

ELECTROMAGNETIC EMISSION COMPLIANCE REPORT FOR LOW-POWER, NON-LICENSED TRANSMITTER

Test Report No. : OT-19D-RWD-040
AGR No. : A19NA-393
Applicant : HYUNDAI MOBIS CO., LTD.
Address : 203, Teheran-ro, Gangnam-gu, Seoul, Korea
Manufacturer : Jiangsu Mobis Automotive Parts Co., Ltd.
Address : No.70 Hope Road South, Economic Developing Zone, Yancheng City, Jiangsu Province, China
Type of Equipment : DIGITAL CAR AUDIO SYSTEM
FCC ID. : TQ8-ACB10H7GN
Model Name : ACB10H7GN
Multiple Model Name : N/A
Serial number : N/A
Total page of Report : 78 pages (including this page)
Date of Incoming : November 26, 2019
Date of issue : December 11, 2019

SUMMARY

The equipment complies with the regulation; *FCC PART 15 SUBPART C Section 15.247*

This test report only contains the result of a single test of the sample supplied for the examination.

It is not a generally valid assessment of the features of the respective products of the mass-production.

Reviewed by:



Ha-Ram Lee / Assistant Manager
ONETECH Corp.

Approved by:



Jae-Ho Lee / Chief Engineer
ONETECH Corp.

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Revision History

| Rev. No. | Issue Report No. | Issued Date | Revisions | Section Affected |
|----------|------------------|-------------------|---------------|------------------|
| 0 | OT-19D-RWD-040 | December 11, 2019 | Initial Issue | All |
| | | | | |
| | | | | |

1. VERIFICATION OF COMPLIANCE

Applicant : HYUNDAI MOBIS CO., LTD.
 Address : 203, Teheran-ro, Gangnam-gu, Seoul, Korea
 CONTACT PERSON : Seung hoon Choe / Senior Engineer
 Telephone No. : +82-31-260-0098
 FCC ID : TQ8-ACB10H7GN
 Model Name : ACB10H7GN
 Brand Name : HYUNDAI MOBIS
 Serial Number : N/A
 DATE : December 11, 2019

| | |
|---|---|
| EQUIPMENT CLASS | <i>DSS – PART 15 SPREAD SPECTRUM TRANSMITTER</i> |
| KIND OF EQUIPMENT | DIGITAL CAR AUDIO SYSTEM |
| THIS REPORT CONCERNS | Original Grant |
| MEASUREMENT PROCEDURES | ANSI C63.10: 2013 |
| TYPE OF EQUIPMENT TESTED | Pre-Production |
| KIND OF EQUIPMENT AUTHORIZATION REQUESTED | Certification |
| EQUIPMENT WILL BE OPERATED UNDER FCC RULES PART(S) | FCC PART 15 SUBPART C Section 15.247 |
| MODIFICATIONS ON THE EQUIPMENT TO ACHIEVE COMPLIANCE | None |
| FINAL TEST WAS CONDUCTED ON | 3 m Semi Anechoic Chamber |

-. The above equipment was tested by ONETECH Corp. for compliance with the requirement set forth in the FCC Rules and Regulations. This said equipment in the configuration described in this report, shows the maximum emission levels emanating from equipment are within the compliance requirements.

2. TEST SUMMARY

2.1 Test items and results

| SECTION | TEST ITEMS | RESULTS |
|----------------------|---|------------------------|
| 15.247 (a) (1) | Carrier Frequency Separation | Met the Limit / PASS |
| 15.247 (a) (1) (iii) | Minimum Number of Hopping Channels | Met the Limit / PASS |
| 15.247 (a) (1) (iii) | Average Time of Occupancy | Met the Limit / PASS |
| 15.247 (b) (1) | Maximum Peak Conducted Output Power | Met the Limit / PASS |
| 15.247 (d) | 100 kHz Bandwidth Outside the Frequency Band | Met the Limit / PASS |
| 15.247 (d) | Radiated Emission which fall in the Restricted Band | Met the Limit / PASS |
| 15.209 | Radiated Emission Limits, General Requirement | Met the Limit / PASS |
| 15.207 | Conducted Limits | N/A (See Note) |
| 15.203 | Antenna Requirement | Met requirement / PASS |

Note: This test is not performed because the EUT is operated by DC.

2.2 Additions, deviations, exclusions from standards

No additions, deviations or exclusions have been made from standard.

2.3 Related Submittal(s) / Grant(s)

Original submittal only

2.4 Purpose of the test

To determine whether the equipment under test fulfills the requirements of the regulation stated in FCC PART 15 SUBPART C Section 15.247

2.5 Test Methodology

Both conducted and radiated testing was performed according to the procedures in ANSI C63.10: 2013. Radiated testing was performed at a distance of 3 m from EUT to the antenna.

2.6 Test Facility

The Onetech Corp. has been designated to perform equipment testing in compliance with ISO/IEC 17025.

The Electromagnetic compatibility measurement facilities are located at 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea

-. Site Filing:

VCCI (Voluntary Control Council for Interference) – Registration No. R-4112/ C-14617/ G-10666 / T-1842

ISED (Innovation, Science and Economic Development Canada) – Registration No. Site# 3736A-3

KOLAS (Korea Laboratory Accreditation Scheme) - Accreditation NO. KT085

FCC (Federal Communications Commission) - Accreditation No. KR0013

RRA (Radio Research Agency) – Designation No. KR0013

3. GENERAL INFORMATION

3.1 Product Description

The HYUNDAI MOBIS CO., LTD., Model ACB10H7GN (referred to as the EUT in this report) is a DIGITAL CAR AUDIO SYSTEM. The product specification described herein was obtained from product data sheet or user's manual.

| | | |
|--|---|-----------|
| Device Type | DIGITAL CAR AUDIO SYSTEM | |
| Operating Frequency | 2 402 MHz ~ 2 480 MHz | |
| RF Output Power | 1 Mbps | -4.68 dBm |
| | 2 Mbps | -4.37 dBm |
| | 3 Mbps | -4.03 dBm |
| Number of Channel | 79 Channels | |
| Modulation Type | GFSK for 1 Mbps, $\pi/4$ -DQPSK for 2 Mbps, 8-DPSK for 3 Mbps | |
| Antenna Type | PCB Antenna | |
| Antenna Gain | -0.16 dBi | |
| List of each Osc. or crystal Freq.(Freq. \geq 1 MHz) | 12 MHz, 26 MHz, 62.4 MHz | |
| Rated Supply Voltage | DC 14.4 V | |

3.2 Alternative type(s)/model(s); also covered by this test report.

-. None

4. EUT MODIFICATIONS

-. None

5. SYSTEM TEST CONFIGURATION

5.1 Justification

This device was configured for testing in a typical way as a normal customer is supposed to be used. During the test, the following components were installed inside of the EUT.

| DEVICE TYPE | MANUFACTURER | MODEL/PART NUMBER | FCC ID |
|-------------|--------------|-------------------|--------|
| Main Board | N/A | N/A | - |
| Front Board | N/A | N/A | - |

5.2 Peripheral equipment

-None

5.3 Mode of operation during the test

For Bluetooth function testing, software used to control the EUT for staying in continuous transmitting and receiving mode is programmed. The EUT was set at Low Channel (2 402 MHz), Middle Channel (2 441 MHz), and High Channel (2 480 MHz) with each data transfer rate, 1 Mbps, 2 Mbps, and 3 Mbps. To get a maximum radiated emission levels from the EUT, the EUT was moved throughout the XY, XZ, and YZ planes and the worst case is “XY” axis, but the worst data was recorded in this test report.

