



FCC RADIO TEST REPORT

FCC ID : 2AEUPBHASC081
Equipment : Stick Up Cam Pro
Brand Name : ring
Model Name : 5E72E9
Applicant : Ring LLC
12515 Cerise Ave, Hawthorne, CA 90250, USA
Manufacturer : Ring LLC
12515 Cerise Ave, Hawthorne, CA 90250, USA
Standard : FCC Part 15 Subpart C §15.247

The product was received on Apr. 28, 2022 and testing was performed from Jun. 16, 2022 to Sep. 07, 2022. We, Sporton International Inc. Wensan Laboratory, would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

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

Louis Wu

Reviewed by: Louis Wu

Sporton International Inc. Wensan Laboratory

No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan (R.O.C)



Table of Contents

History of this test report..... 3

Summary of Test Result..... 4

1 General Description..... 5

 1.1 Product Feature of Equipment Under Test..... 5

 1.2 Modification of EUT 5

 1.3 Testing Location 5

 1.4 Applicable Standards..... 6

2 Test Configuration of Equipment Under Test 7

 2.1 Carrier Frequency Channel 7

 2.2 Test Mode..... 10

 2.3 Connection Diagram of Test System..... 11

 2.4 Support Unit used in test configuration and system 12

 2.5 EUT Operation Test Setup 12

 2.6 Measurement Results Explanation Example..... 13

3 Test Result..... 14

 3.1 Number of Channel Measurement 14

 3.2 Hopping Channel Separation Measurement 20

 3.3 Dwell Time Measurement..... 27

 3.4 20dB and 99% Bandwidth Measurement 31

 3.5 Output Power Measurement..... 44

 3.6 Conducted Band Edges Measurement..... 45

 3.7 Conducted Spurious Emission Measurement 52

 3.8 Radiated Band Edges and Spurious Emission Measurement 59

 3.9 AC Conducted Emission Measurement..... 63

 3.10 Antenna Requirements..... 65

4 List of Measuring Equipment 66

5 Uncertainty of Evaluation..... 68

Appendix A. Conducted Test Results

Appendix B. AC Conducted Emission Test Result

Appendix C. Radiated Spurious Emission

Appendix D. Radiated Spurious Emission Plots

Appendix E. Duty Cycle Plots

Appendix F. Setup Photographs



Summary of Test Result

| Report Clause | Ref Std. Clause | Test Items | Result (PASS/FAIL) | Remark |
|---------------|--------------------|--|--------------------|---------------------------------------|
| 3.1 | 15.247(a)(1) | Number of Channels | Pass | - |
| 3.2 | 15.247(a)(1) | Hopping Channel Separation | Pass | - |
| 3.3 | 15.247(a)(1) | Dwell Time of Each Channel | Pass | - |
| 3.4 | 15.247(a)(1) | 20dB Bandwidth | Pass | - |
| 3.4 | 2.1049 | 99% Occupied Bandwidth | Reporting only | - |
| 3.5 | 15.247(b)(2) | Output Power | Pass | - |
| 3.6 | 15.247(d) | Conducted Band Edges | Pass | - |
| 3.7 | 15.247(d) | Conducted Spurious Emission | Pass | - |
| 3.8 | 15.247(d) | Radiated Band Edges and Radiated Spurious Emission | Pass | 4.53 dB under the limit at 34.850 MHz |
| 3.9 | 15.207 | AC Conducted Emission | Pass | 16.97 dB under the limit at 0.538 MHz |
| 3.10 | 15.203 & 15.247(b) | Antenna Requirement | Pass | - |

Declaration of Conformity:

1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.

It's means measurement values may risk exceeding the limit of regulation standards, if measurement uncertainty is include in test results.

1. The measurement uncertainty please refer to report "Uncertainty of Evaluation".

Comments and Explanations:

The product specifications of the EUT presented in the report are declared by the manufacturer who shall take full responsibility for the authenticity.

Reviewed by: Keven Cheng

Report Producer: Lucy Wu



1 General Description

1.1 Product Feature of Equipment Under Test

Bluetooth-LE, Wi-Fi 2.4GHz 802.11b/g/n, Wi-Fi 5GHz 802.11a/n, Lora, and 24G Radar.

| Product Feature | |
|-----------------|--|
| Antenna Type | WLAN: PIFA Antenna Bluetooth-LE: PIFA Antenna LoRa: PIFA Antenna 24GHz Radar: Patch Antenna |
| SW Version | 1.12.21 |
| HW Version | B6 |

| Antenna information | | |
|---------------------|-----------------|------|
| 902 MHz ~ 928 MHz | Peak Gain (dBi) | -0.3 |

Remark: The above EUT's information was declared by manufacturer. Please refer to Comments and Explanations in report summary.

1.2 Modification of EUT

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

1.3 Testing Location

| | |
|--------------------|--|
| Test Site | Sporton International Inc. Wensan Laboratory |
| Test Site Location | No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan (R.O.C.) TEL: +886-3-327-0868 FAX: +886-3-327-0855 |
| Test Site No. | Sporton Site No. TH05-HT, CO07-HY, 03CH11-HY |

Note: The test site complies with ANSI C63.4 2014 requirement.

FCC designation No.: TW3786



1.4 Applicable Standards

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

- ♦ FCC Part 15 Subpart C §15.247
- ♦ FCC KDB Publication No. 558074 D01 15.247 Meas Guidance v05r02
- ♦ FCC KDB 414788 D01 Radiated Test Site v01r01
- ♦ ANSI C63.10-2013

Remark:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. The TAF code is not including all the FCC KDB listed without accreditation.
3. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.



2 Test Configuration of Equipment Under Test

2.1 Carrier Frequency Channel

LoRa 125KHz FHSS / FSK 50 Kbps

| Frequency Band | Channel | Freq. (MHz) | Channel | Freq. (MHz) | Channel | Freq. (MHz) | Channel | Freq. (MHz) | Channel | Freq. (MHz) |
|----------------|---------|-------------|---------|-------------|---------|-------------|---------|-------------|---------|-------------|
| 902 – 928 MHz | 1 | 902.2 | 28 | 907.6 | 55 | 913.0 | 82 | 918.4 | 109 | 923.8 |
| | 2 | 902.4 | 29 | 907.8 | 56 | 913.2 | 83 | 918.6 | 110 | 924.0 |
| | 3 | 902.6 | 30 | 908.0 | 57 | 913.4 | 84 | 918.8 | 111 | 924.2 |
| | 4 | 902.8 | 31 | 908.2 | 58 | 913.6 | 85 | 919.0 | 112 | 924.4 |
| | 5 | 903.0 | 32 | 908.4 | 59 | 913.8 | 86 | 919.2 | 113 | 924.6 |
| | 6 | 903.2 | 33 | 908.6 | 60 | 914.0 | 87 | 919.4 | 114 | 924.8 |
| | 7 | 903.4 | 34 | 908.8 | 61 | 914.2 | 88 | 919.6 | 115 | 925.0 |
| | 8 | 903.6 | 35 | 909.0 | 62 | 914.4 | 89 | 919.8 | 116 | 925.2 |
| | 9 | 903.8 | 36 | 909.2 | 63 | 914.6 | 90 | 920.0 | 117 | 925.4 |
| | 10 | 904.0 | 37 | 909.4 | 64 | 914.8 | 91 | 920.2 | 118 | 925.6 |
| | 11 | 904.2 | 38 | 909.6 | 65 | 915.0 | 92 | 920.4 | 119 | 925.8 |
| | 12 | 904.4 | 39 | 909.8 | 66 | 915.2 | 93 | 920.6 | 120 | 926.0 |
| | 13 | 904.6 | 40 | 910.0 | 67 | 915.4 | 94 | 920.8 | 121 | 926.2 |
| | 14 | 904.8 | 41 | 910.2 | 68 | 915.6 | 95 | 921.0 | 122 | 926.4 |
| | 15 | 905.0 | 42 | 910.4 | 69 | 915.8 | 96 | 921.2 | 123 | 926.6 |
| | 16 | 905.2 | 43 | 910.6 | 70 | 916.0 | 97 | 921.4 | 124 | 926.8 |
| | 17 | 905.4 | 44 | 910.8 | 71 | 916.2 | 98 | 921.6 | 125 | 927.0 |
| | 18 | 905.6 | 45 | 911.0 | 72 | 916.4 | 99 | 921.8 | 126 | 927.2 |
| | 19 | 905.8 | 46 | 911.2 | 73 | 916.6 | 100 | 922.0 | 127 | 927.4 |
| | 20 | 906.0 | 47 | 911.4 | 74 | 916.8 | 101 | 922.2 | 128 | 927.6 |
| | 21 | 906.2 | 48 | 911.6 | 75 | 917.0 | 102 | 922.4 | 129 | 927.8 |
| | 22 | 906.4 | 49 | 911.8 | 76 | 917.2 | 103 | 922.6 | - | - |
| | 23 | 906.6 | 50 | 912.0 | 77 | 917.4 | 104 | 922.8 | - | - |
| | 24 | 906.8 | 51 | 912.2 | 78 | 917.6 | 105 | 923.0 | - | - |
| | 25 | 907.0 | 52 | 912.4 | 79 | 917.8 | 106 | 923.2 | - | - |
| | 26 | 907.2 | 53 | 912.6 | 80 | 918.0 | 107 | 923.4 | - | - |
| | 27 | 907.4 | 54 | 912.8 | 81 | 918.2 | 108 | 923.6 | - | - |



FSK 150 Kbps

| Frequency Band | Channel | Freq. (MHz) | Channel | Freq. (MHz) |
|----------------|---------|-------------|---------|-------------|
| 902 – 928 MHz | 1 | 902.4 | 33 | 915.2 |
| | 2 | 902.8 | 34 | 915.6 |
| | 3 | 903.2 | 35 | 916.0 |
| | 4 | 903.6 | 36 | 916.4 |
| | 5 | 904.0 | 37 | 916.8 |
| | 6 | 904.4 | 38 | 917.2 |
| | 7 | 904.8 | 39 | 917.6 |
| | 8 | 905.2 | 40 | 918.0 |
| | 9 | 905.6 | 41 | 918.4 |
| | 10 | 906.0 | 42 | 918.8 |
| | 11 | 906.4 | 43 | 919.2 |
| | 12 | 906.8 | 44 | 919.6 |
| | 13 | 907.2 | 45 | 920.0 |
| | 14 | 907.6 | 46 | 920.4 |
| | 15 | 908.0 | 47 | 920.8 |
| | 16 | 908.4 | 48 | 921.2 |
| | 17 | 908.8 | 49 | 921.6 |
| | 18 | 909.2 | 50 | 922.0 |
| | 19 | 909.6 | 51 | 922.4 |
| | 20 | 910.0 | 52 | 922.8 |
| | 21 | 910.4 | 53 | 923.2 |
| | 22 | 910.8 | 54 | 923.6 |
| | 23 | 911.2 | 55 | 924.0 |
| | 24 | 911.6 | 56 | 924.4 |
| | 25 | 912.0 | 57 | 924.8 |
| | 26 | 912.4 | 58 | 925.2 |
| | 27 | 912.8 | 59 | 925.6 |
| | 28 | 913.2 | 60 | 926.0 |
| | 29 | 913.6 | 61 | 926.4 |
| | 30 | 914.0 | 62 | 926.8 |
| | 31 | 914.4 | 63 | 927.2 |
| | 32 | 914.8 | 64 | 927.6 |



FSK 250 Kbps

| Frequency Band | Channel | Freq. (MHz) | Channel | Freq. (MHz) |
|----------------|---------|-------------|---------|-------------|
| 902 – 928 MHz | 1 | 902.5 | 28 | 916.0 |
| | 2 | 903.0 | 29 | 916.5 |
| | 3 | 903.5 | 30 | 917.0 |
| | 4 | 904.0 | 31 | 917.5 |
| | 5 | 904.5 | 32 | 918.0 |
| | 6 | 905.0 | 33 | 918.5 |
| | 7 | 905.5 | 34 | 919.0 |
| | 8 | 906.0 | 35 | 919.5 |
| | 9 | 906.5 | 36 | 920.0 |
| | 10 | 907.0 | 37 | 920.5 |
| | 11 | 907.5 | 38 | 921.0 |
| | 12 | 908.0 | 39 | 921.5 |
| | 13 | 908.5 | 40 | 922.0 |
| | 14 | 909.0 | 41 | 922.5 |
| | 15 | 909.5 | 42 | 923.0 |
| | 16 | 910.0 | 43 | 923.5 |
| | 17 | 910.5 | 44 | 924.0 |
| | 18 | 911.0 | 45 | 924.5 |
| | 19 | 911.5 | 46 | 925.0 |
| | 20 | 912.0 | 47 | 925.5 |
| | 21 | 912.5 | 48 | 926.0 |
| | 22 | 913.0 | 49 | 926.5 |
| | 23 | 913.5 | 50 | 927.0 |
| | 24 | 914.0 | 51 | 927.5 |
| | 25 | 914.5 | | |
| | 26 | 915.0 | | |
| | 27 | 915.5 | | |



2.2 Test Mode

- a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: conduction emission (150 kHz to 30 MHz), radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, the measured emission level of the EUT was maximized by rotating the EUT on a turntable, adjusting the orientation of the EUT and EUT antenna in three orthogonal axis (X: flat, Y: portrait, Z: landscape), and adjusting the measurement antenna orientation, following C63.10 exploratory test procedures and only the worst case emissions were reported in this report.
- b. AC power line Conducted Emission was tested under maximum output power.

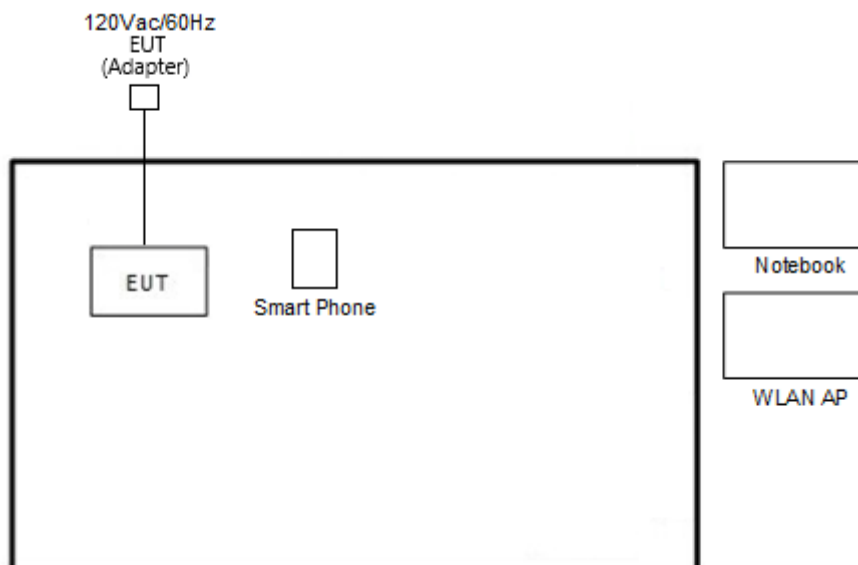
The following summary table is showing all test modes to demonstrate in compliance with the standard.

| Summary table of Test Cases | | |
|-----------------------------|--------------------------|---|
| Test Item | Feature | LoRa/FSK |
| Conducted Test Cases | LoRa 125 KHz FHSS | Mode 1: SF7 CH01 Tx_902.20 MHz Mode 2: SF7 CH65 Tx_915.00 MHz Mode 3: SF7 CH129 Tx_927.80 MHz Mode 4: SF8 CH01 Tx_902.20 MHz Mode 5: SF8 CH65 Tx_915.00 MHz Mode 6: SF8 CH129 Tx_927.80 MHz Mode 7: SF9 CH01 Tx_902.20 MHz Mode 8: SF9 CH65 Tx_915.00 MHz Mode 9: SF9 CH129 Tx_927.80 MHz |
| | FSK 50 Kbps FHSS | Mode 10: CH01 Tx_902.20 MHz Mode 11: CH65 Tx_915.00 MHz Mode 12: CH129 Tx_927.80 MHz |
| | FSK 150 Kbps FHSS | Mode 13: CH01 Tx_902.40 MHz Mode 14: CH33 Tx_915.20 MHz Mode 15: CH64 Tx_927.60 MHz |
| | FSK 250 Kbps FHSS | Mode 16: CH01 Tx_902.50 MHz Mode 17: CH26 Tx_915.00 MHz Mode 18: CH51 Tx_927.50 MHz |

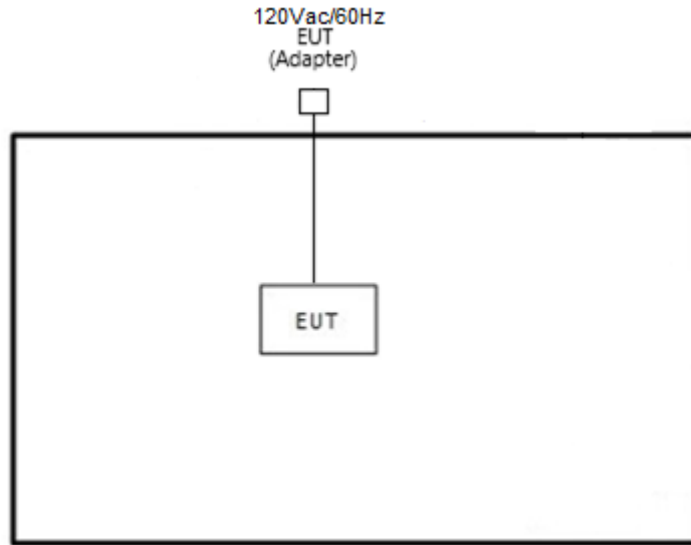
| Summary table of Test Cases | | |
|---|---|---|
| Test Item | Feature | LoRa/FSK |
| Radiated Test Cases | LoRa 125 KHz FHSS | Mode 1: SF7 CH01 Tx_902.20 MHz Mode 2: SF7 CH65 Tx_915.00 MHz Mode 3: SF7 CH129 Tx_927.80 MHz Mode 4: SF8 CH01 Tx_902.20 MHz Mode 5: SF8 CH65 Tx_915.00 MHz Mode 6: SF8 CH129 Tx_927.80 MHz Mode 7: SF9 CH01 Tx_902.20 MHz Mode 8: SF9 CH65 Tx_915.00 MHz Mode 9: SF9 CH129 Tx_927.80 MHz |
| | FSK 50 Kbps FHSS | Mode 10: CH01 Tx_902.20 MHz Mode 11: CH65 Tx_915.00 MHz Mode 12: CH129 Tx_927.80 MHz |
| | FSK 150 Kbps FHSS | Mode 13: CH01 Tx_902.40 MHz Mode 14: CH33 Tx_915.20 MHz Mode 15: CH64 Tx_927.60 MHz |
| | FSK 250 Kbps FHSS | Mode 16: CH01 Tx_902.50 MHz Mode 17: CH26 Tx_915.00 MHz Mode 18: CH51 Tx_927.50 MHz |
| AC Conducted Emission | Mode 1: IR LED On + PIR Sensor On+ Lora Tx + WLAN (2.4GHz) Link + Camera On + Mounting Plate (Base) + Charging Battery 1 + Adapter + Bluetooth-LE Link + Speaker + 24G Radar On | |
| Remark: For Radiated Test Cases, the tests were performed with Battery 1 | | |

2.3 Connection Diagram of Test System

<AC Conducted Emission Mode>



<Lora / FSKTx Mode>



2.4 Support Unit used in test configuration and system

| Item | Equipment | Brand Name | Model Name | FCC ID | Data Cable | Power Cord |
|------|-------------|------------|------------|---------|------------|--|
| 1. | WLAN AP | ASUS | RT-AC52 | N/A | N/A | Unshielded, 1.8 m |
| 2. | Notebook | DELL | P79G | FCC DoC | N/A | AC I/P: Unshielded, 1.2 m DC O/P: Shielded, 1.8 m |
| 3. | Smart phone | HTC | M9pw | N/A | N/A | N/A |

2.5 EUT Operation Test Setup

The RF test items, utility "Tera Term 4.104[SVN# 8043]" was installed in Notebook which was programmed in order to make the EUT get into the engineering modes to provide channel selection, power level, data rate and the application type and for continuous transmitting signals.



