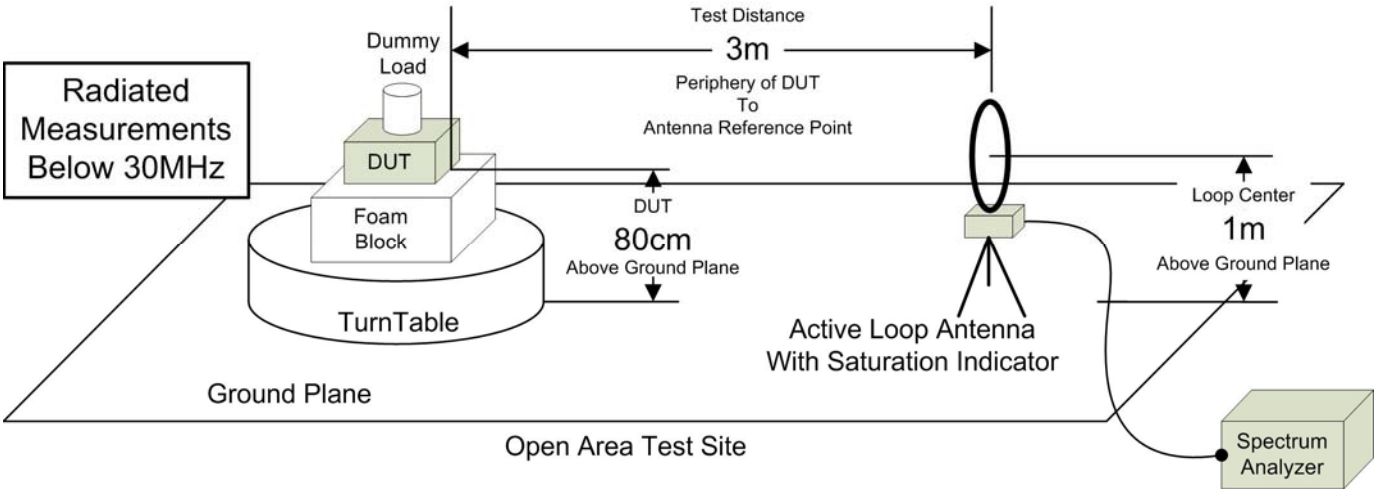


Figure A.3 – Test Setup Radiated Measurements 30MHz – 1GHz

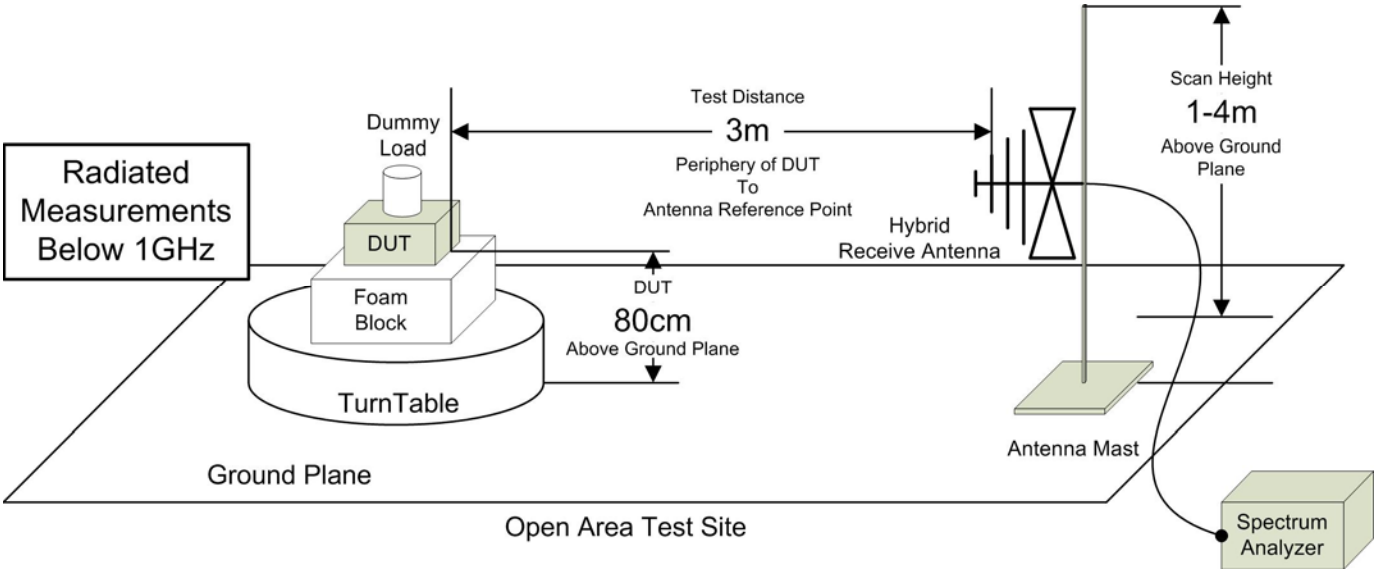