5.4 Configuration of Test System

Radiated Emission Test: The EUT was tested in the Transmitting mode. Preliminary radiated emissions test was conducted using the procedure in ANSI C63.10: 2013 to determine the worse operating conditions. Final radiated emission tests were conducted at 3 m Semi Anechoic Chamber. The turntable was rotated through 360 degrees and the EUT was tested by positioned three orthogonal planes to obtain the highest reading on the field strength meter. Once maximum reading was determined, the search antenna was raised and lowered in both vertical and horizontal polarization.

5.5 Antenna Requirement

For intentional device, according to section 15.203, an intentional radiator shall be designed as to be attached permanently to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

Antenna Construction:

The transmitter antenna of the EUT is a PCB Antenna, so no consideration of replacement by the user.

6. PRELIMINARY TEST

6.1 AC Power line Conducted Emissions Tests

- As this product is only using DC power, AC conducted emission test has not been performed.

6.2 General Radiated Emissions Tests

During Preliminary Tests, the following operating modes were investigated

| Operation Mode | The Worse operating condition (Please check one only) |
|--------------------|---|
| Transmitting mode. | X |

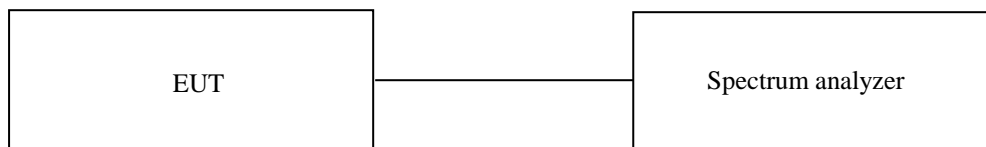
7. MINIMUM 20 dB BANDWIDTH

7.1 Operating environment

Temperature : 24 °C
Relative humidity : 48 % R.H.

7.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 10 kHz, and peak detection was used. The 20 dB bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 20 dB.



7.3 Test equipment used

| | Model Number | Manufacturer | Description | Serial Number | Last Cal. |
|-----|--------------|-----------------|-----------------|---------------|--------------------|
| ■ - | FSV30 | Rohde & Schwarz | Signal Analyzer | 101199 | Mar. 11, 2019 (1Y) |

All test equipment used is calibrated on a regular basis.

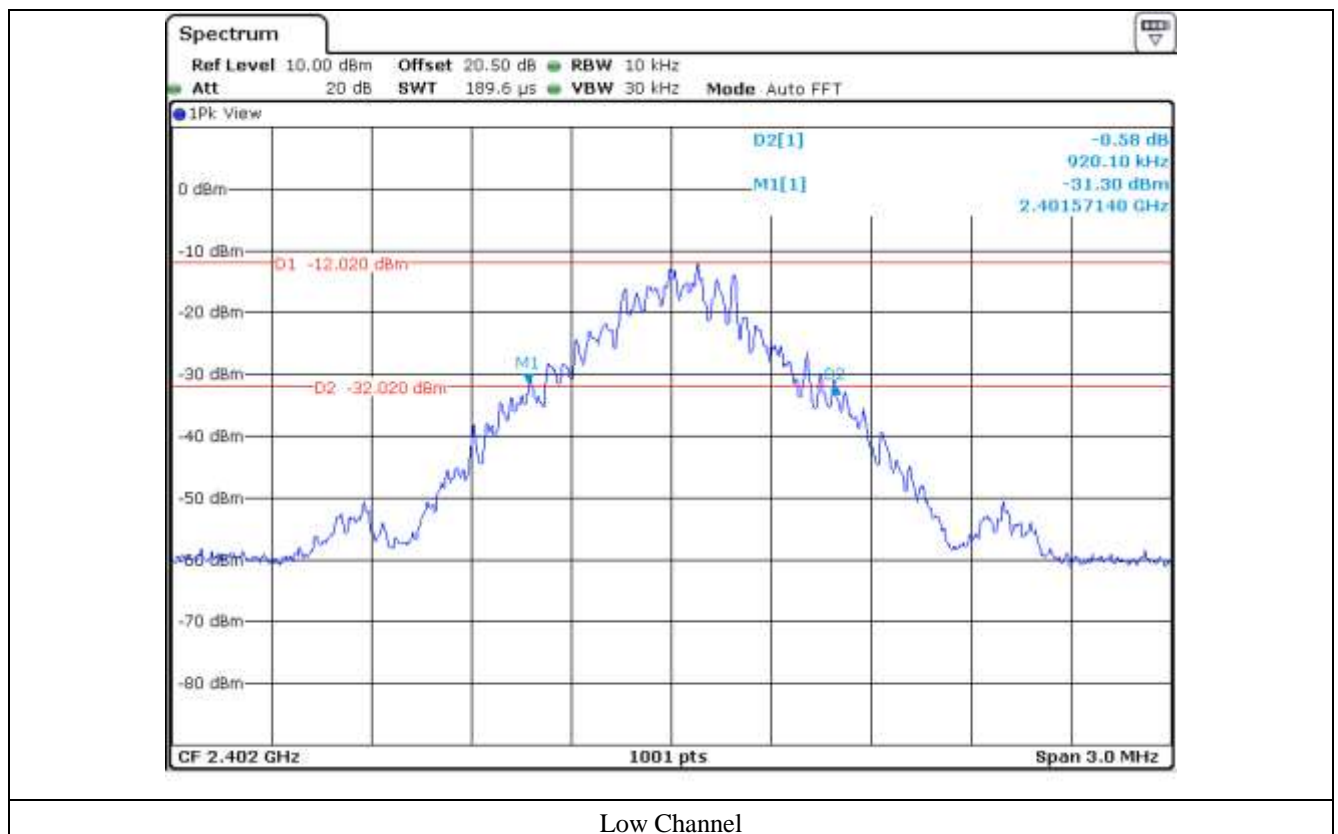
7.4 Test data for 1 Mbps

-. Test Date : November 28, 2019

| CHANNEL | FREQUENCY (MHz) | 20 dB Bandwidth (kHz) |
|---------|-----------------|-----------------------|
| Low | 2 402 | 920.10 |
| Middle | 2 441 | 920.10 |
| High | 2 480 | 920.10 |