2.6 Measurement Results Explanation Example

For all conducted test items:

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

Example:

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

Offset = RF cable loss + attenuator factor.

Following shows an offset computation example with cable loss 4.2 dB and 10dB attenuator.

$$\begin{aligned} \text{Offset(dB)} &= \text{RF cable loss(dB)} + \text{attenuator factor(dB)}. \\ &= 4.2 + 10 = 14.2 \text{ (dB)} \end{aligned}$$

3 Test Result

3.1 Number of Channel Measurement

3.1.1 Limits of Number of Hopping Frequency

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies.

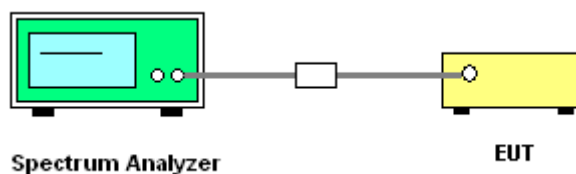
3.1.2 Measuring Instruments

See list of measuring equipment of this test report.

3.1.3 Test Procedure

1. The testing follows ANSI C63.10-2013 clause 7.8.3.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Enable the EUT hopping function.
5. Use the following spectrum analyzer settings: Span = the frequency band of operation; set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.; Sweep = auto; Detector function = peak; Trace = max hold.
6. The number of hopping frequency used is defined as the number of total channel.
7. Record the measurement data derived from spectrum analyzer.

3.1.4 Test Setup



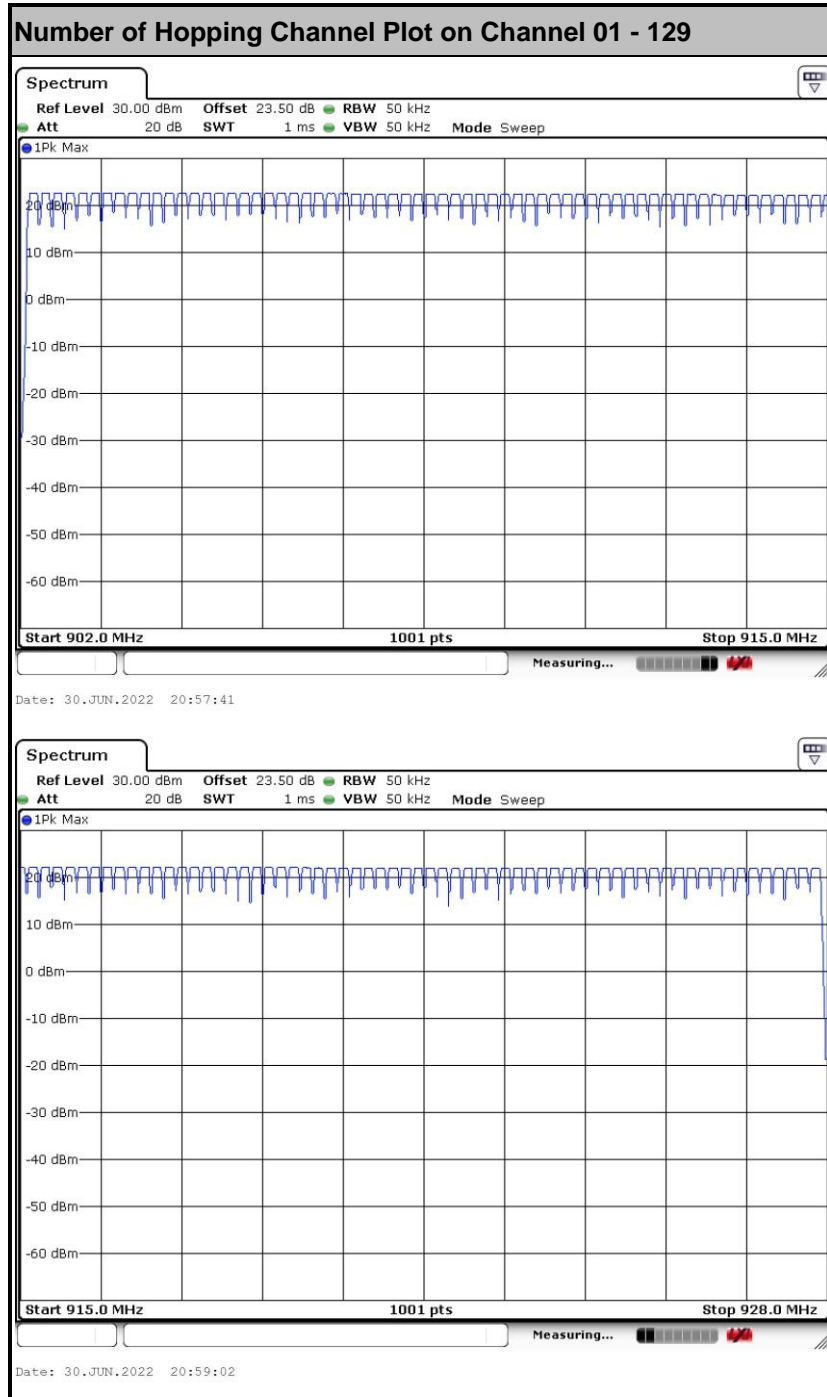


3.1.5 Test Result of Number of Hopping Frequency

Please refer to Appendix A.