Figure A.4 – Test Setup Radiated Measurements 30MHz – 1GHz, Signal Substitution

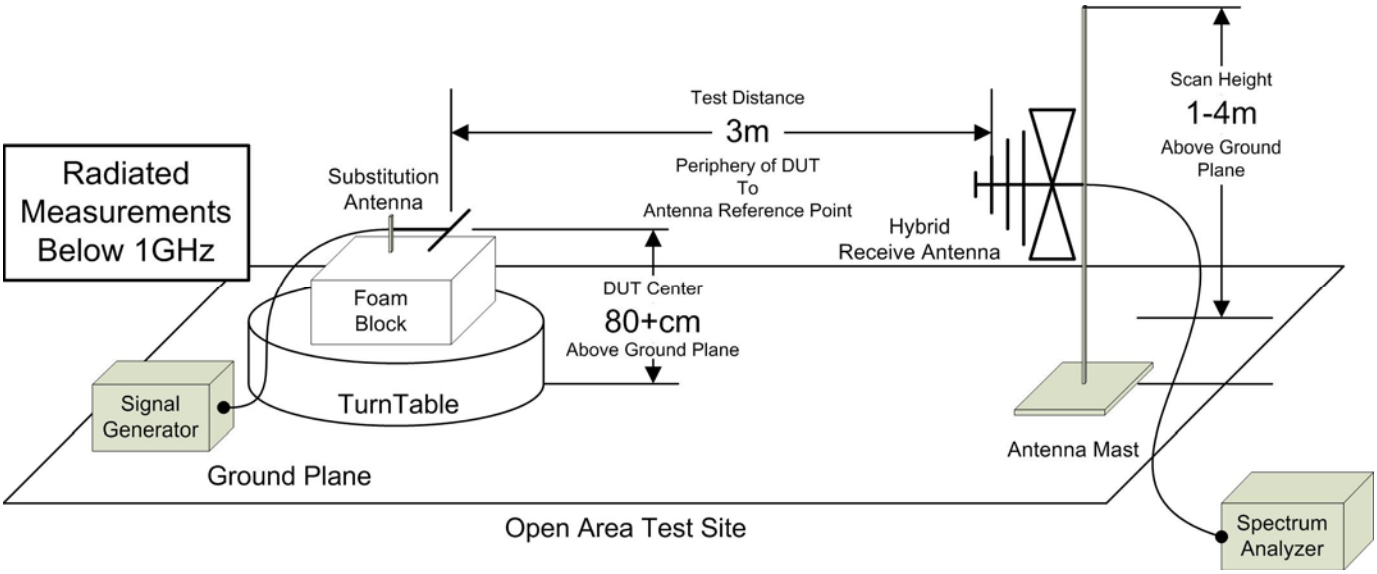