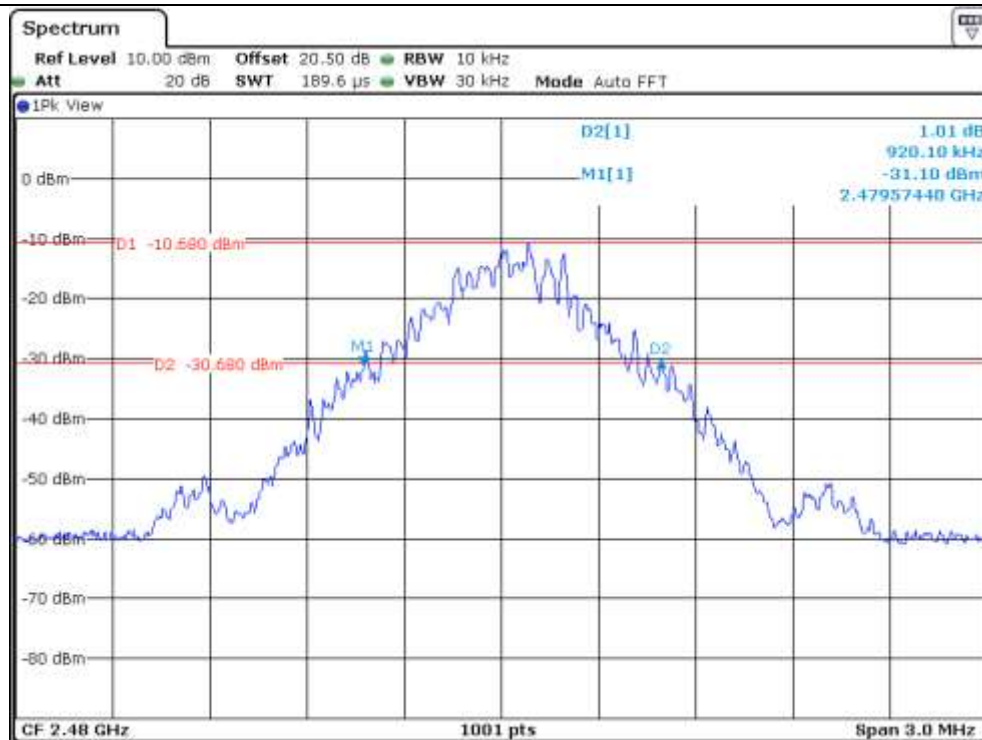


Tested by: Sieon Lee / Assistant Manager





Middle Channel



High Channel

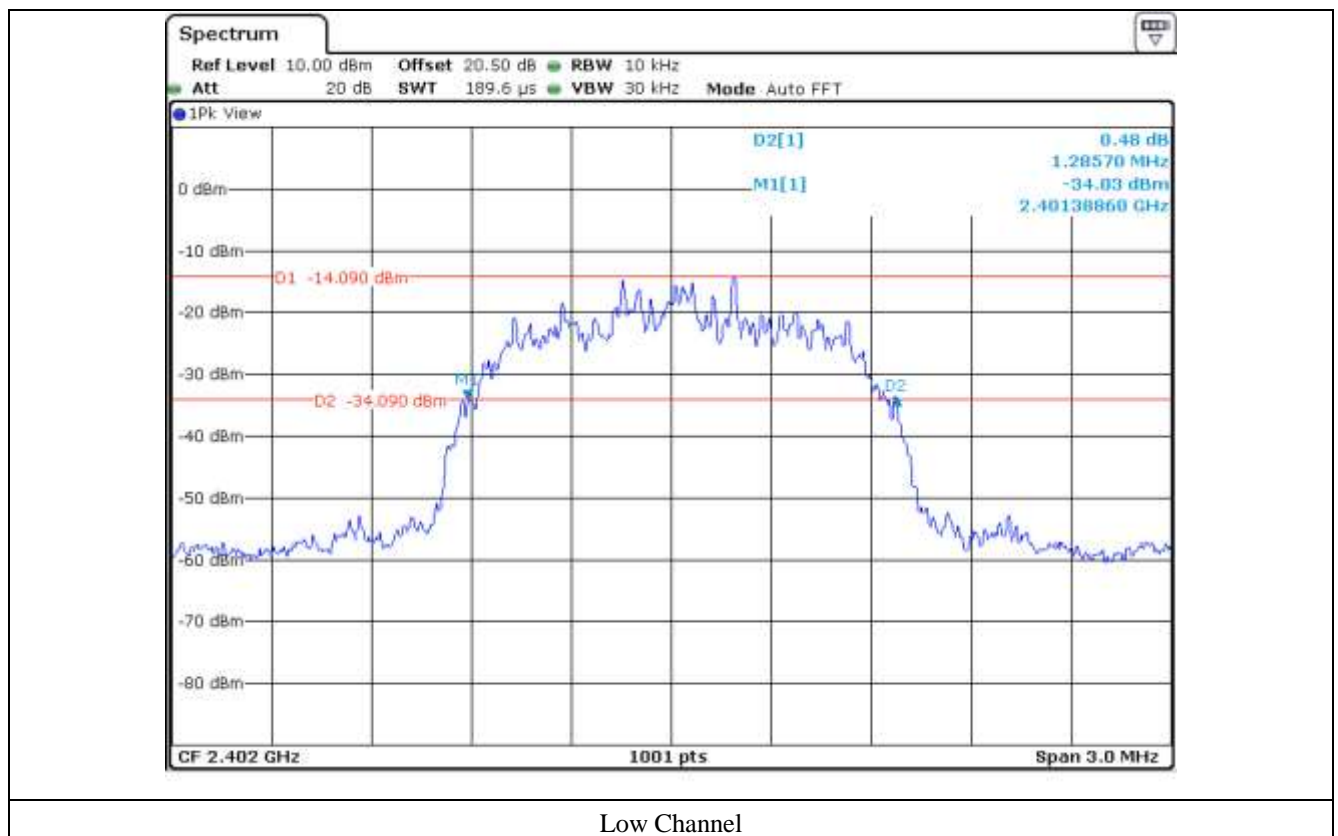
7.5 Test data for 2 Mbps

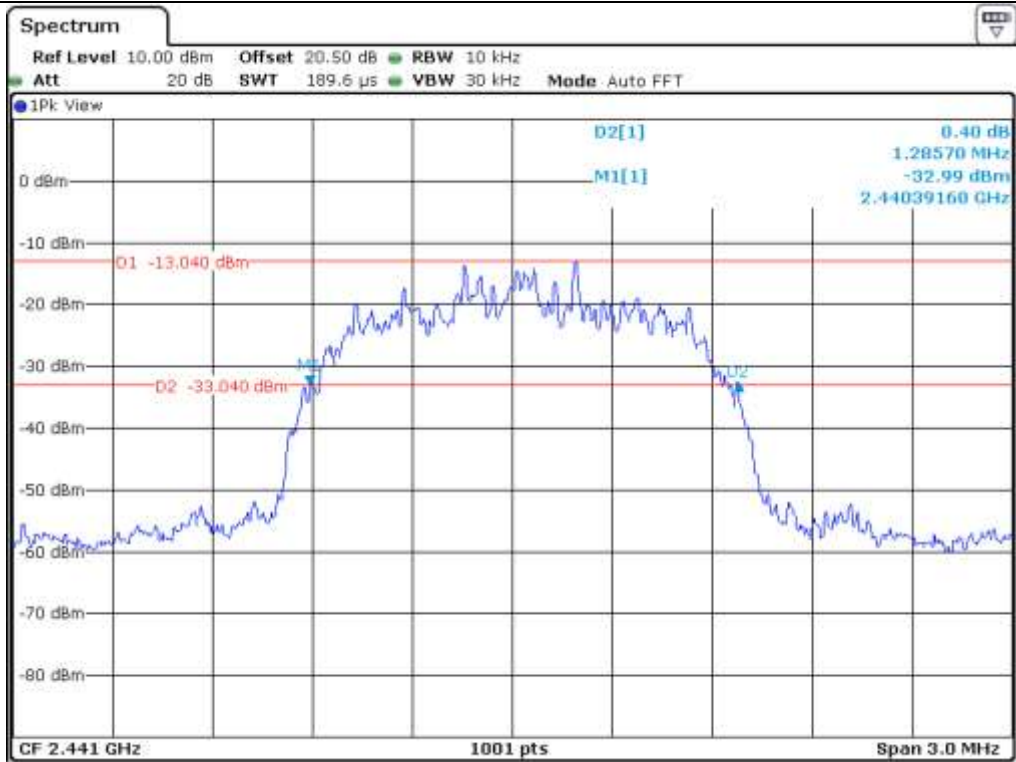
-. Test Date : November 28, 2019

| CHANNEL | FREQUENCY (MHz) | 20 dB Bandwidth (kHz) |
|---------|-----------------|-----------------------|
| Low | 2 402 | 1 285.70 |
| Middle | 2 441 | 1 285.70 |
| High | 2 480 | 1 285.70 |



Tested by: Sieon Lee / Assistant Manager





Middle Channel



High Channel

7.6 Test data for 3 Mbps

-. Test Date : November 28, 2019

| CHANNEL | FREQUENCY (MHz) | 20 dB Bandwidth (kHz) |
|---------|-----------------|-----------------------|
| Low | 2 402 | 1 255.70 |
| Middle | 2 441 | 1 261.70 |
| High | 2 480 | 1 258.70 |



Tested by: Sieon Lee / Assistant Manager



Low Channel



Middle Channel



High Channel

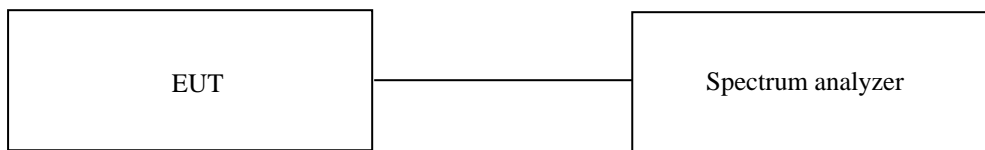
8. HOPPING FREQUENCY SEPARATION

8.1 Operating environment

Temperature : 24 °C
Relative humidity : 48 % R.H.