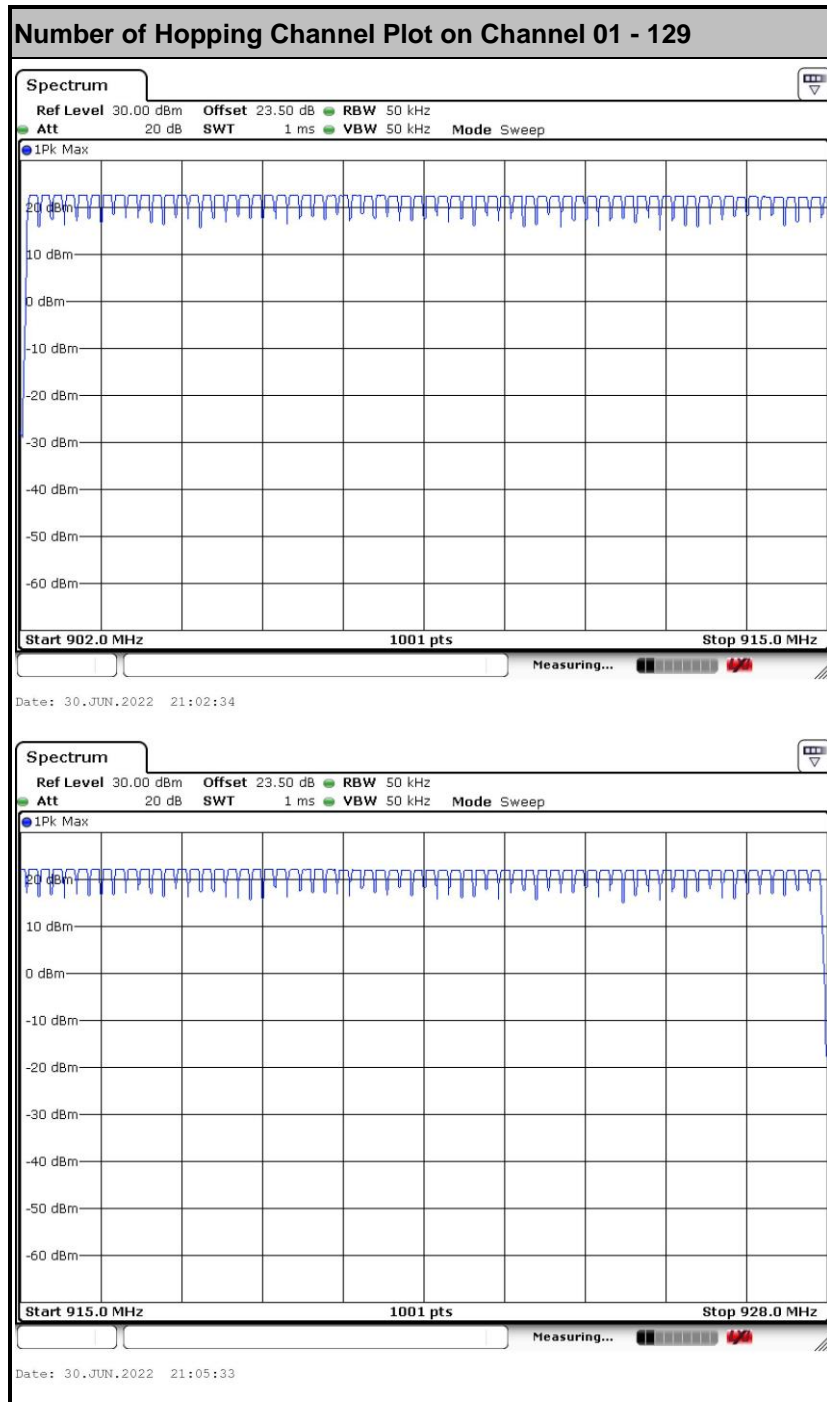
<LoRa 125kHz FHSS>

<Data Rate: SF7>



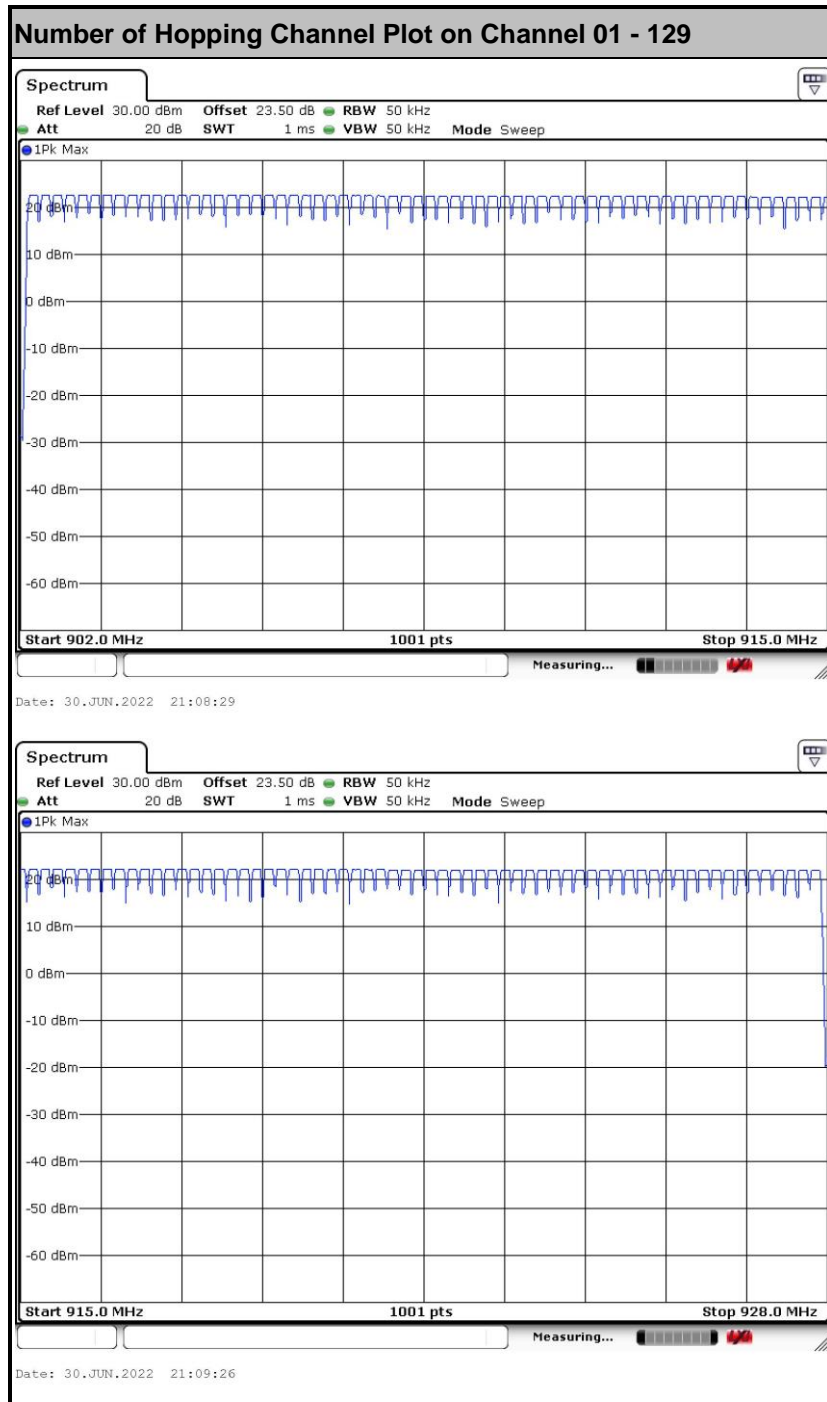


<Data Rate: SF8>



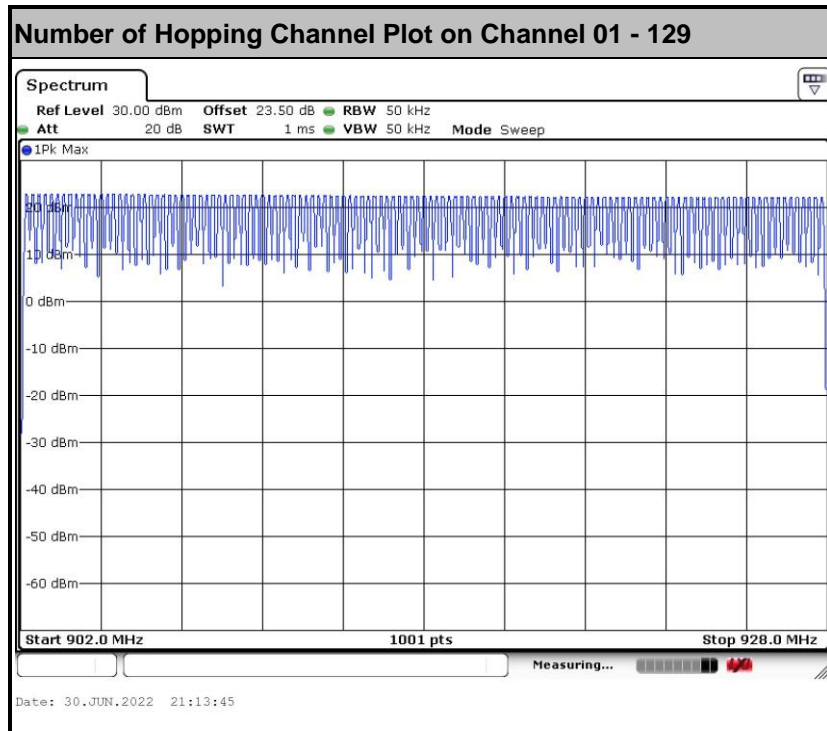


<Data Rate: SF9>

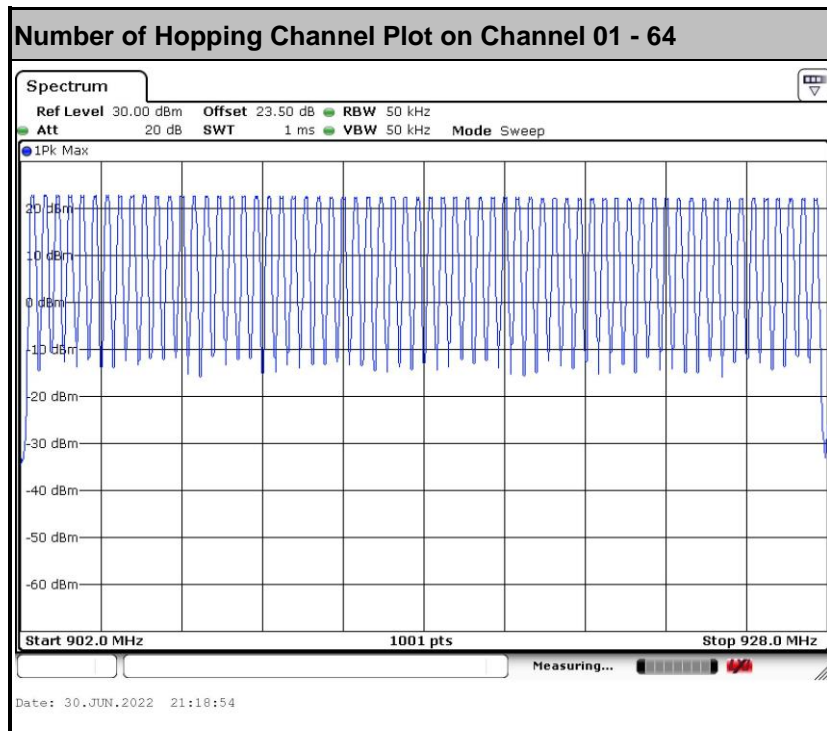




<FSK 50Kbps FHSS>

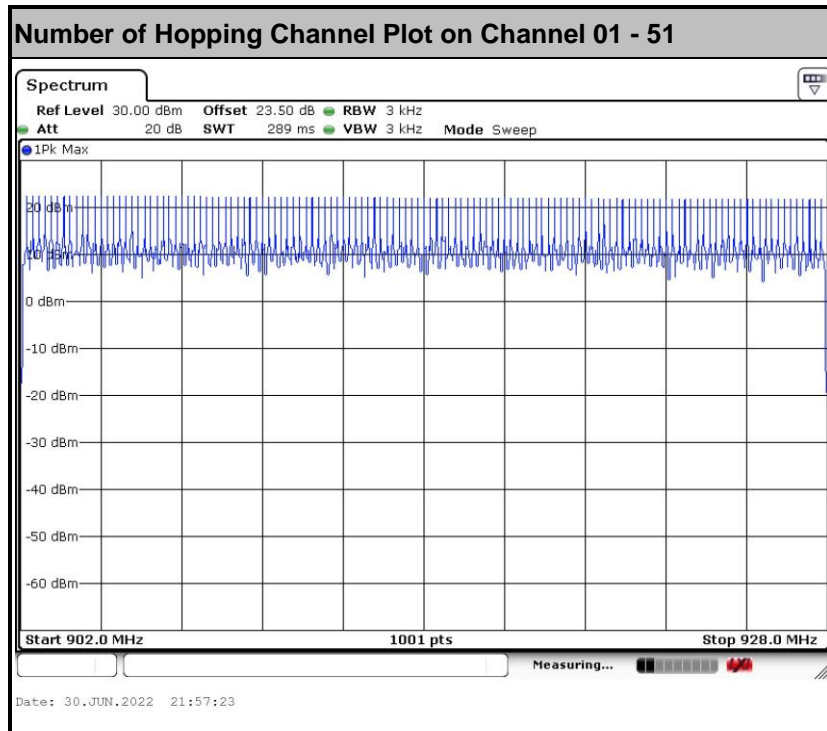


<FSK 150Kbps FHSS>





<FSK 250Kbps FHSS>



3.2 Hopping Channel Separation Measurement

3.2.1 Limit of Hopping Channel Separation

Frequency hopping systems operating in the 902 – 928 MHz band shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

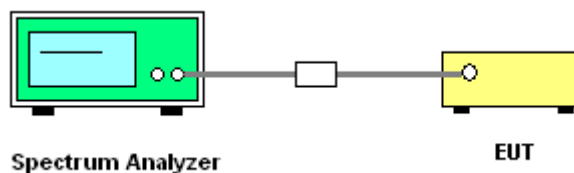
3.2.2 Measuring Instruments

See list of measuring equipment of this test report.

3.2.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.2.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Enable the EUT hopping function.
5. Use the following spectrum analyzer settings: Span = the frequency band of operation; set the RBW set to approximately 30% of the channel spacin.; Sweep = auto; Detector function = peak; Trace = max hold.
6. Measure and record the results in the test report.

3.2.4 Test Setup



3.2.5 Test Result of Hopping Channel Separation

Please refer to Appendix A.



<LoRa 125KHz FHSS>

<Data Rate: SF7>

Channel Separation Plot on Channel 01 - 02



Channel Separation Plot on Channel 64 - 65



Channel Separation Plot on Channel 128 - 129



N/A



<Data Rate: SF8>

Channel Separation Plot on Channel 01 - 02



Channel Separation Plot on Channel 64 - 65



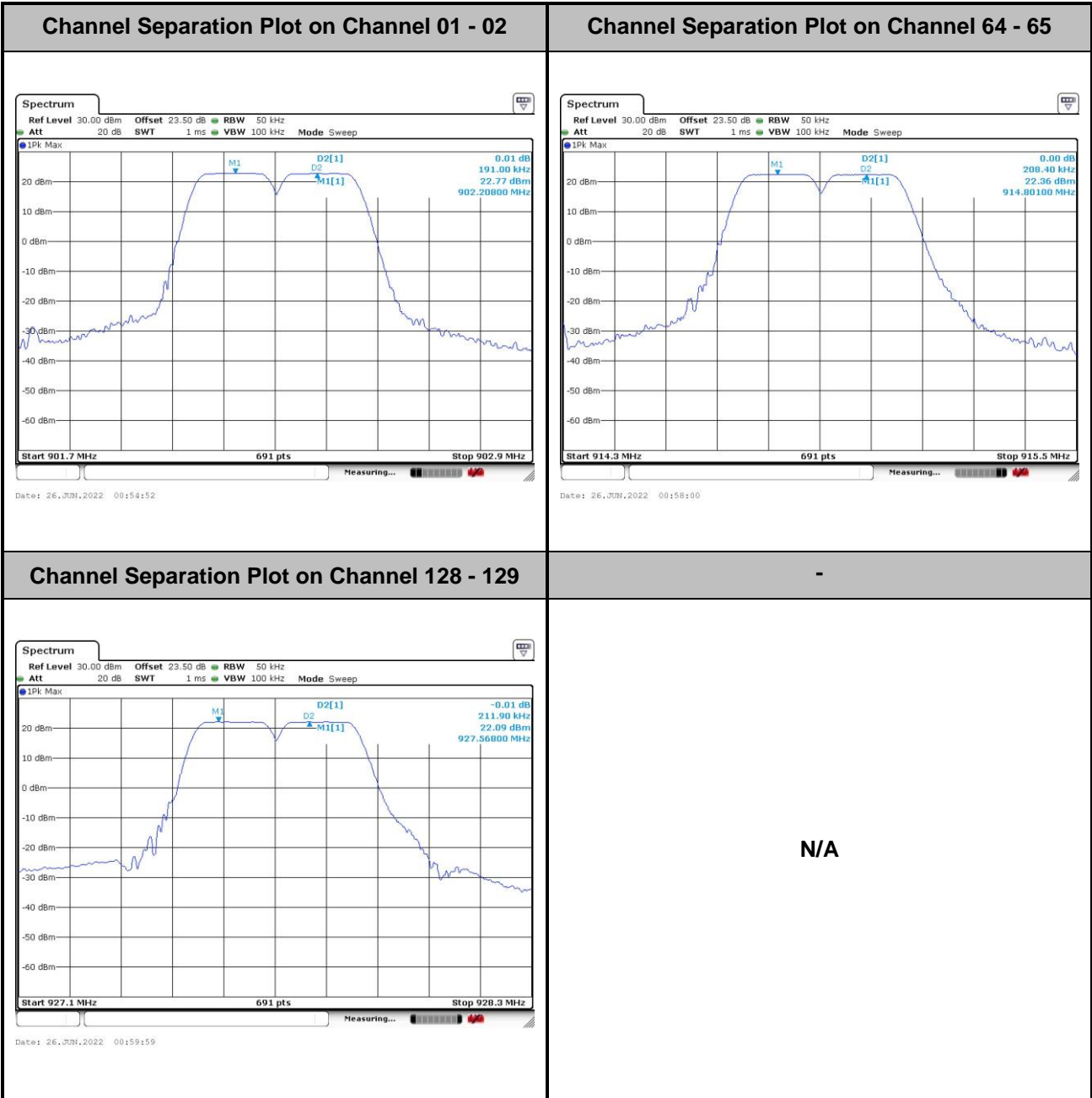
Channel Separation Plot on Channel 128 - 129



N/A

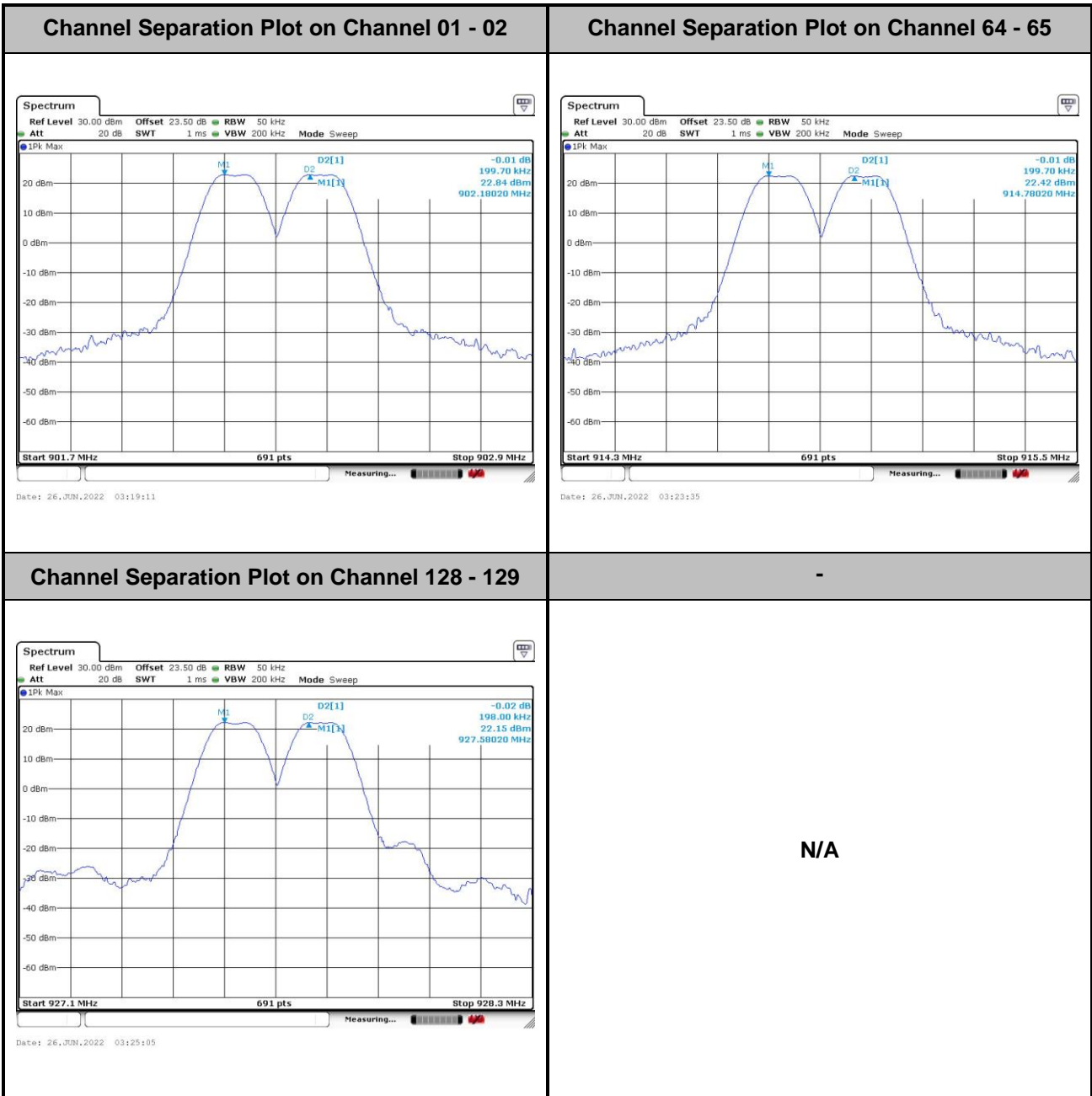


<Data Rate: SF9>



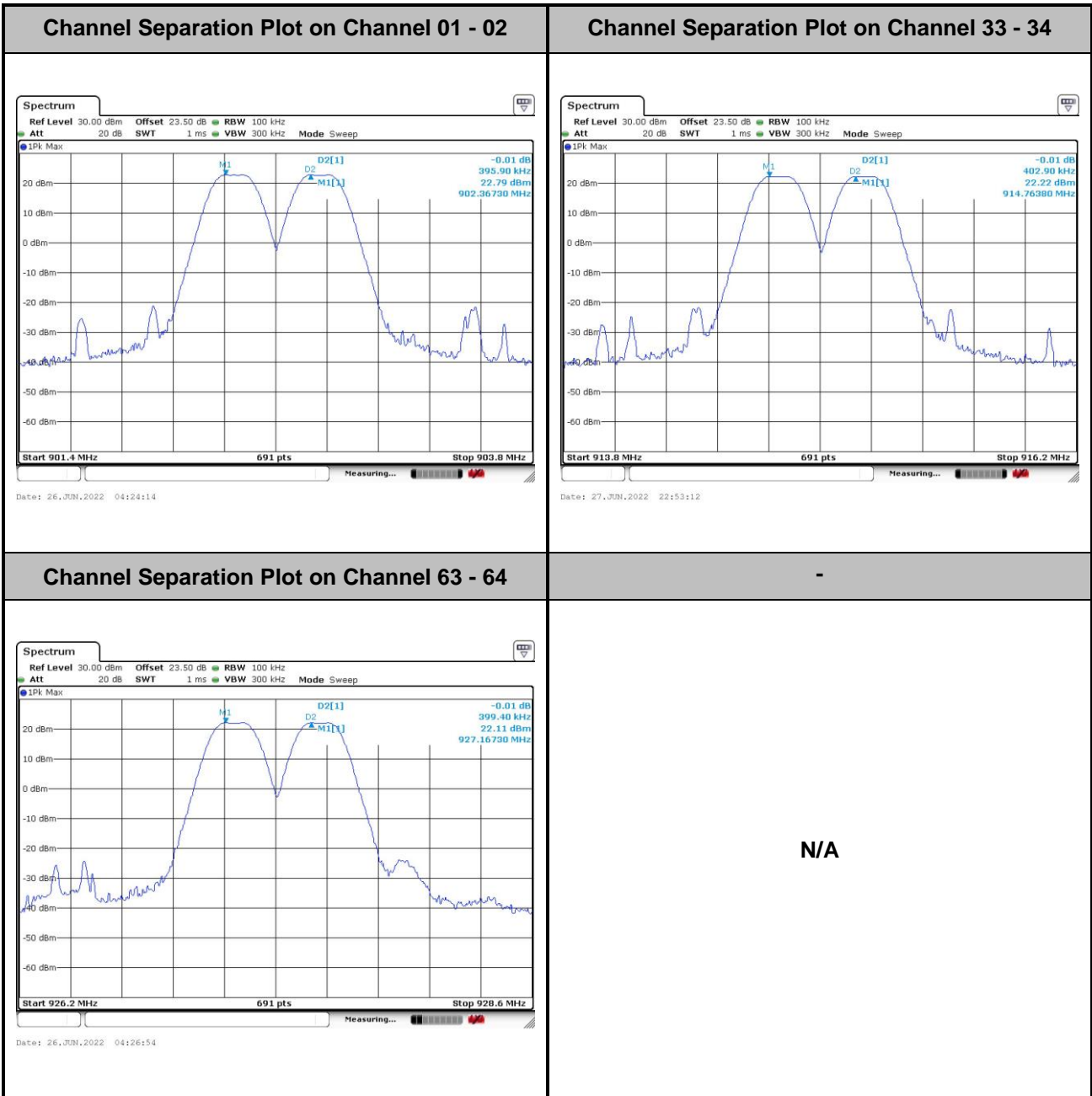


<FSK 50Kbps FHSS>





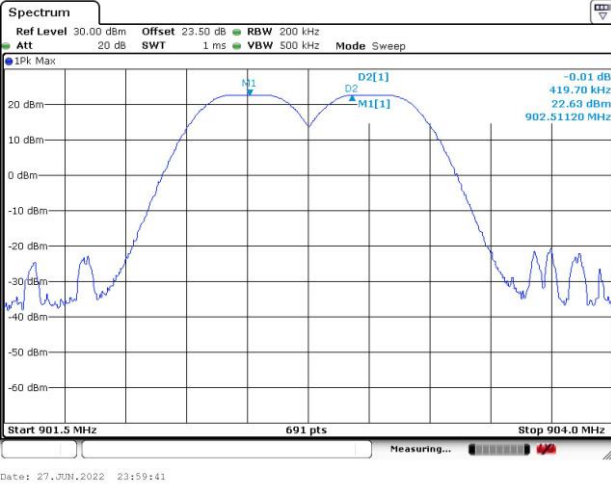
<FSK 150Kbps FHSS>



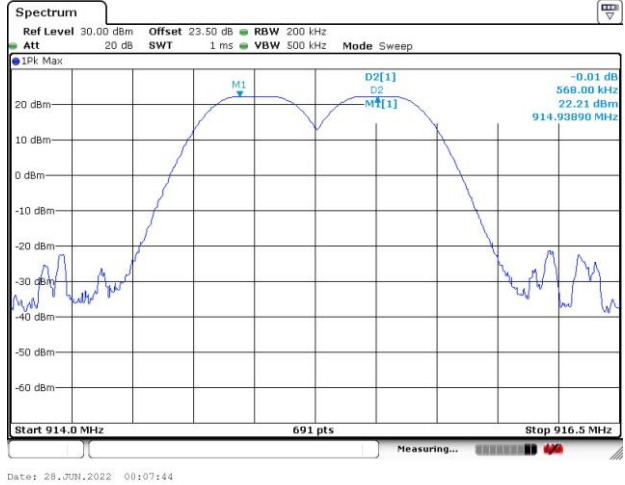


<FSK 250Kbps FHSS>

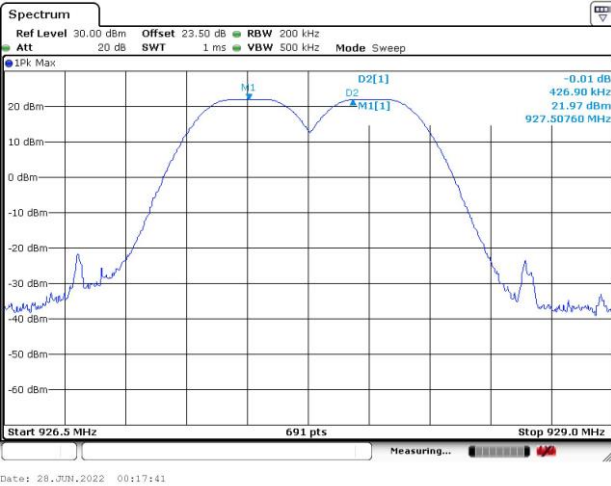
Channel Separation Plot on Channel 01 - 02



Channel Separation Plot on Channel 25 - 26



Channel Separation Plot on Channel 50 - 51



N/A

3.3 Dwell Time Measurement

3.3.1 Limit of Dwell Time

If the 20 dB bandwidth of the hopping channel is less than 250 kHz, 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 average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.