Figure A.5 – Test Setup Radiated Measurements 1 – 18GHz,

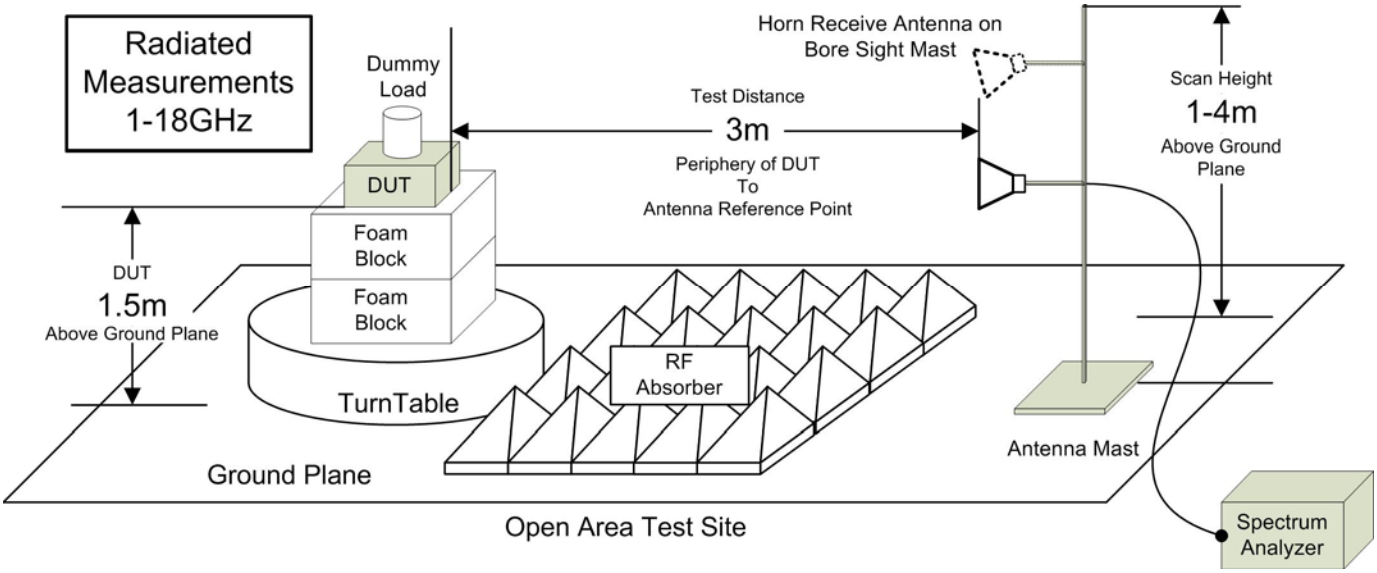
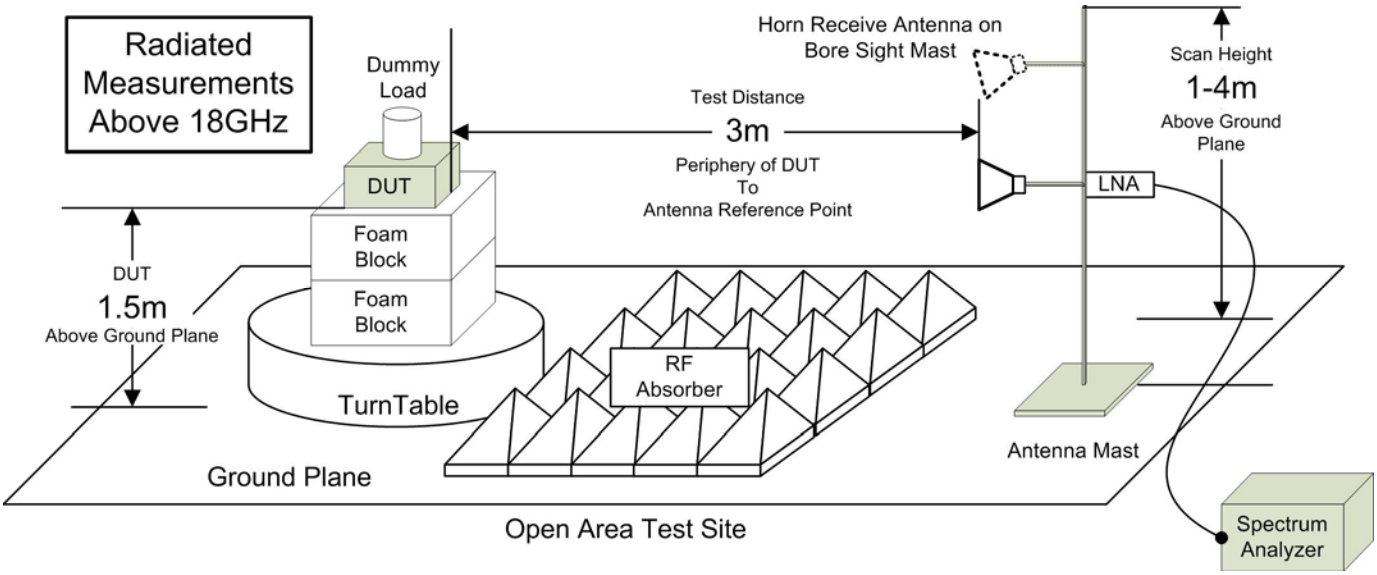