8.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The frequency span is set to 10 MHz. The analyzer is set to peak hold then a pseudo-random hopping sequence of the transmitter is captured. The mark delta function was used to measure the frequency separation between two adjacent hopping channels.



8.3 Test equipment used

| | Model Number | Manufacturer | Description | Serial Number | Last Cal. |
|-----|--------------|-----------------|-----------------|---------------|--------------------|
| ■ - | FSV30 | Rohde & Schwarz | Signal Analyzer | 101199 | Mar. 11, 2019 (1Y) |

All test equipment used is calibrated on a regular basis.

8.4 Test data for 1 Mbps

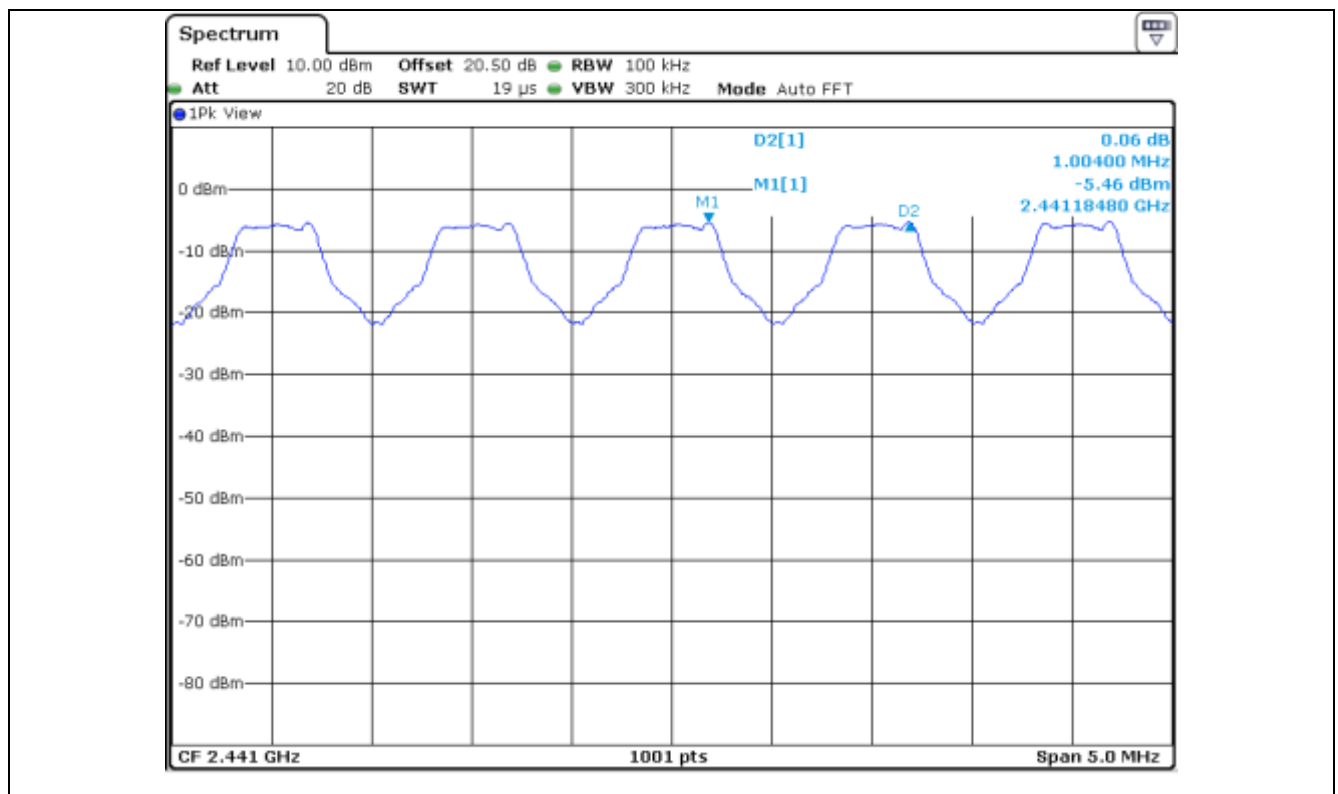
-. Test Date : November 28, 2019

-. Test Result : Pass

| MEASURED VLAUE (kHz) | Two-third of 20 dB Bandwidth (kHz) | LIMIT |
|----------------------|------------------------------------|--|
| 1 004.00 | 613.40 | Separated by 25 kHz or <u>two-thirds of the 20 dB bandwidth of the hopping channel</u> , whichever is greater. |