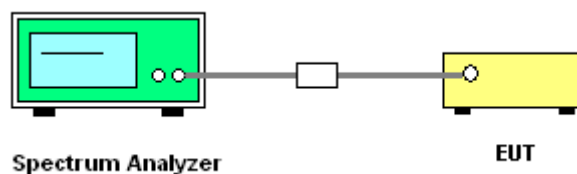
3.3.2 Measuring Instruments

See list of measuring equipment of this test report.

3.3.3 Test Procedures

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

3.3.4 Test Setup



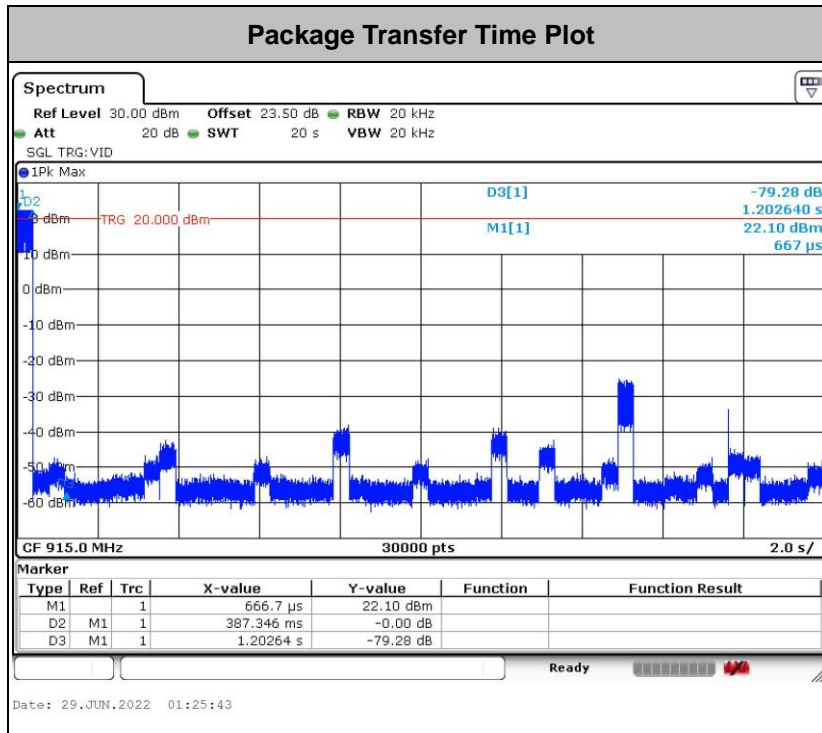
3.3.5 Test Result of Dwell Time

Please refer to Appendix A.



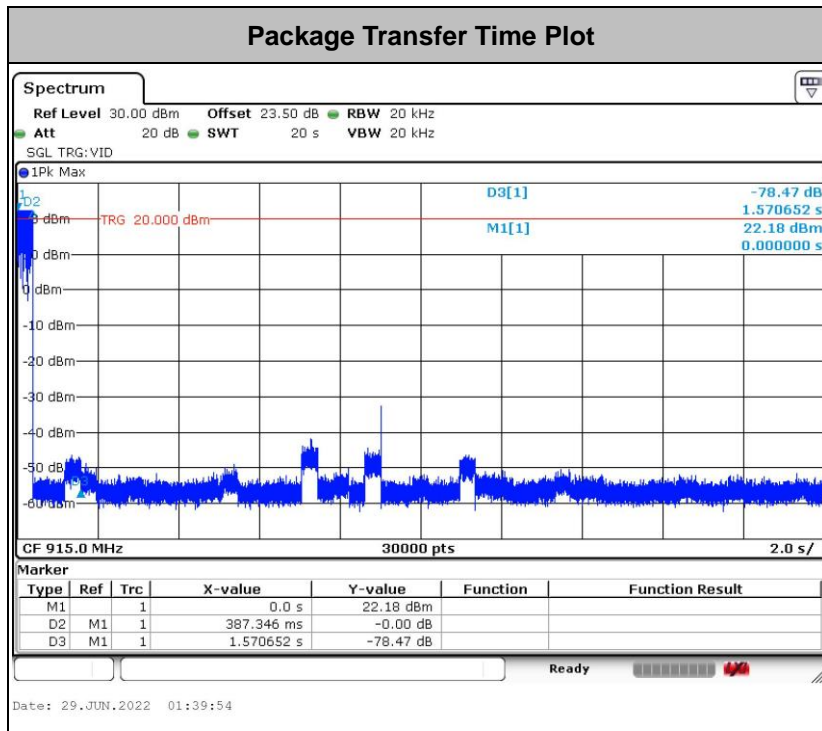
<LoRa 125KHz FHSS>

<Data Rate: SF7>



Remark: Dwell Time(s) = Hops Over Occupancy Time (hops) x Package Transfer Time

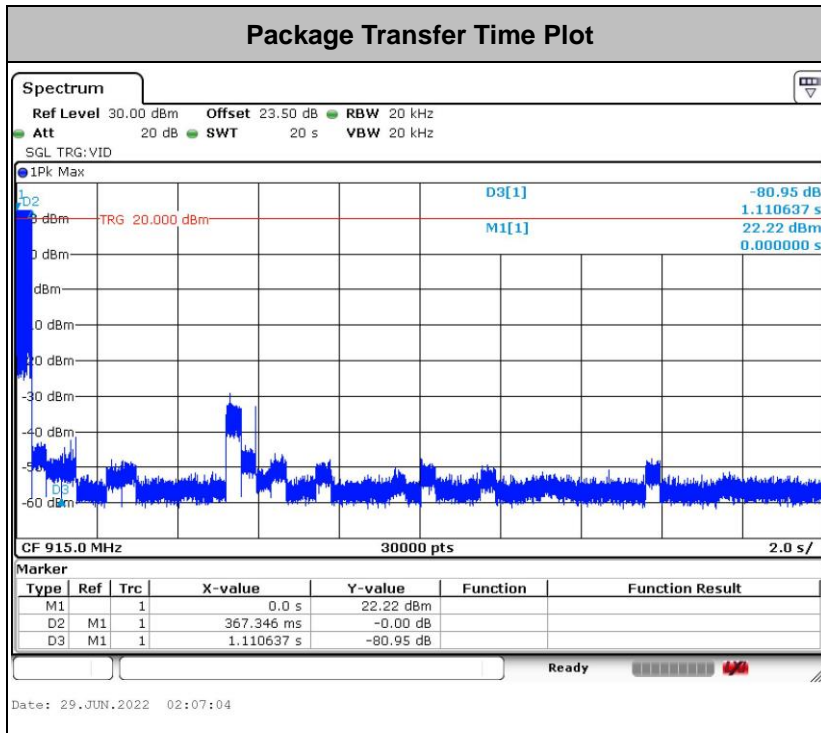
<Data Rate: SF8>



Remark: Dwell Time(s) = Hops Over Occupancy Time (hops) x Package Transfer Time

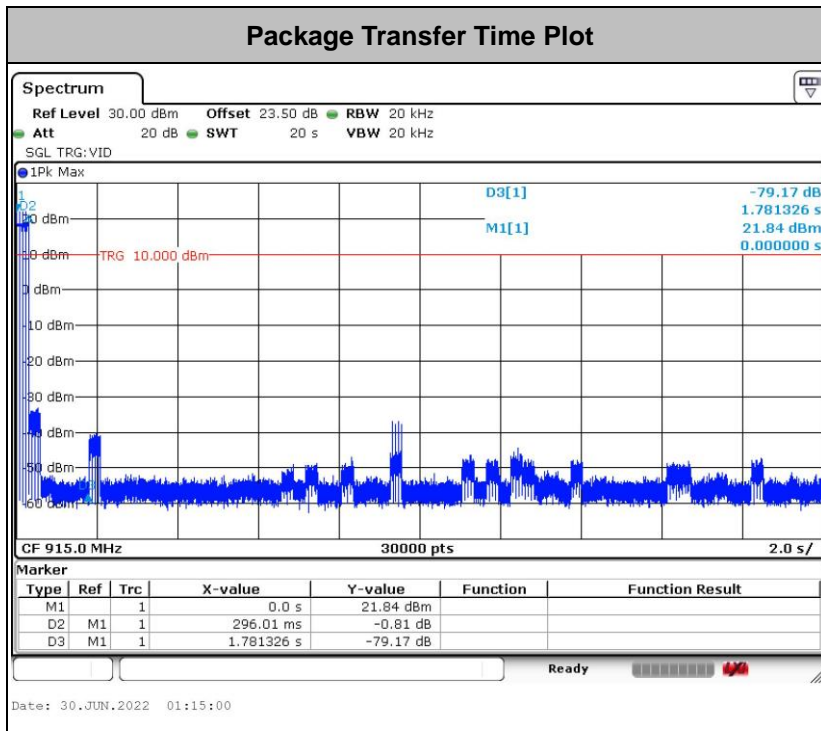


<Data Rate: SF9>



Remark: Dwell Time(s) = Hops Over Occupancy Time (hops) x Package Transfer Time

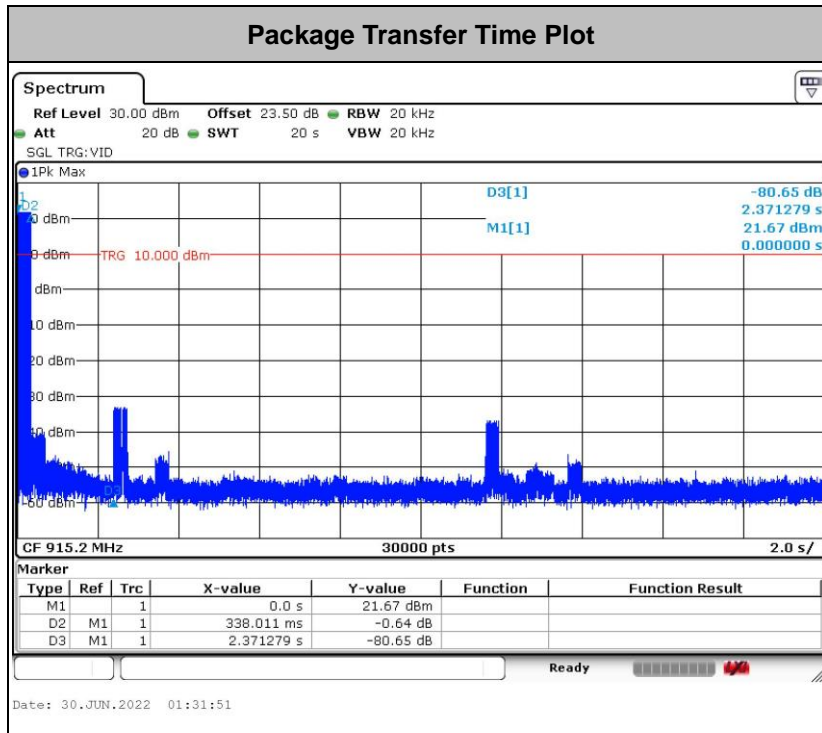
<FSK 50Kbps FHSS>



Remark: Dwell Time(s) = Hops Over Occupancy Time (hops) x Package Transfer Time

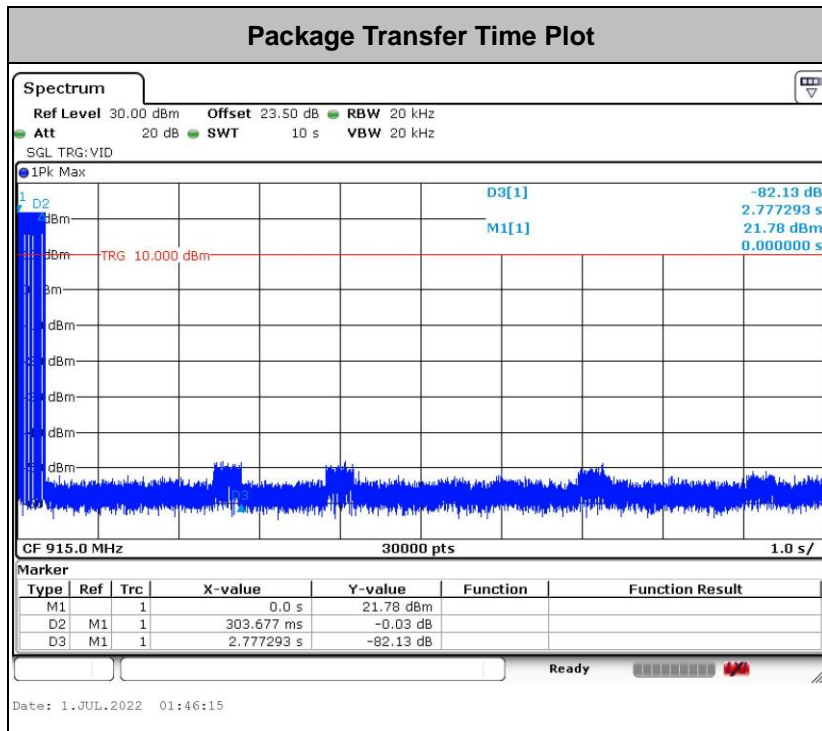


<FSK 150Kbps FHSS>



Remark: Dwell Time(s) = Hops Over Occupancy Time (hops) x Package Transfer Time

<FSK 250Kbps FHSS>



Remark: Dwell Time(s) = Hops Over Occupancy Time (hops) x Package Transfer Time

3.4 20dB and 99% Bandwidth Measurement

3.4.1 Limit of 20dB and 99% Bandwidth

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

99% Bandwidth is reporting only.

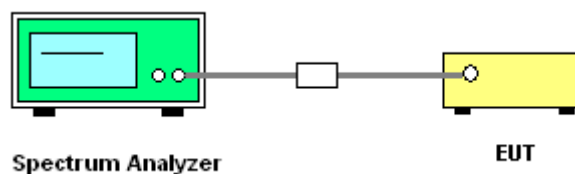
3.4.2 Measuring Instruments

See list of measuring equipment of this test report.

3.4.3 Test Procedures

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

3.4.4 Test Setup



3.4.5 Test Result of 20dB Bandwidth

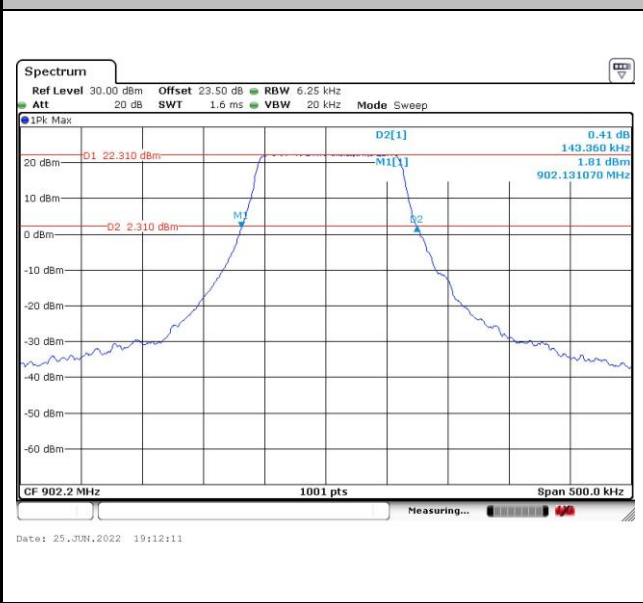
Please refer to Appendix A.