Figure A.6 – Test Setup Radiated Measurements 18 – 26.5GHz,



APPENDIX B – EQUIPMENT LIST AND CALIBRATION

Table B.1 – Equipment Calibration Information

Equipment List							
Asset Number	Manufacturer	Model Number	Serial Number	Description	Last Calibrated	Calibration Interval	Calibration Due
00050	Chase	CBL-6111A	1607	Bilog Antenna	3 Jan 2019	Triennial	3 Jan 2022
00034	ETS	3115	6267	Double Ridged Guide Horn	26 Nov 2018	Triennial	26 Nov 2021
00035	ETS	3115	6276	Double Ridged Guide Horn	22 Mar 2019	Triennial	21 Mar 2022
00085	EMCO	6502	9203-2724	Loop Antenna	11 Jun 2019	Triennial	11 Jun 2022
00161	Waveline Inc.	889		Standard Gain Horn 18-26GHz	NCR	n/a	NCR
00162	Waveline Inc.	889		Standard Gain Horn 18-26GHz	NCR	n/a	NCR
00165	Waveline Inc.	801-KF		Waveguide Adapter 18-26GHz	NCR	n/a	NCR
00166	Waveline Inc.	801-KF		Waveguide Adapter 18-26GHz	NCR	n/a	NCR
00333	HP	85685A	3010A01095	RF Preselector	23 Jun 2020	Triennial	30 Jun 2023
00049	HP	85650A	2043A00162	Quasi-peak Adapter	23 Jun 2020	Triennial	23 Jun 2023
00051	HP	8566B	2747A05510	Spectrum Analyzer	23 Jun 2020	Triennial	23 Jun 2023
00241	R&S	FSU40	100500	Spectrum Analyzer	15 July 2018	Triennial	15 July 2021
00005	HP	8648D	3847A00611	Signal Generator	23 Jun 2020	Triennial	23 Jun 2023
00006	R&S	SMR20	100104	Signal Generator	29 May 2017	Triennial	29 May 2020
00257	Com-Power	LI-215A	191934	LISN	5 Jan 2019	Triennial	5 Jan 2022
00071	EMCO	2090	9912-1484	Multi-Device Controller	n/a	n/a	n/a
00072	EMCO	2075	0001-2277	Mini-mast	n/a	n/a	n/a
00073	EMCO	2080	0002-1002	Turn Table	n/a	n/a	n/a
00081	ESPEC	ECT-2	0510154-B	Environmental Chamber	NCR	n/a	CNR
00234	VWR	61161-378	140320430	Temp/Humidity Meter	New	Triennial	New
00263	Koaxis	KP10-1.00M-TD	263	1m Armoured Cable	COU	n/a	COU
00263B	Koaxis	KP10-1.00M-TD	263B	1m Armoured Cable	COU	n/a	COU
00275	TMS	LMR400	n/a	25m Cable	COU	n/a	COU
00278	TILE	34G3	n/a	TILE Test Software	NCR	n/a	NCR

NCR: No Calibration Required
COU: Calibrate On Use

APPENDIX C – MEASUREMENT INSTRUMENT UNCERTAINTY

CISPR 16-4 Measurement Uncertainty (U_{LAB})
This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence interval using a coverage factor of k=2
Radiated Emissions 30MHz - 200MHz
U_{LAB} = 5.14dB U_{CISPR} = 6.3dB
Radiated Emissions 200MHz - 1000MHz
U_{LAB} = 5.90dB U_{CISPR} = 6.3dB
Radiated Emissions 1GHz - 6GHz
U_{LAB} = 4.80dB U_{CISPR} = 5.2dB
Radiated Emissions 6GHz - 18GHz
U_{LAB} = 5.1dB U_{CISPR} = 5.5dB
Power Line Conducted Emissions 9kHz to 150kHz
U_{LAB} = 2.96dB U_{CISPR} = 3.8dB
Power Line Conducted Emissions 150kHz to 30MHz
U_{LAB} = 3.12dB U_{CISPR} = 3.4dB

	If the calculated uncertainty U_{lab} is **less** than U_{CISPR} then:
1	Compliance is deemed to occur if **NO** measured disturbance exceeds the disturbance limit
2	Non-Compliance is deemed to occur if **ANY** measured disturbance **EXCEEDS** the disturbance limit
	If the calculated uncertainty U_{lab} is **greater** than U_{CISPR} then:
3	Compliance is deemed to occur if **NO** measured disturbance, increased by (U_{lab} - U_{CISPR}), exceeds the disturbance limit
4	Non-Compliance is deemed to occur if **ANY** measured disturbance, increased by (U_{lab} - U_{CISPR}), **EXCEEDS** the disturbance limit

Other Measurement Uncertainties (U_{LAB})
RF Conducted Emissions 9kHz - 40GHz
U_{LAB} = 1.0dB U_{CISPR} = n/a
Frequency/Bandwidth 9kHz - 40GHz
U_{LAB} = 0.1ppm U_{CISPR} = n/a
Temperature
U_{LAB} = 1^{O}C U_{CISPR} = n/a

END OF REPORT

APPENDIX D – CONDUCTED SPURIOUS EMISSIONS MEASUREMENT PLOTS

APPENDIX E – RADIATED TX EMISSIONS (RESTRICTED BAND) MEASUREMENT PLOTS

APPENDIX F – RADIATED RX EMISSIONS MEASUREMENT PLOTS