Tested by: Sieon Lee / Assistant Manager



8.5 Test data for 2 Mbps

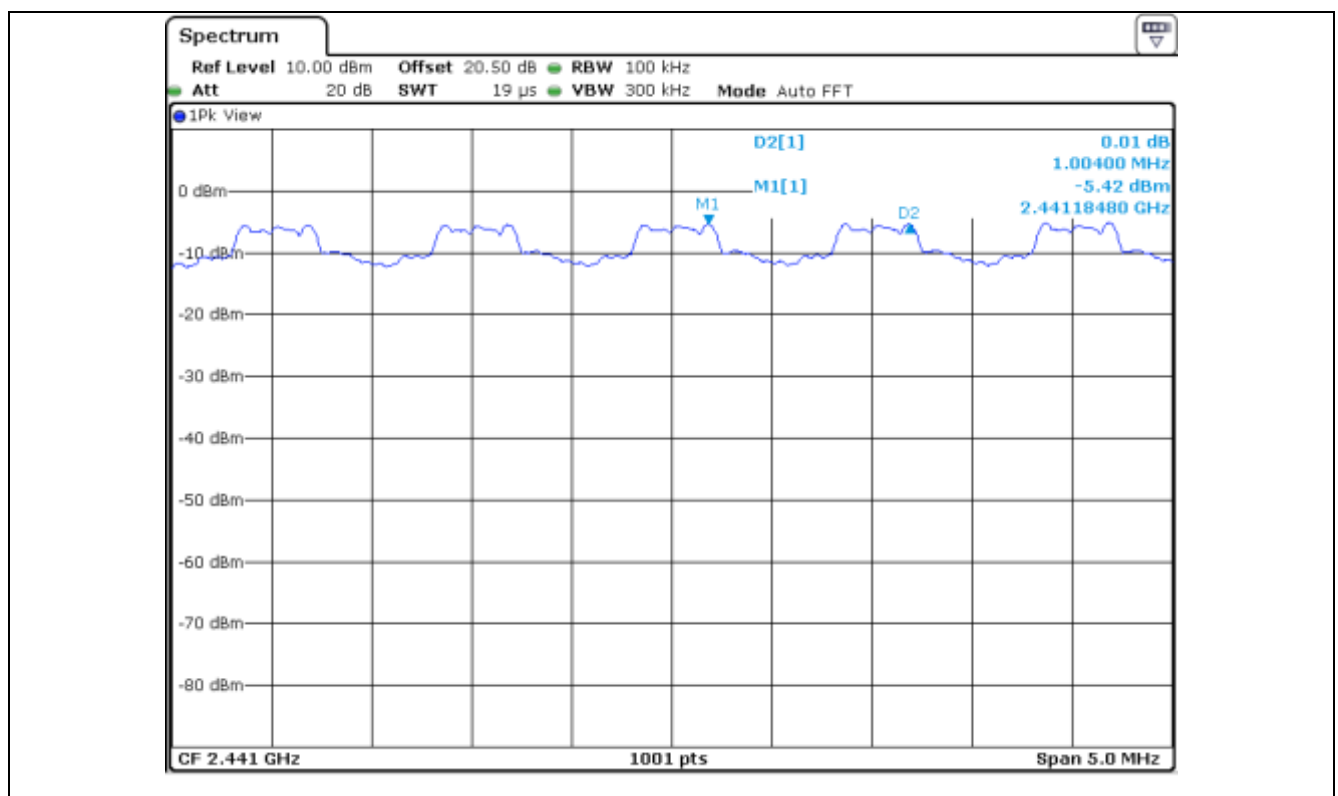
-. Test Date : November 28, 2019

-. Test Result : Pass

| MEASURED VLAUE (kHz) | Two-third of 20 dB Bandwidth (kHz) | LIMIT |
|----------------------|------------------------------------|--|
| 1 004.00 | 857.13 | Separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater. |



Tested by: Sieon Lee / Assistant Manager



8.6 Test data for 3 Mbps

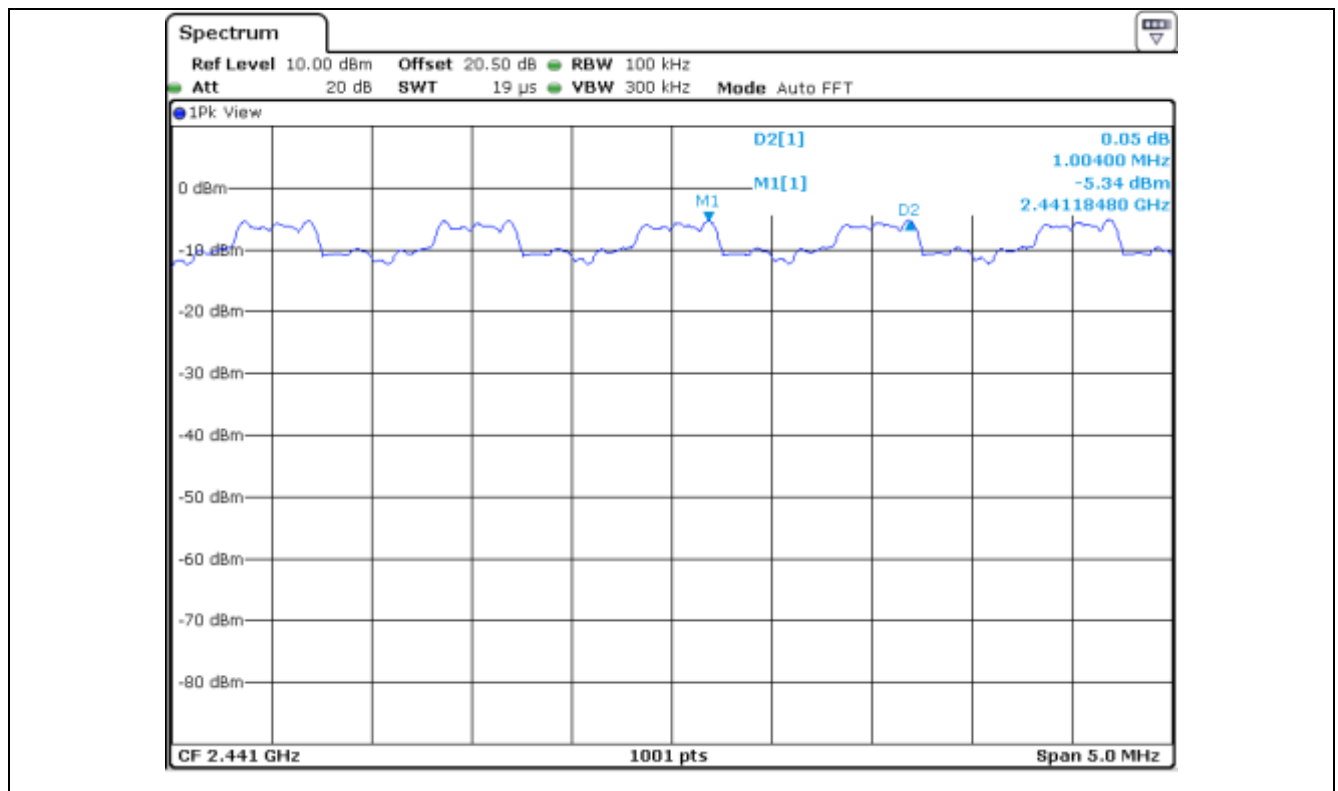
-. Test Date : November 28, 2019

-. Test Result : Pass

| MEASURED VLAUE (kHz) | Two-third of 20 dB Bandwidth (kHz) | LIMIT |
|----------------------|------------------------------------|--|
| 1004.00 | 841.13 | Separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater. |