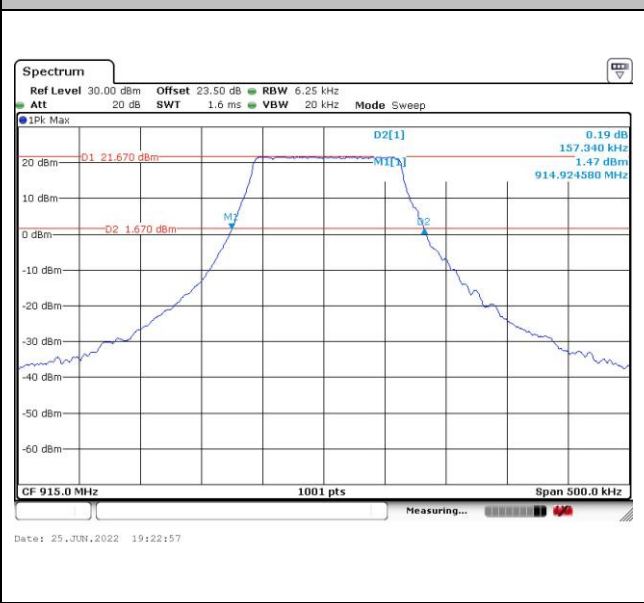
<LoRa 125KHz FHSS>

<Data Rate: SF7>

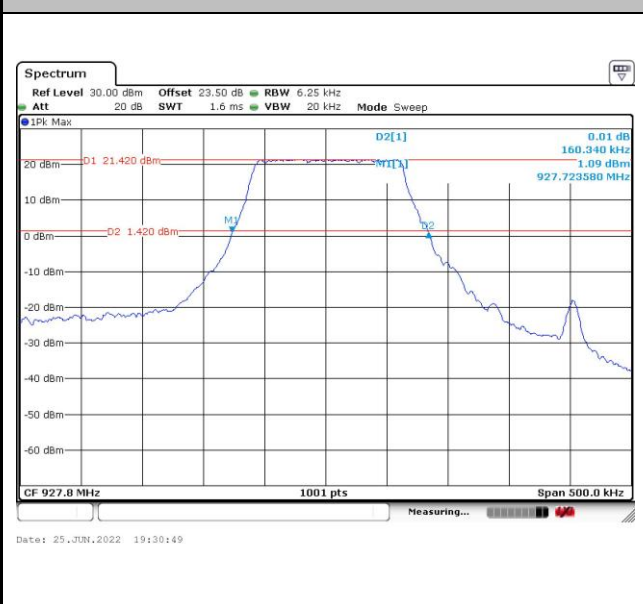
20 dB Bandwidth Plot on Channel 01



20 dB Bandwidth Plot on Channel 65



20 dB Bandwidth Plot on Channel 129

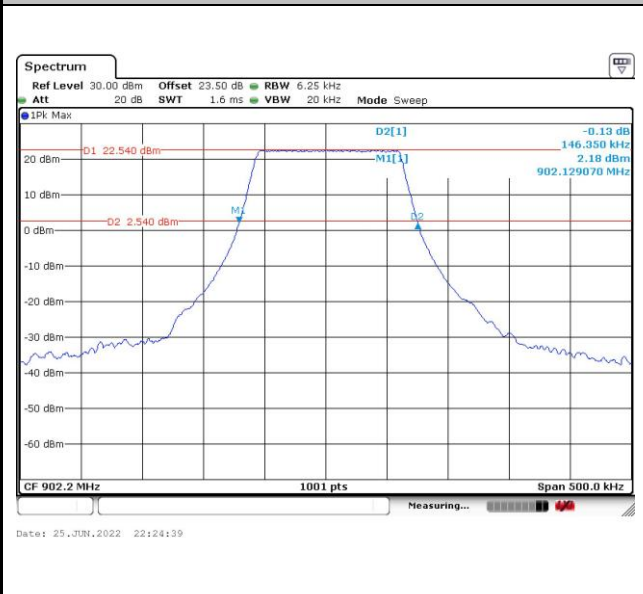


N/A



<Data Rate: SF8>

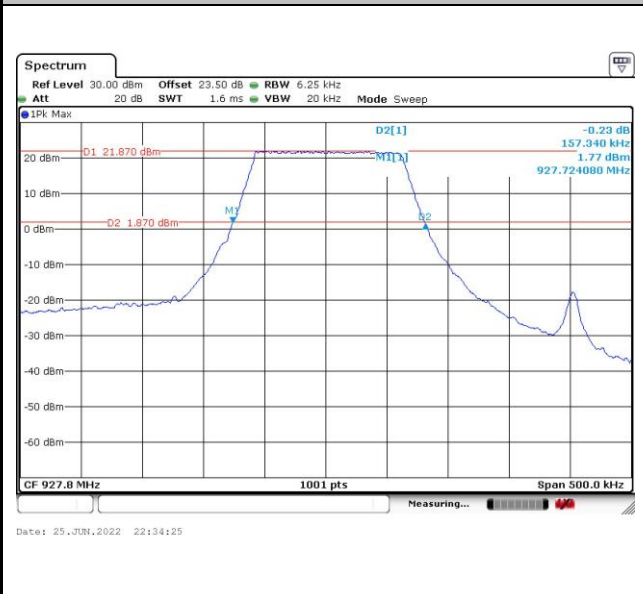
20 dB Bandwidth Plot on Channel 01



20 dB Bandwidth Plot on Channel 65



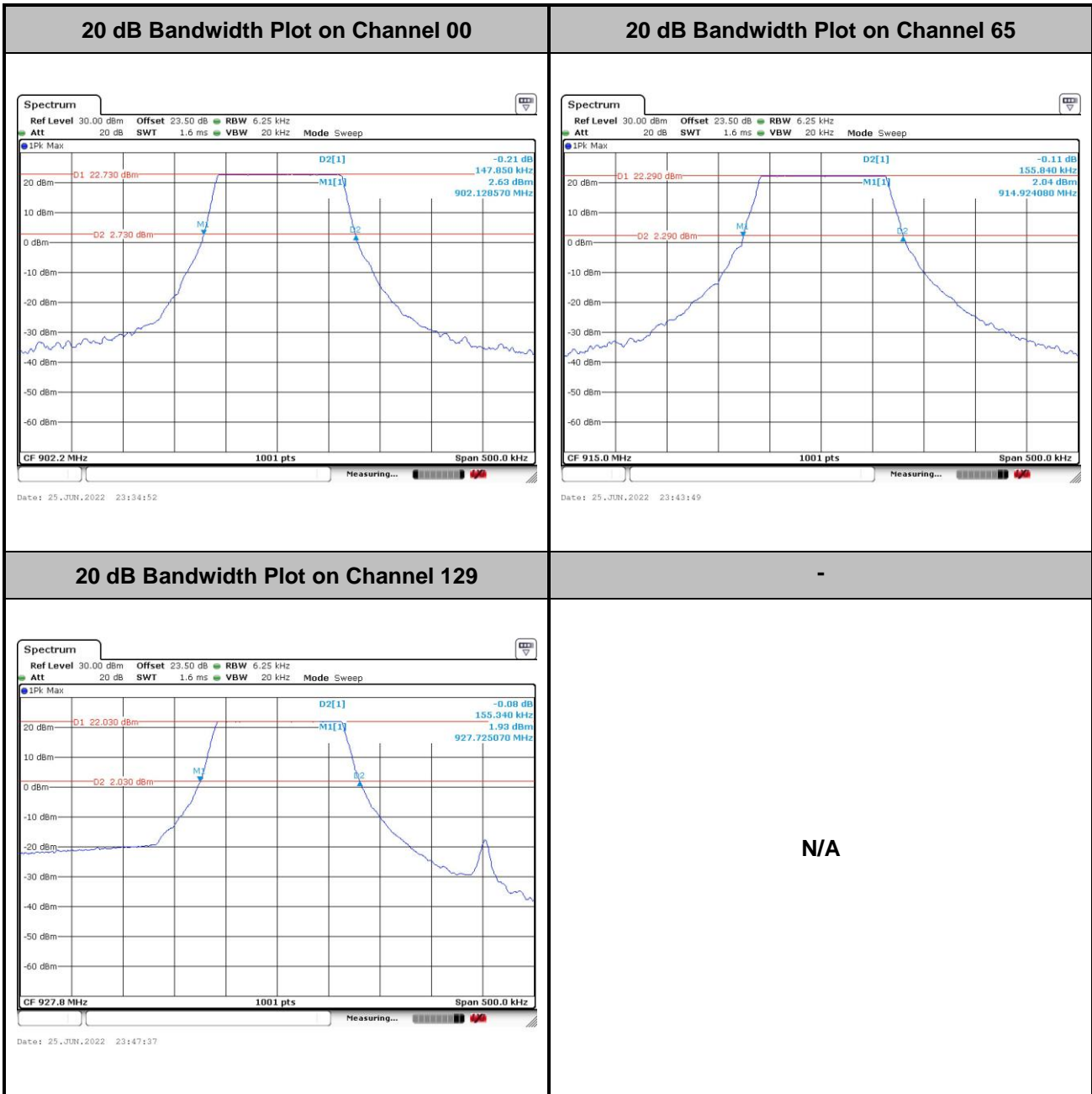
20 dB Bandwidth Plot on Channel 129



N/A



<Data Rate: SF9>



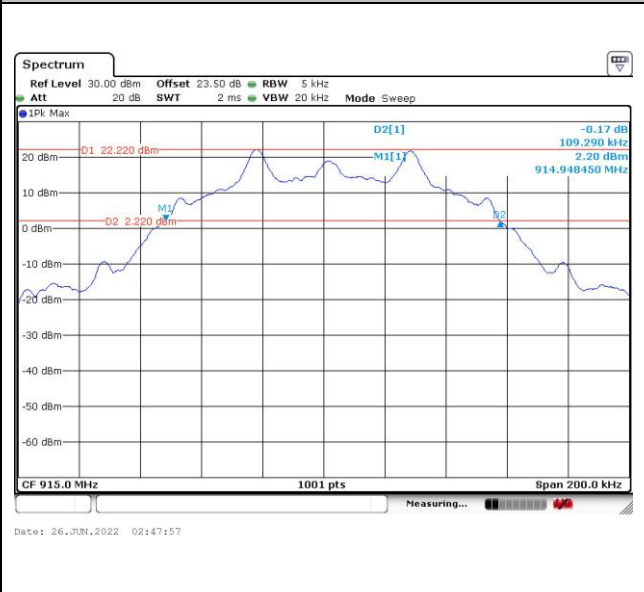


<FSK 50Kbps FHSS>

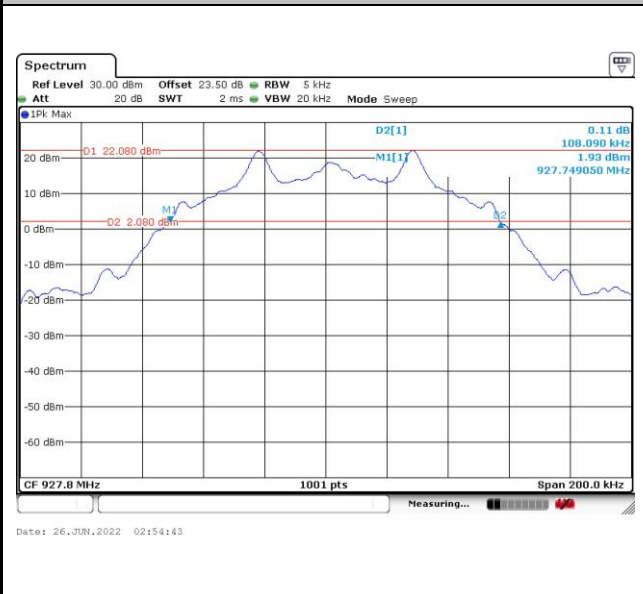
20 dB Bandwidth Plot on Channel 00



20 dB Bandwidth Plot on Channel 65



20 dB Bandwidth Plot on Channel 129

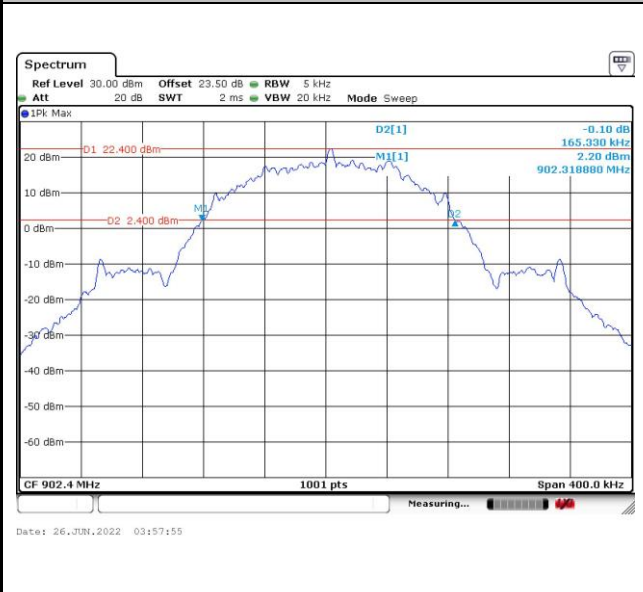


N/A

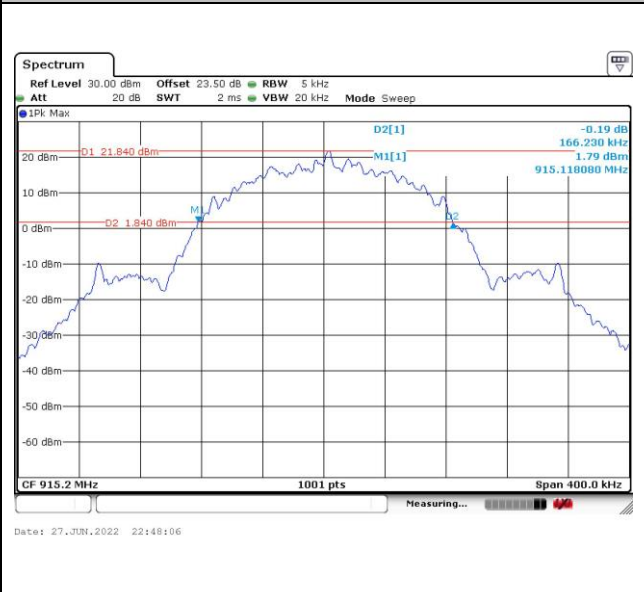


<FSK 150Kbps FHSS>

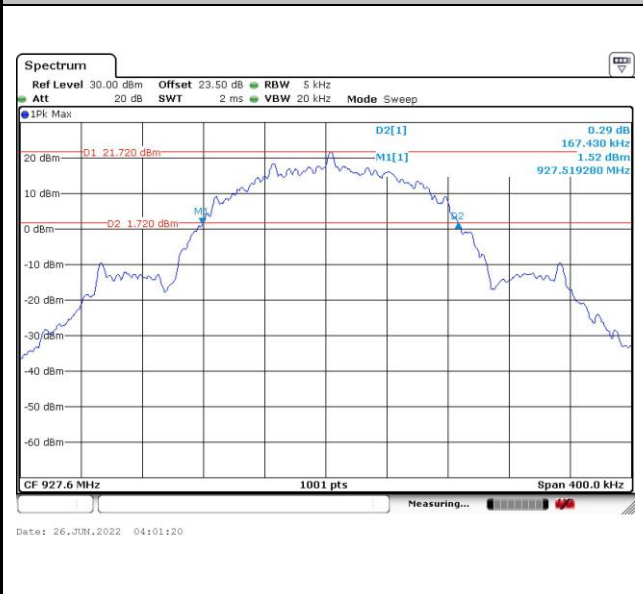
20 dB Bandwidth Plot on Channel 01



20 dB Bandwidth Plot on Channel 33