Tested by: Sieon Lee / Assistant Manager



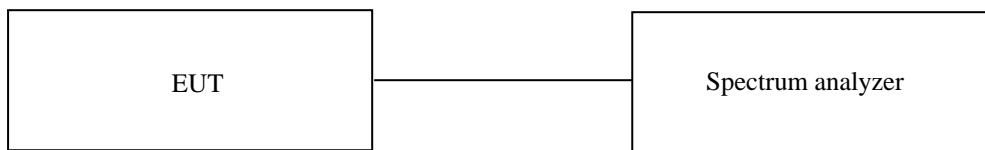
9. NUMBER OF HOPPING CHANNELS

9.1 Operating environment

Temperature : 24 °C
Relative humidity : 48 % R.H.

9.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The frequency span is set to 100 MHz and the resolution bandwidth is set to 1 MHz. The analyzer is set to peak hold and then complete pseudo-random hopping sequence of the transmitter is captured.



9.3 Test equipment used

| | Model Number | Manufacturer | Description | Serial Number | Last Cal. |
|-----|--------------|-----------------|-----------------|---------------|--------------------|
| ■ - | FSV30 | Rohde & Schwarz | Signal Analyzer | 101199 | Mar. 11, 2019 (1Y) |

All test equipment used is calibrated on a regular basis.

9.4 Test data for 1 Mbps

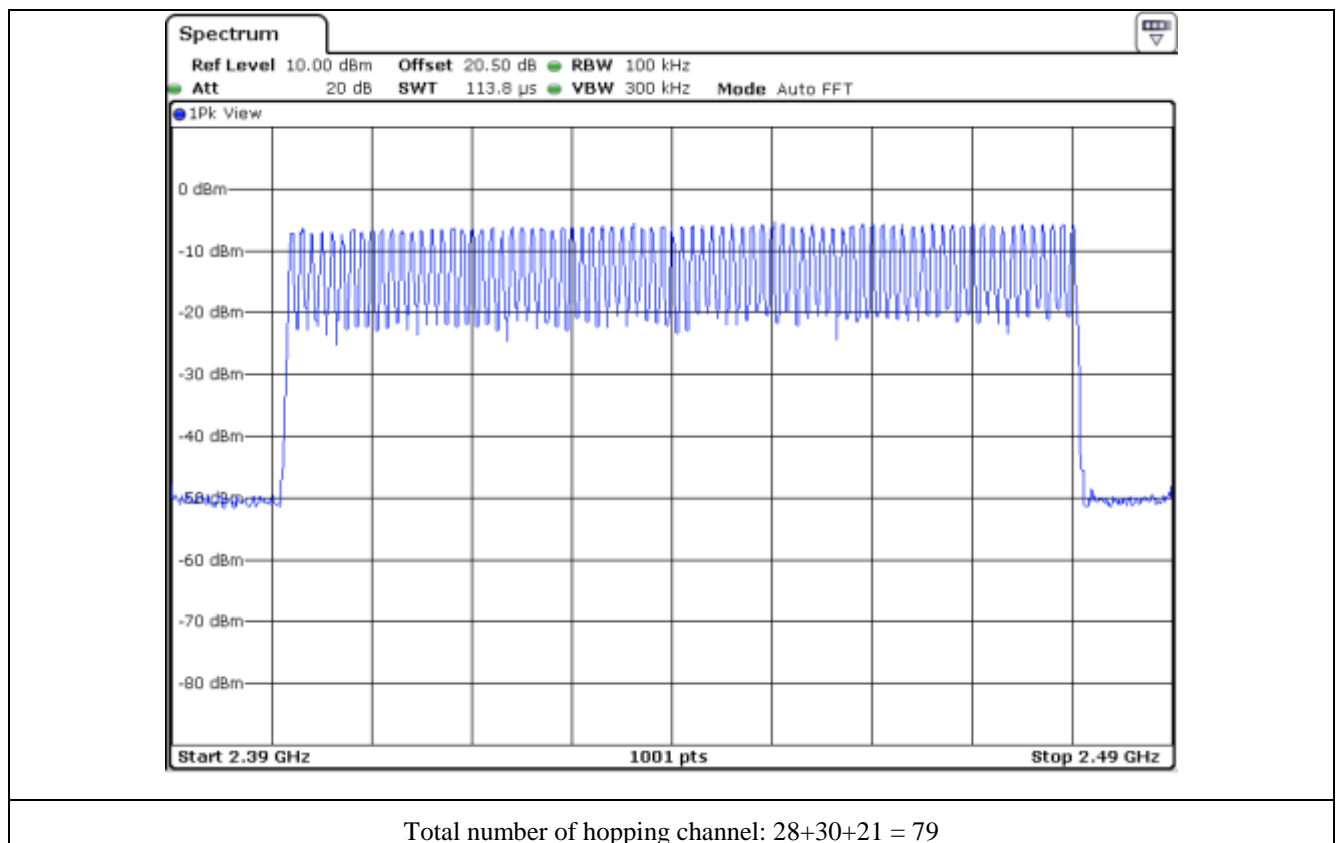
-. Test Date : November 28, 2019

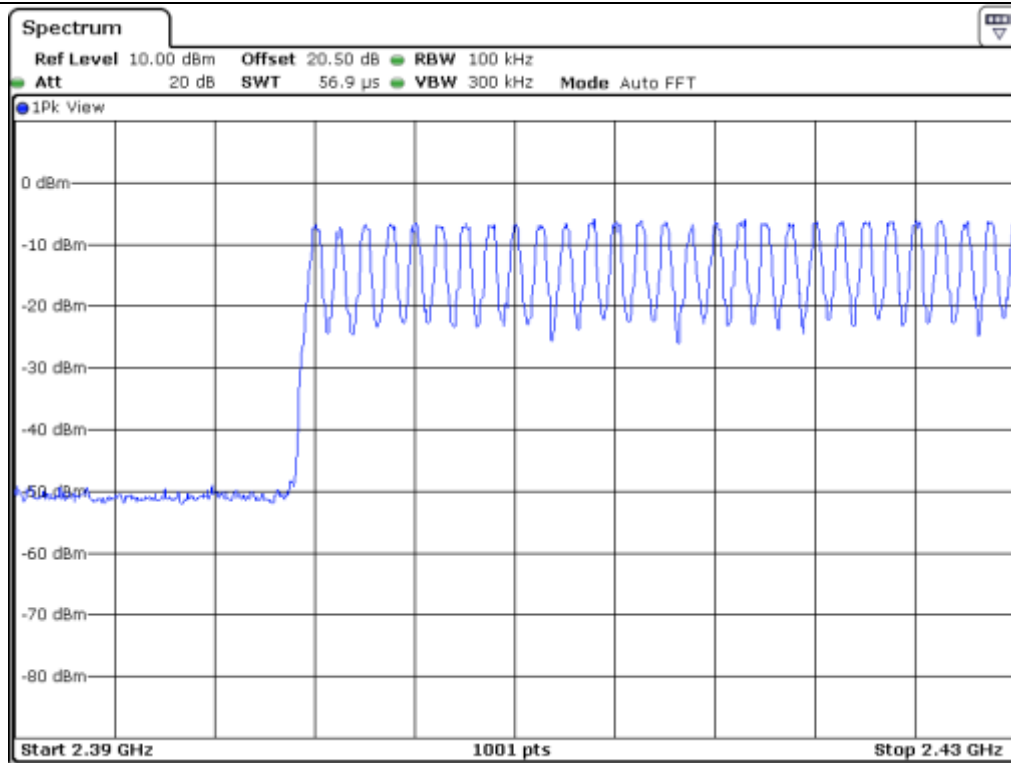
-. Test Result : Pass

| Data Transfer Rate | Measured value (Number) | Limit (Number) | Margin (Number) |
|--------------------|-------------------------|----------------|-----------------|
| 1 Mbps | 79 | Minimum of 15 | 64 |