20 dB Bandwidth Plot on Channel 64

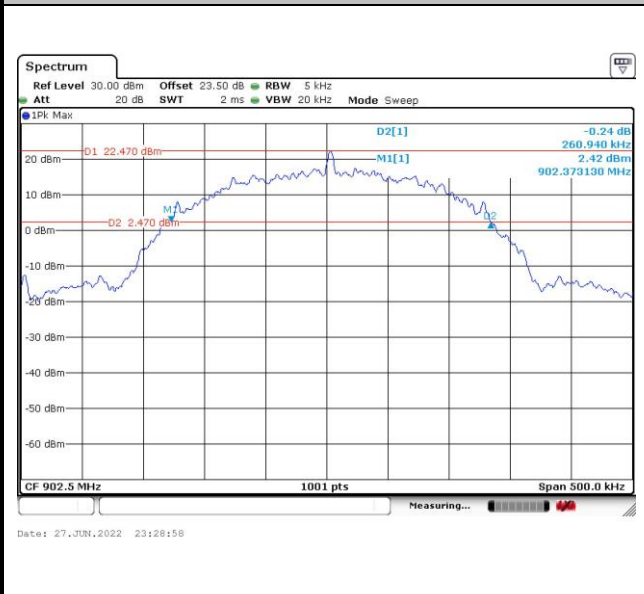


N/A

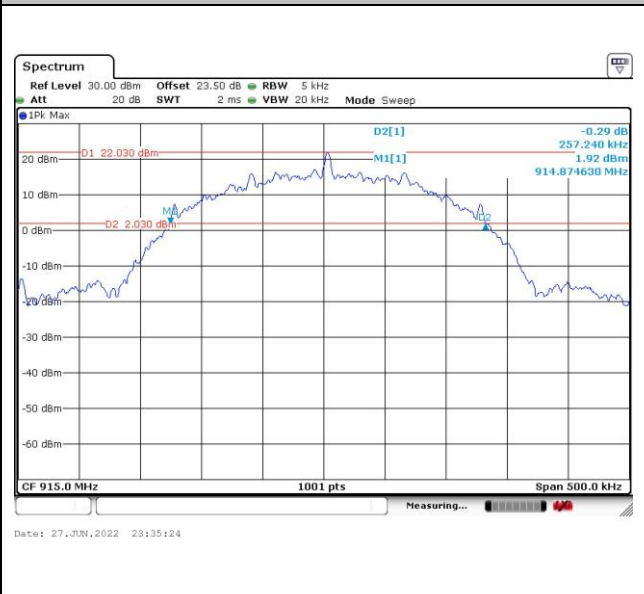


<FSK 250Kbps FHSS>

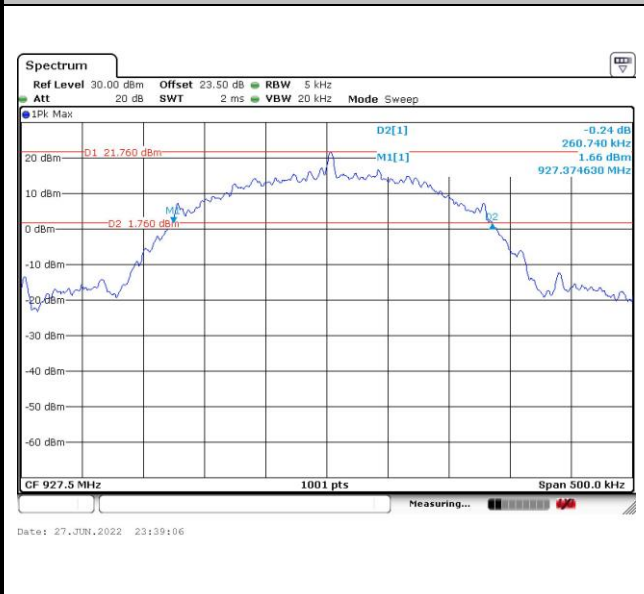
20 dB Bandwidth Plot on Channel 01



20 dB Bandwidth Plot on Channel 26



20 dB Bandwidth Plot on Channel 51



N/A

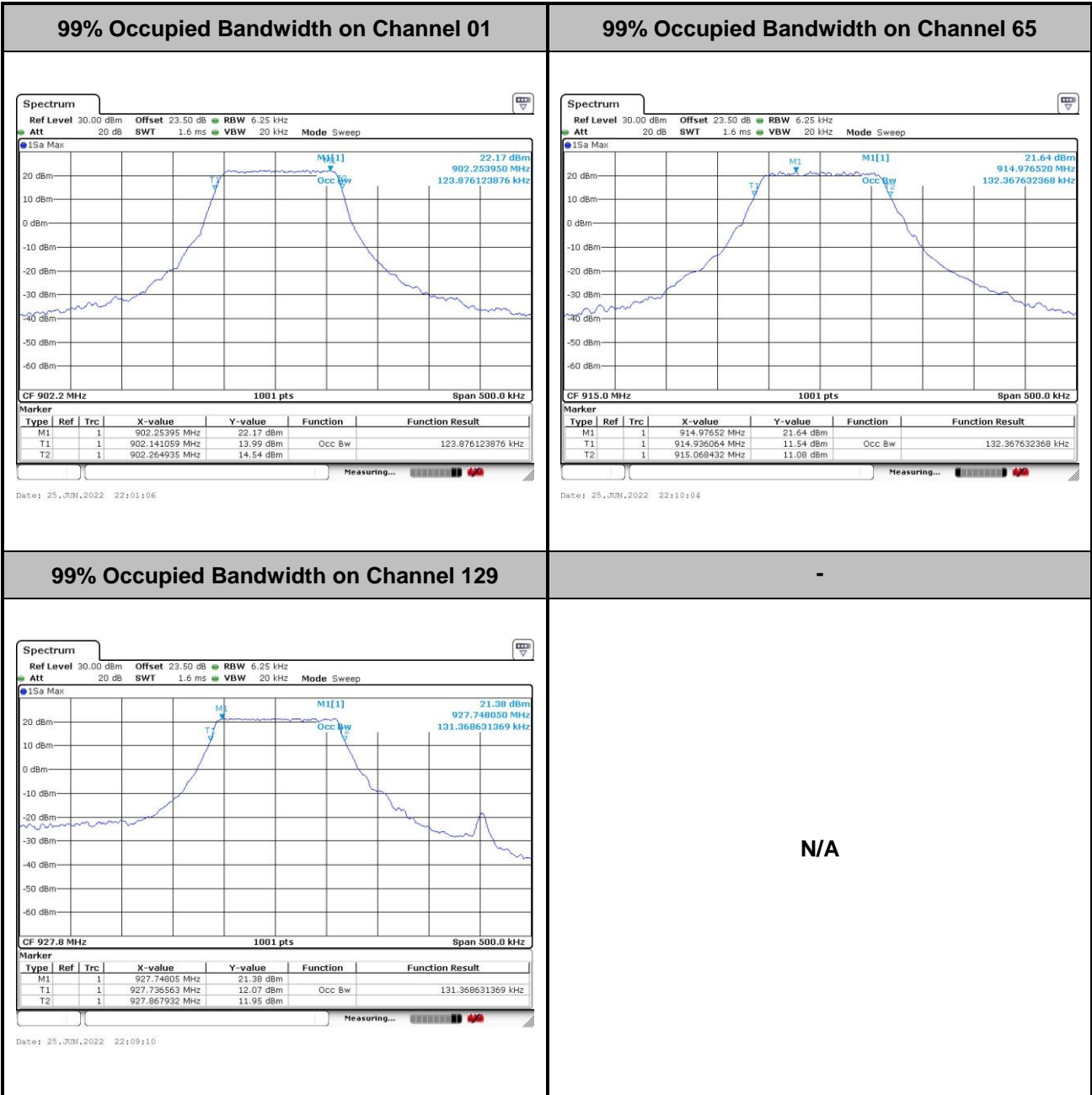


3.4.6 Test Result of 99% Occupied Bandwidth

Please refer to Appendix A.

<LoRa 125KHz FHSS>

<Data Rate: SF7>

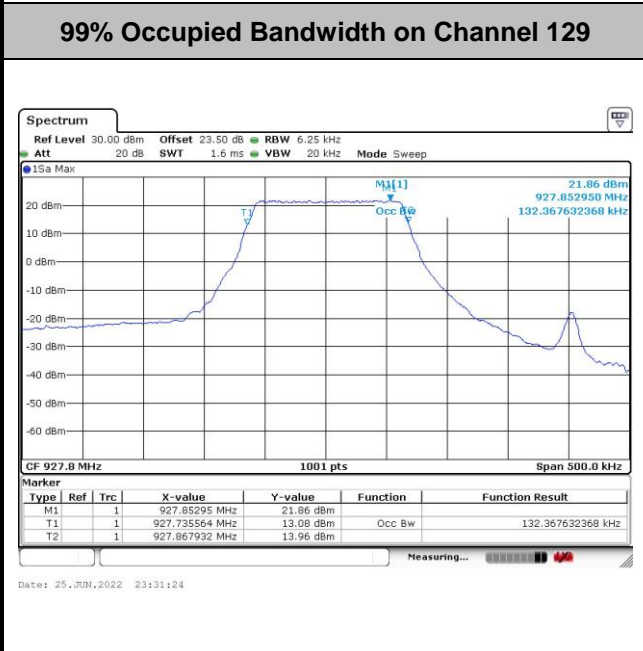
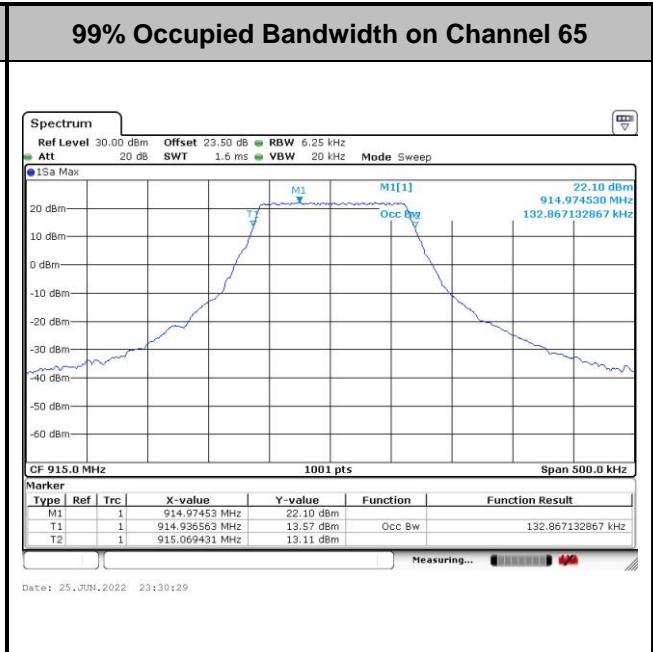
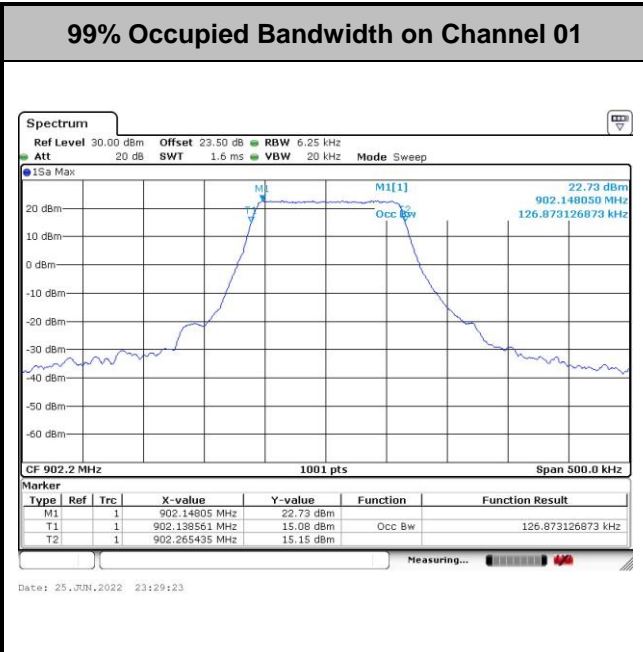


N/A

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



<Data Rate: SF8>



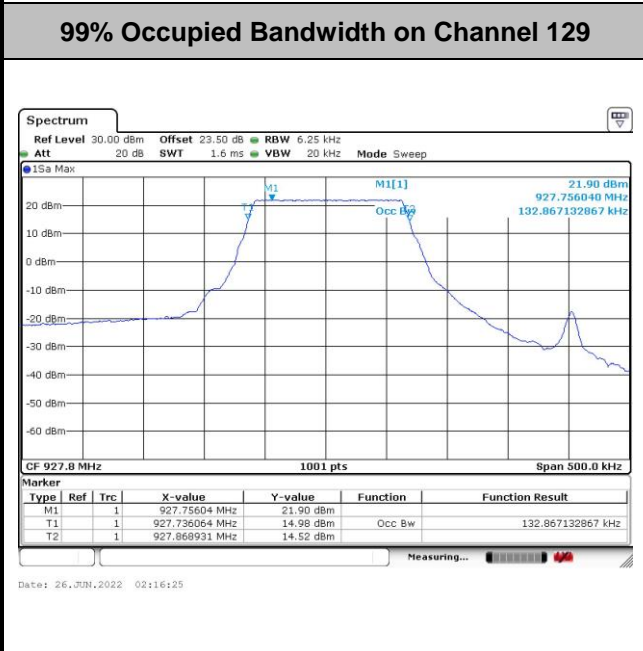
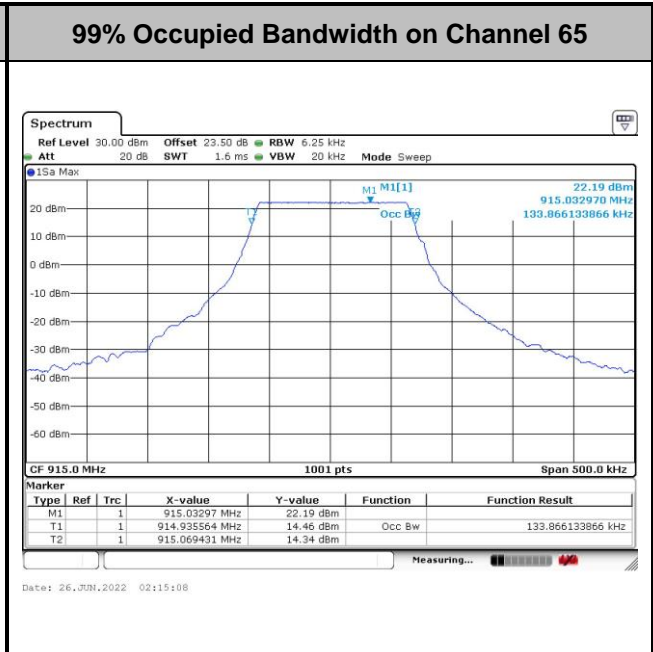
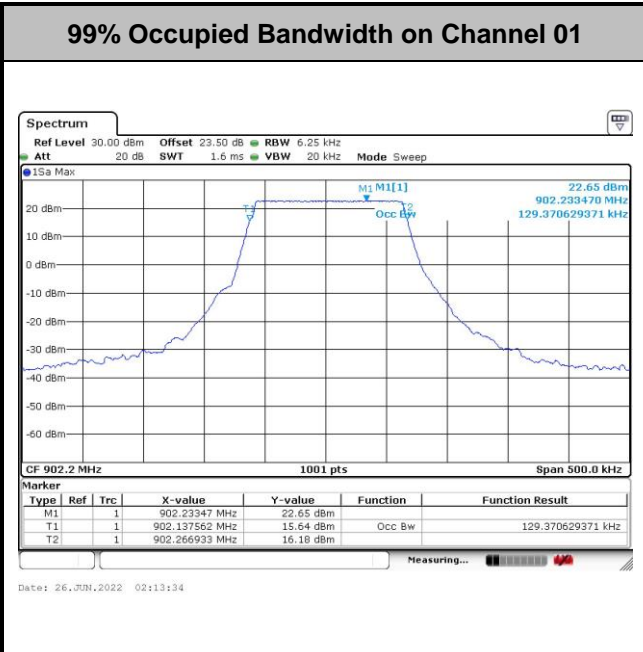
-

N/A

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



<Data Rate: SF9>



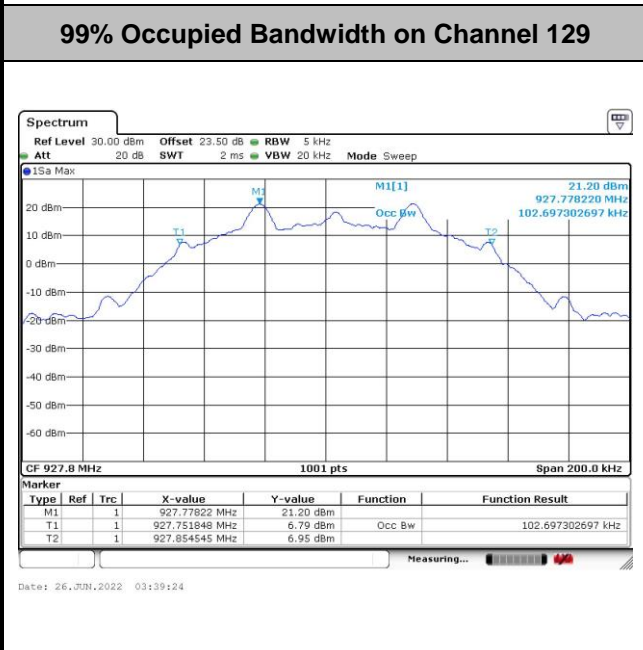
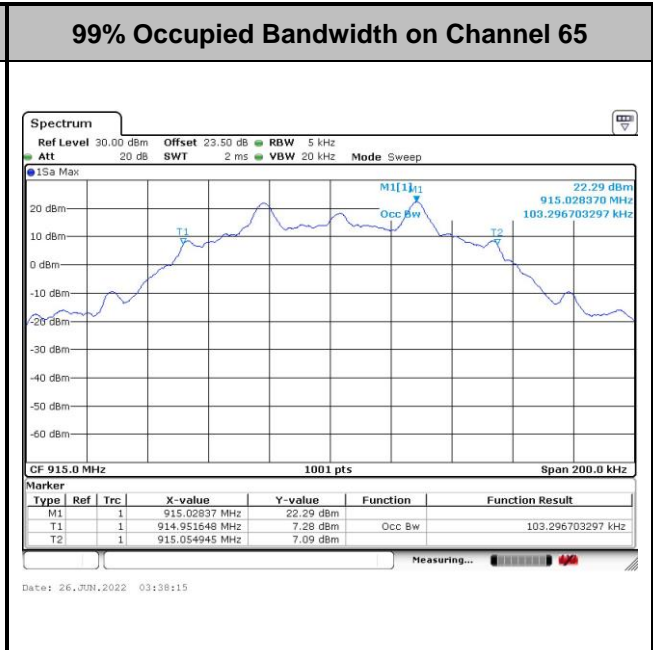
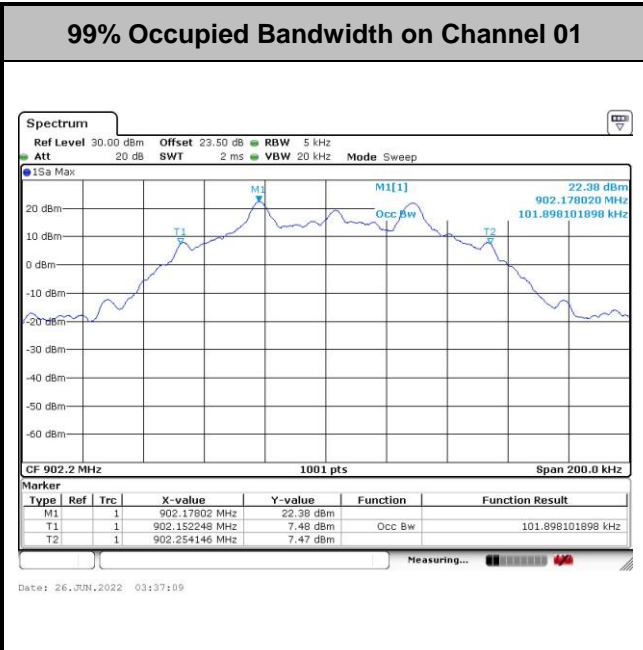
-

N/A

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



<FSK 50Kbps FHSS>



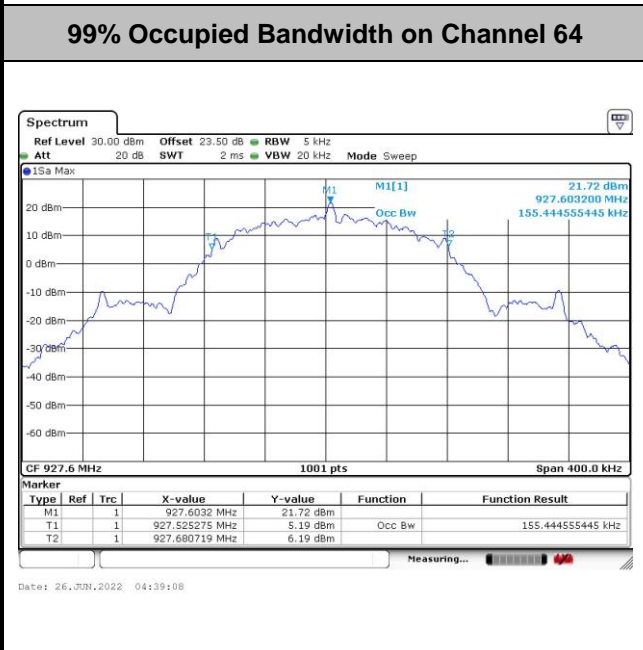
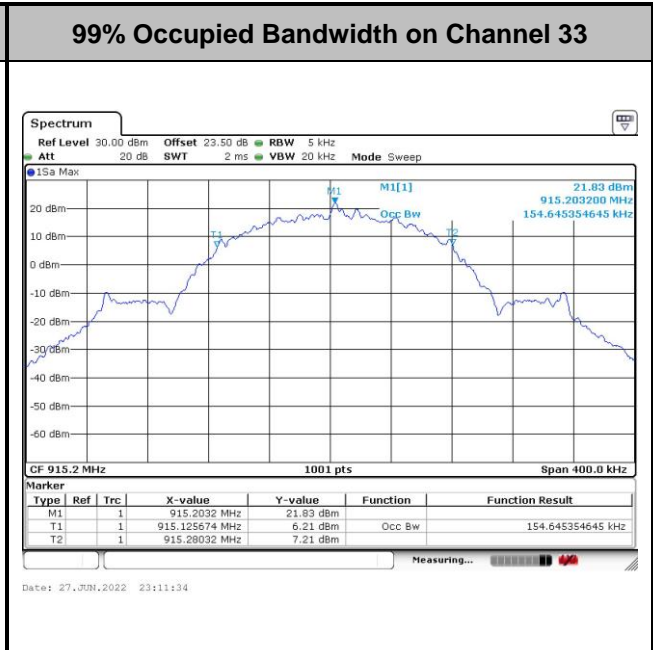
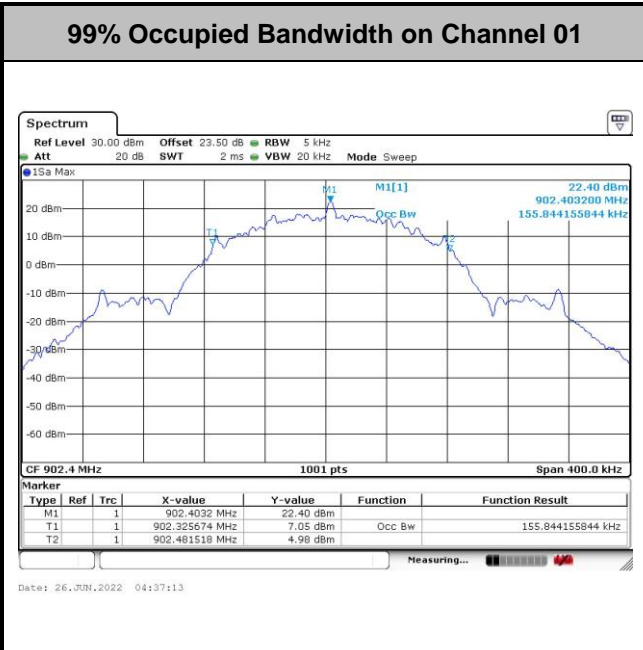
-

N/A

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



<FSK 150Kbps FHSS>



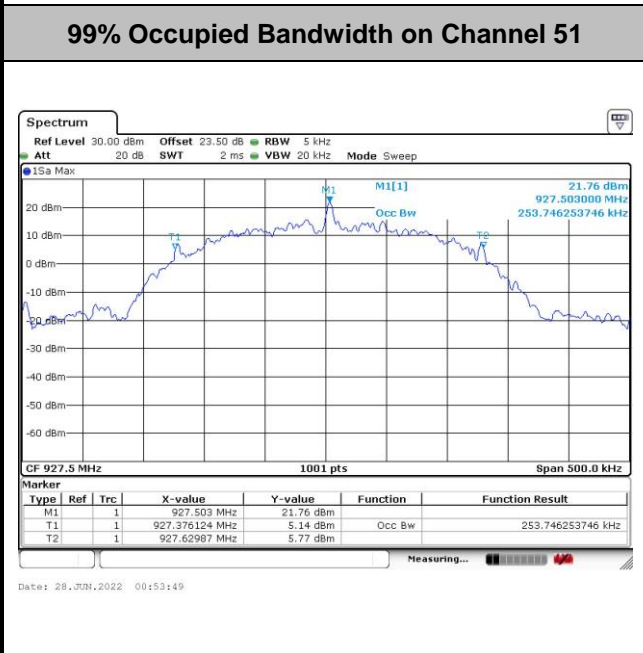
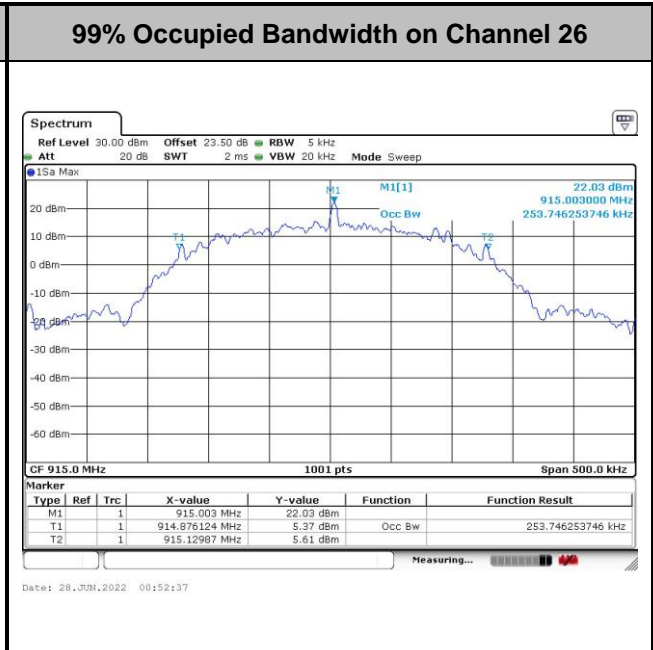
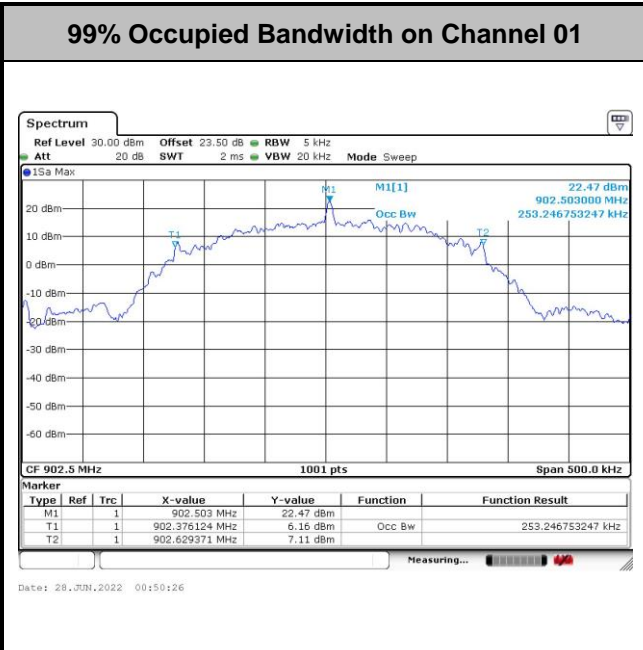
-

N/A

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



<FSK 250Kbps FHSS>



-

N/A

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

3.5 Output Power Measurement

3.5.1 Limit of Output Power

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

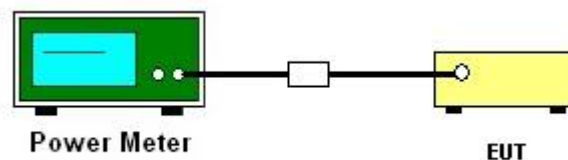
3.5.2 Measuring Instruments

See list of measuring equipment of this test report.

3.5.3 Test Procedures

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

3.5.4 Test Setup



3.5.5 Test Result of Peak Output Power

Please refer to Appendix A.

3.5.6 Test Result of Average Output Power (Reporting Only)

Please refer to Appendix A.

3.6 Conducted Band Edges Measurement

3.6.1 Limit of Band Edges

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

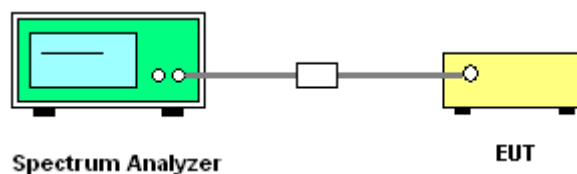
3.6.2 Measuring Instruments

See list of measuring equipment of this test report.

3.6.3 Test Procedures

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

3.6.4 Test Setup

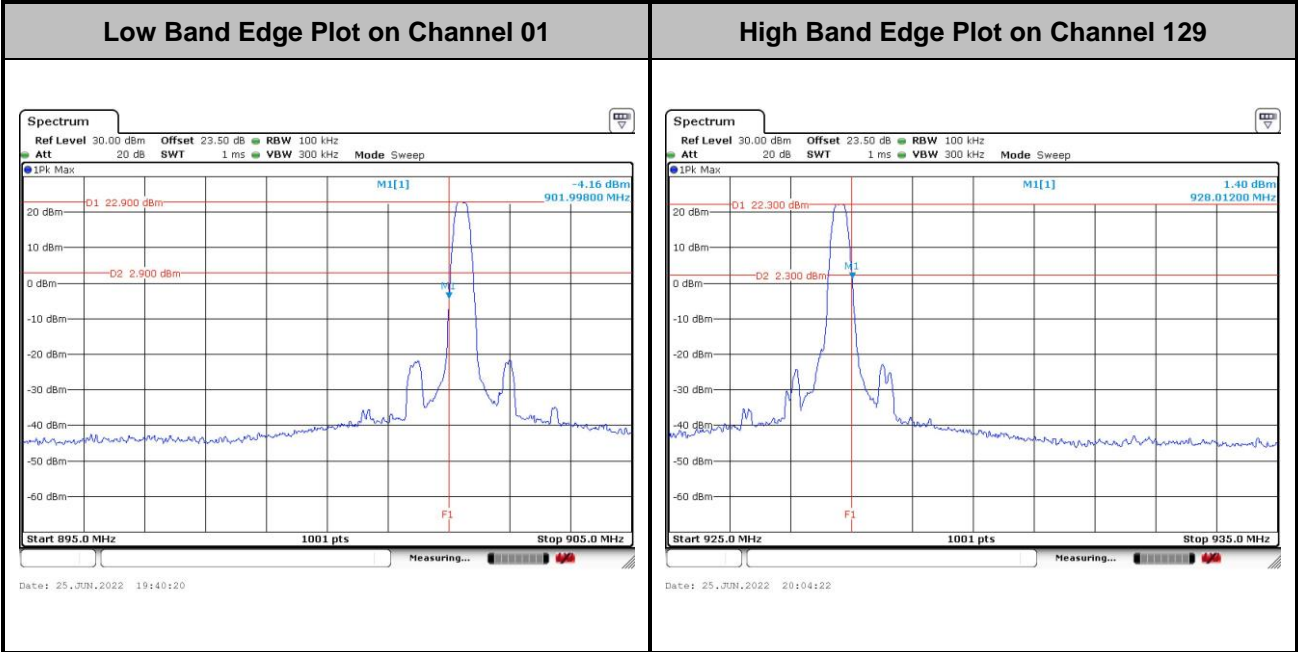




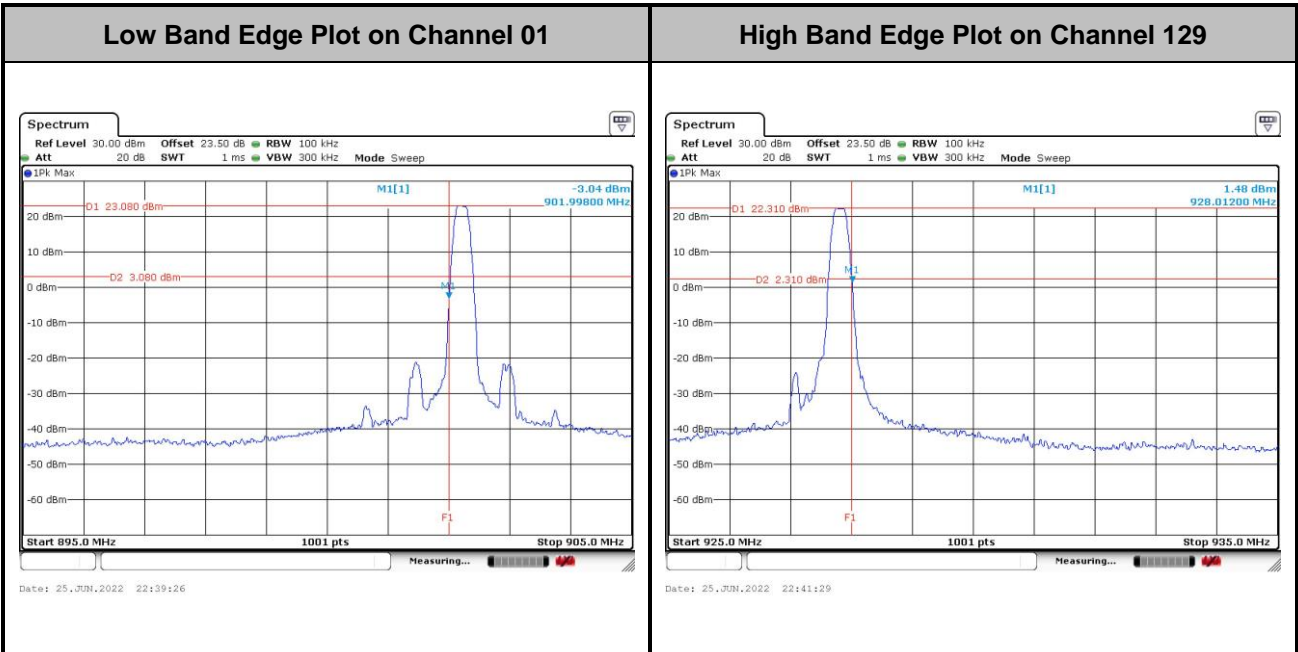
3.6.5 Test Result of Conducted Band Edges

<LoRa 125KHz FHSS>

<Data Rate: SF7>

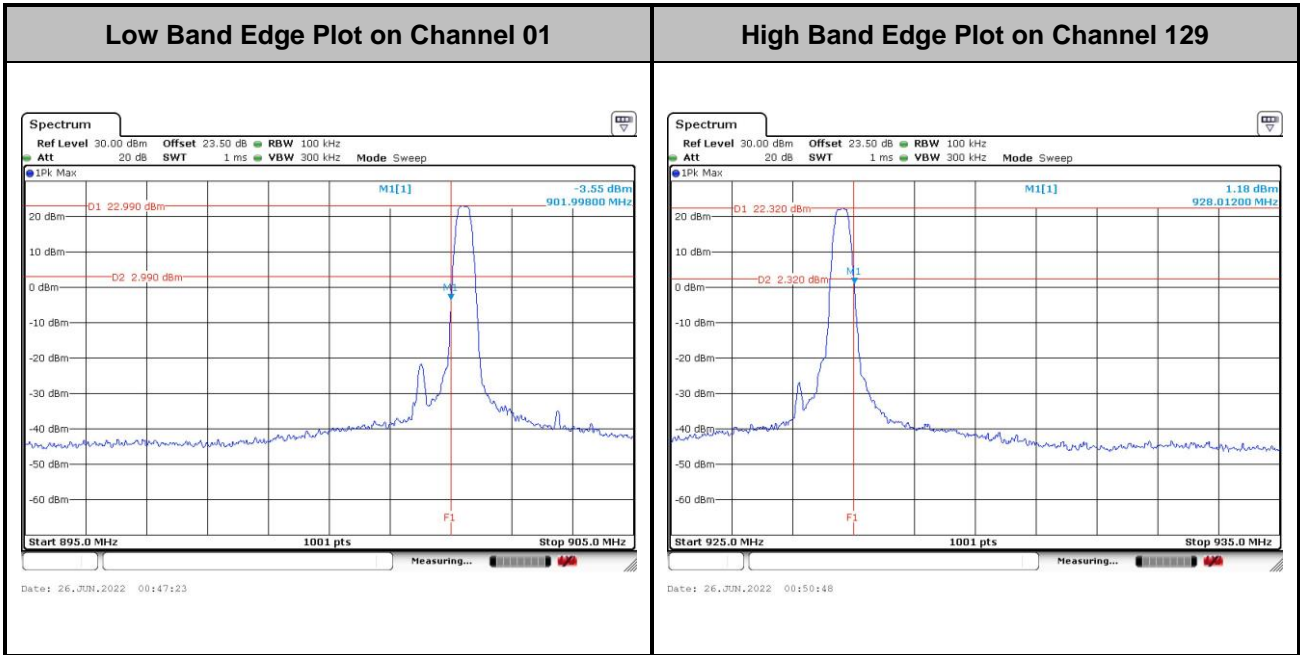


<Data Rate: SF8>

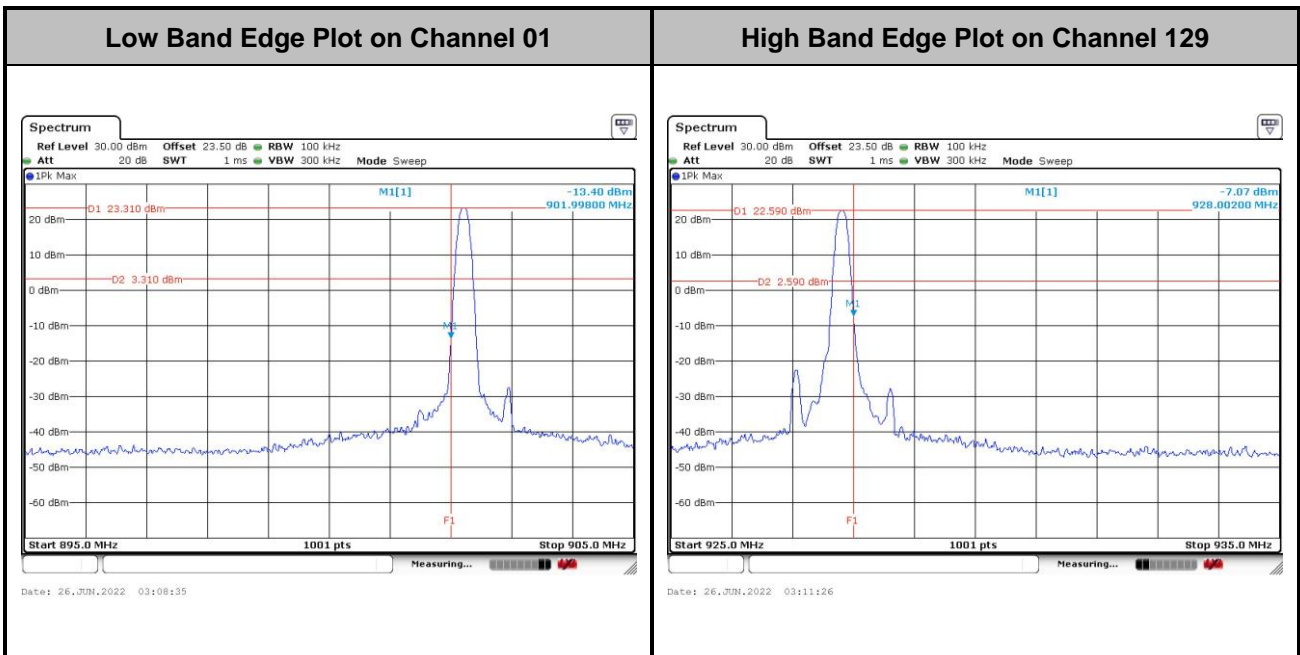




<Data Rate: SF9>

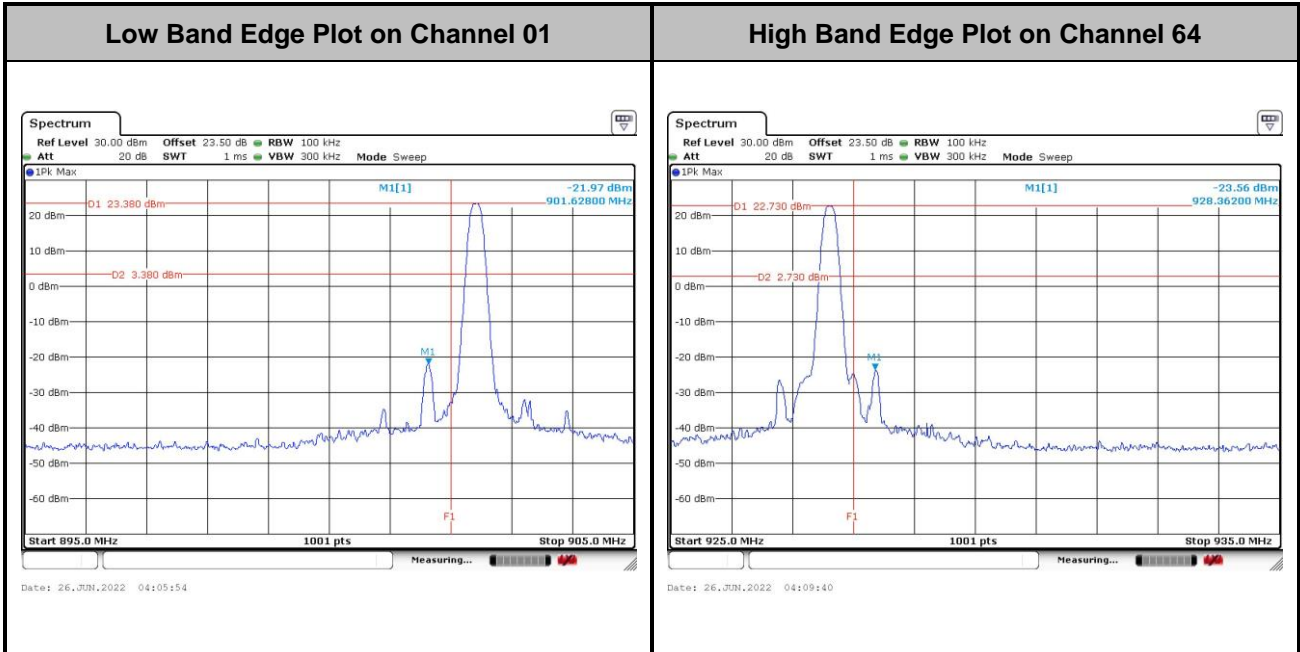


<FSK 50Kbps FHSS>

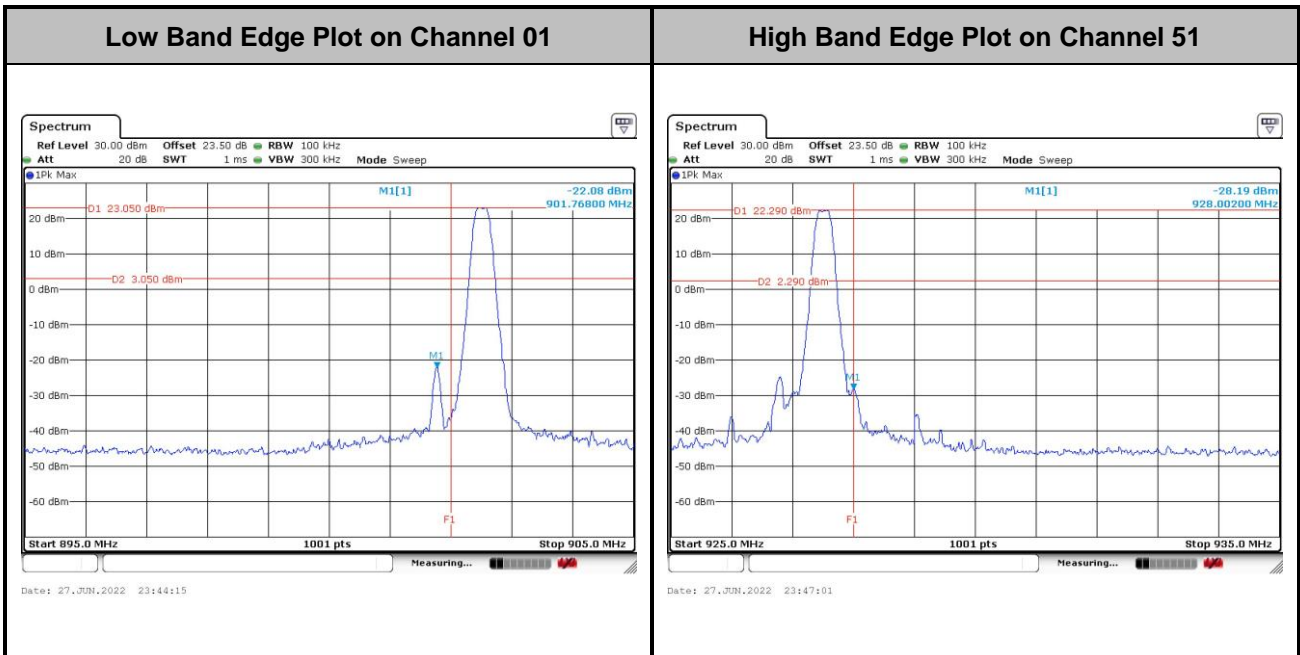




<FSK 150Kbps FHSS>



<FSK 250Kbps FHSS>

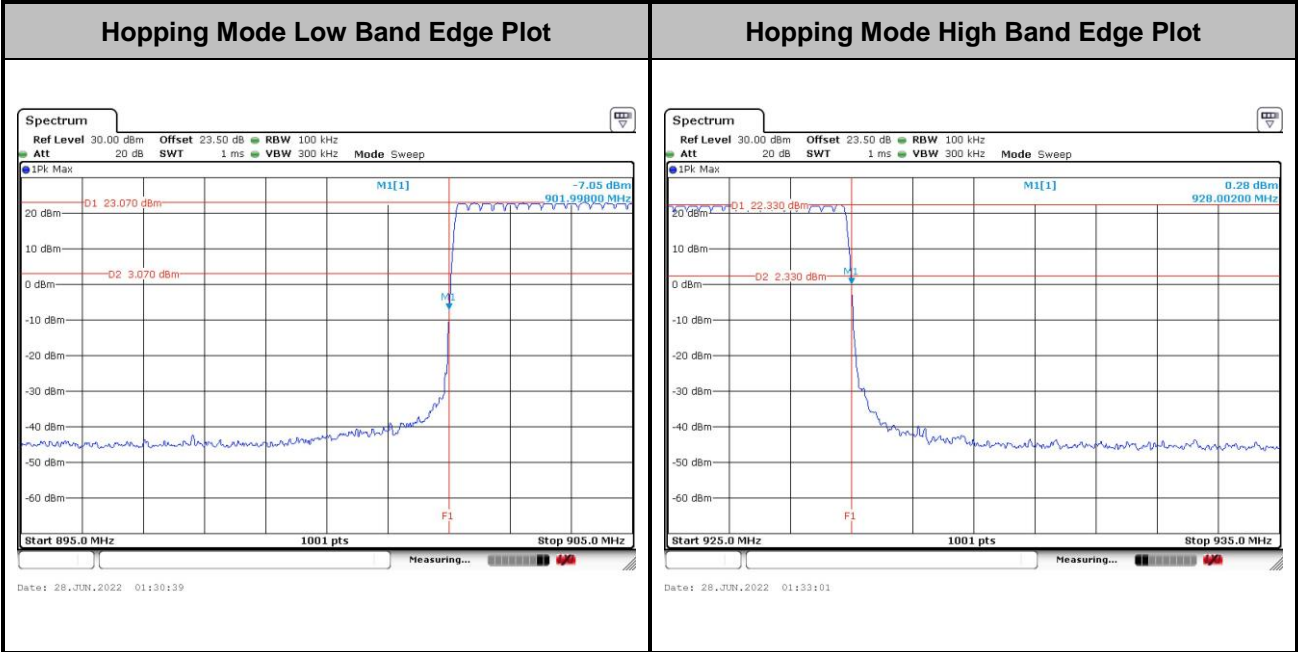




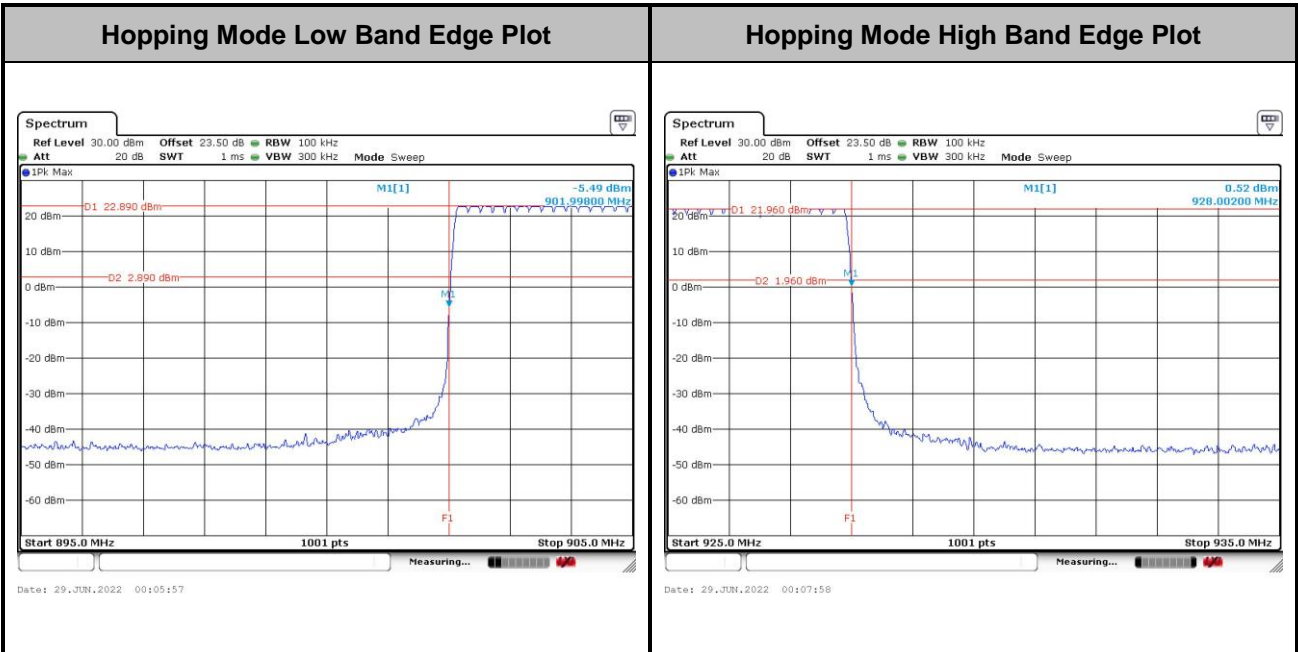
3.6.6 Test Result of Conducted Hopping Mode Band Edges

<LoRa 125KHz FHSS>

<Data Rate: SF7>

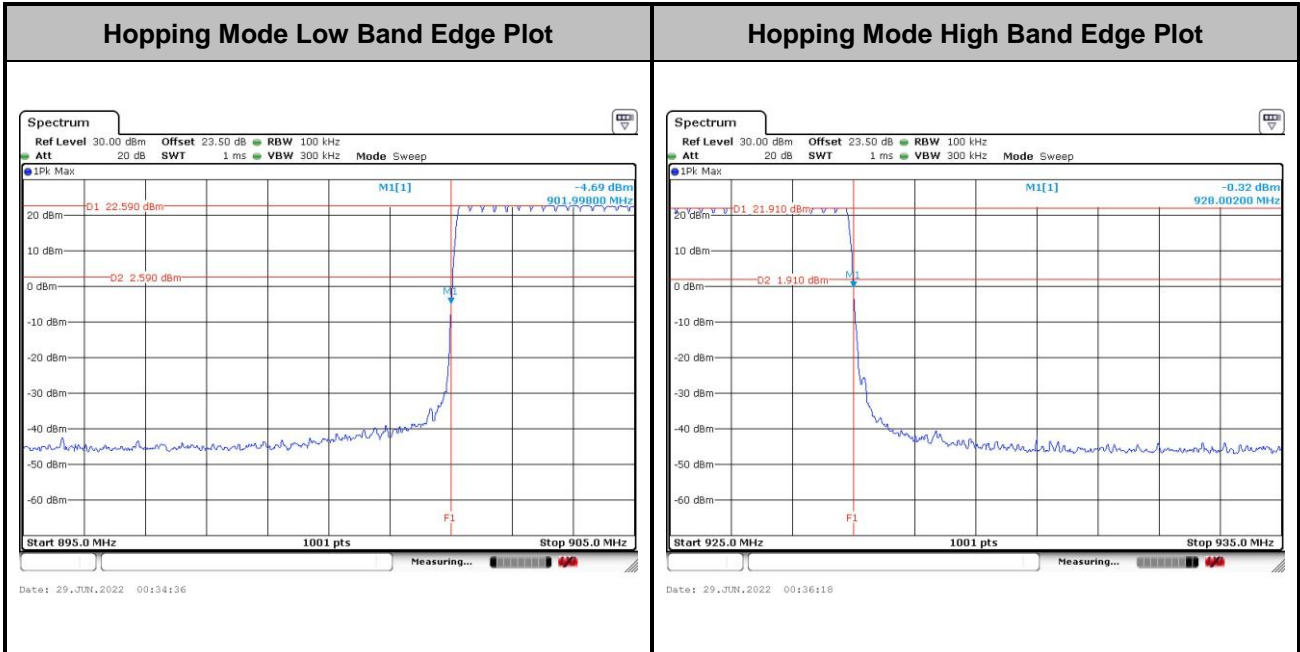


<Data Rate: SF8>





<Data Rate: SF9>



<FSK 50Kbps FHSS>