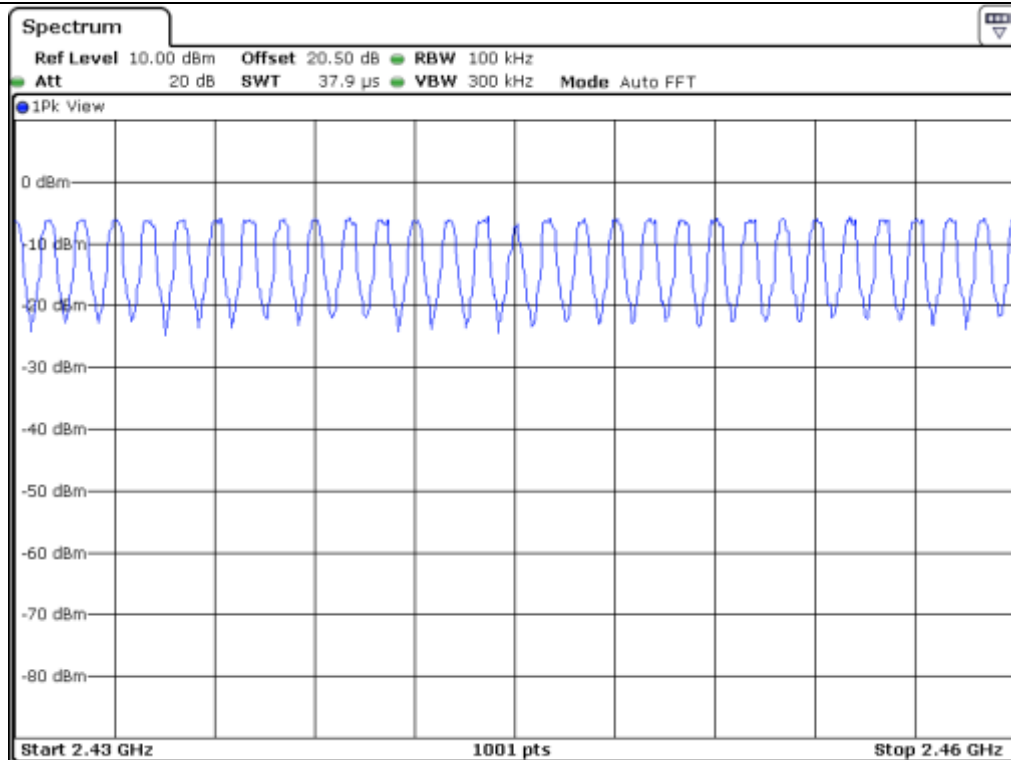


Tested by: Sieon Lee / Assistant Manager

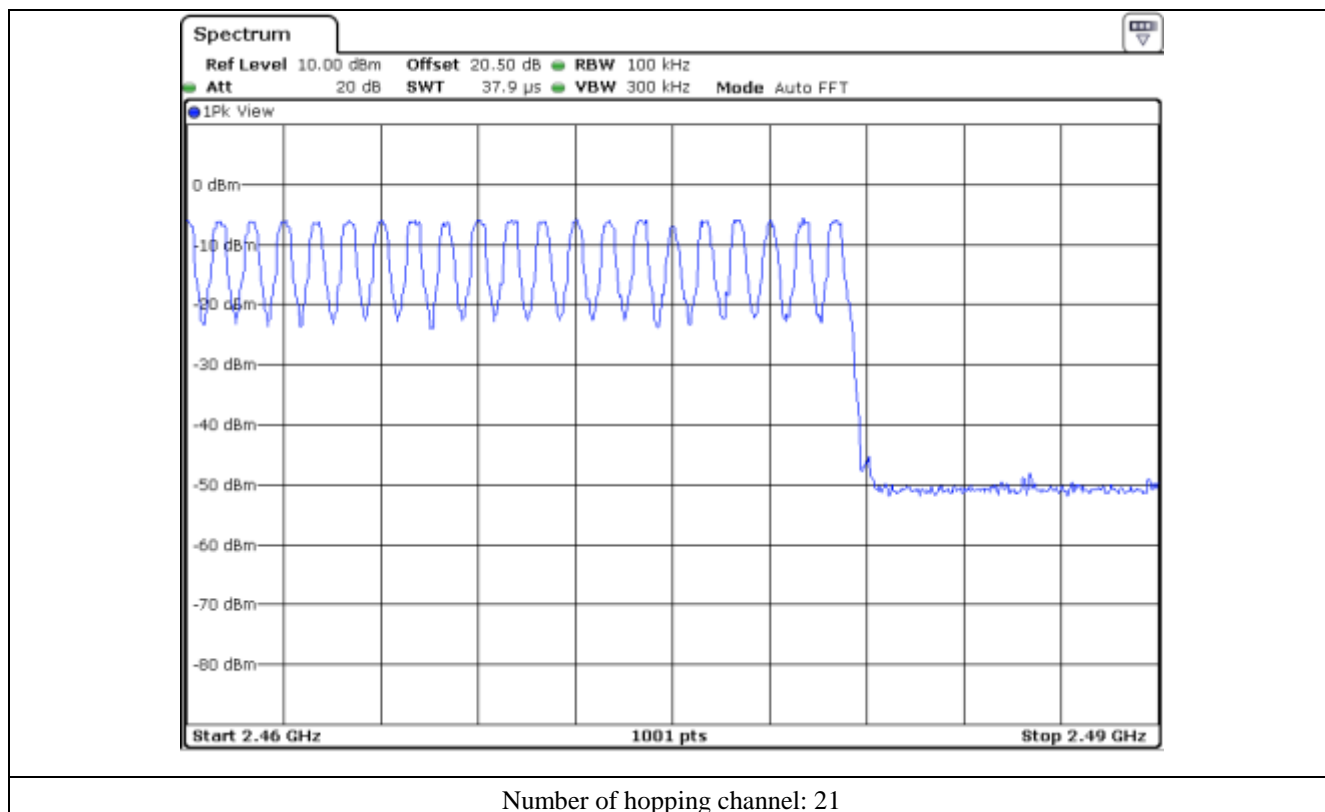




Number of hopping channel: 28



Number of hopping channel: 30



9.5 Test data for 2 Mbps

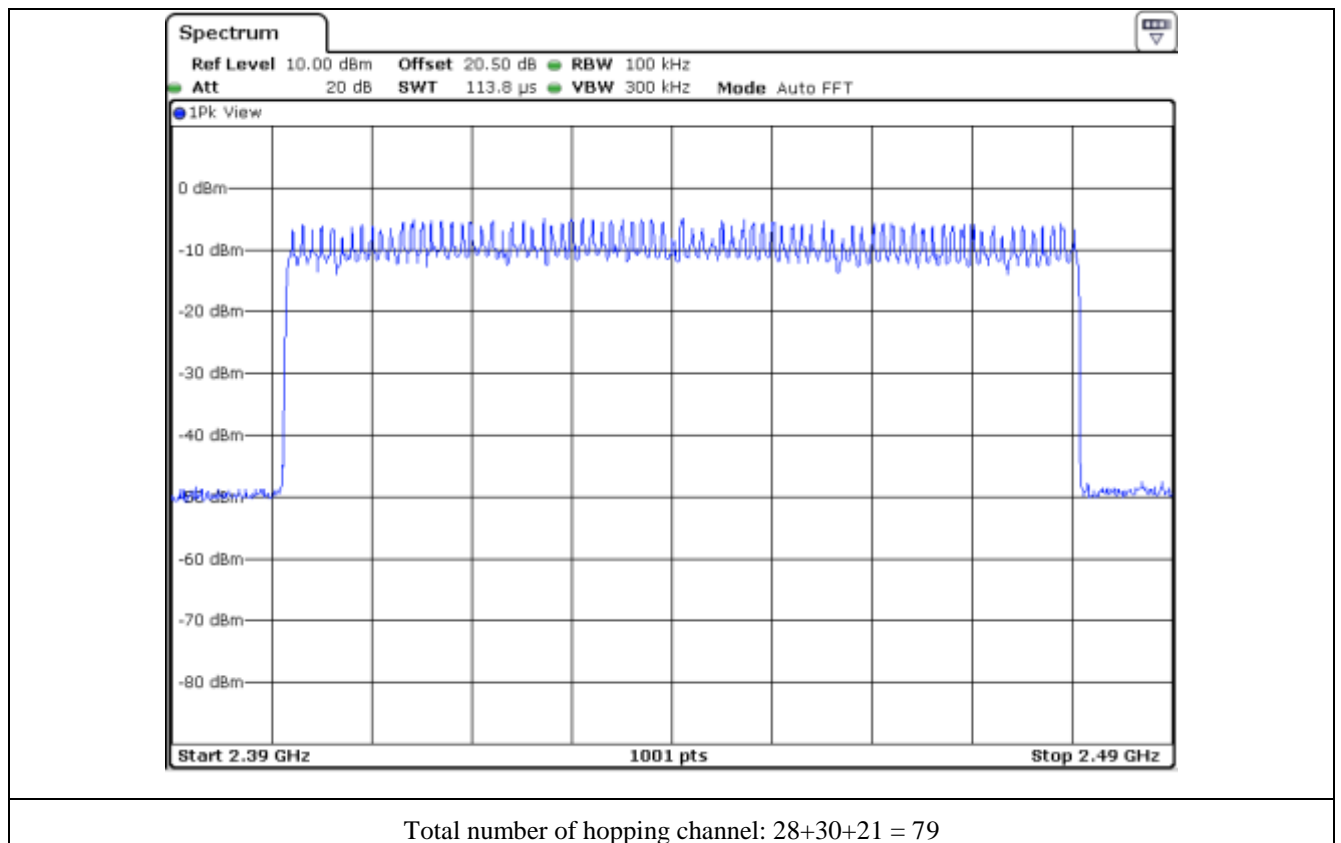
-. Test Date : November 28, 2019

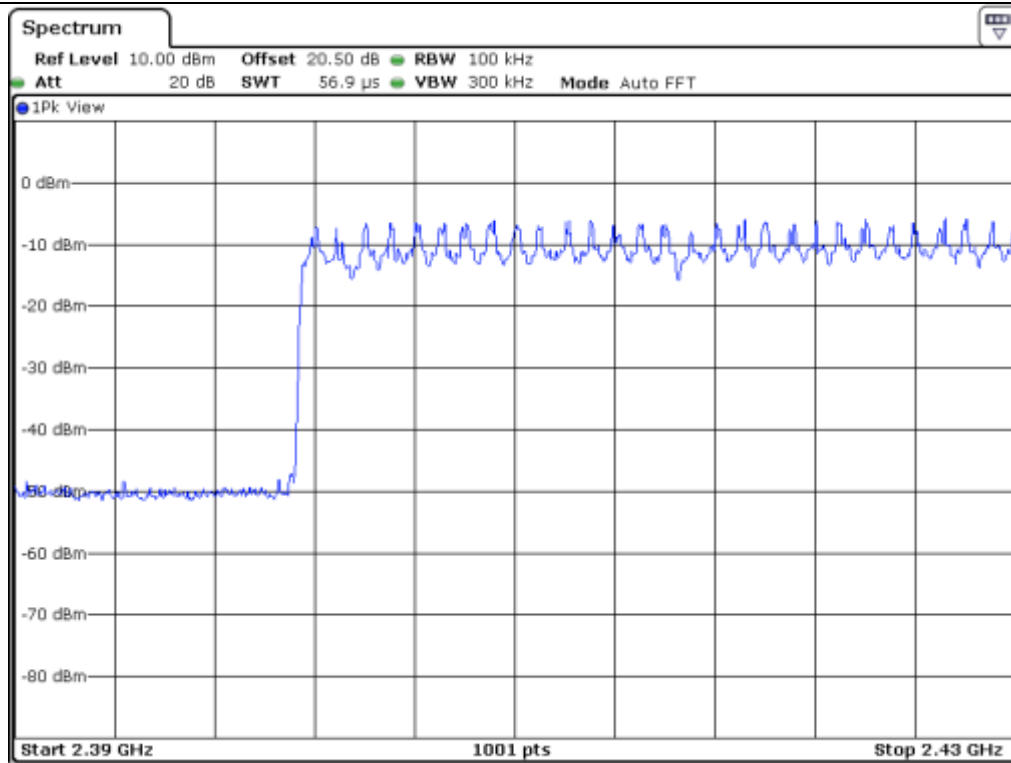
-. Test Result : Pass

| Data Transfer Rate | Measured value (Number) | Limit (Number) | Margin (Number) |
|--------------------|-------------------------|----------------|-----------------|
| 2 Mbps | 79 | Minimum of 15 | 64 |

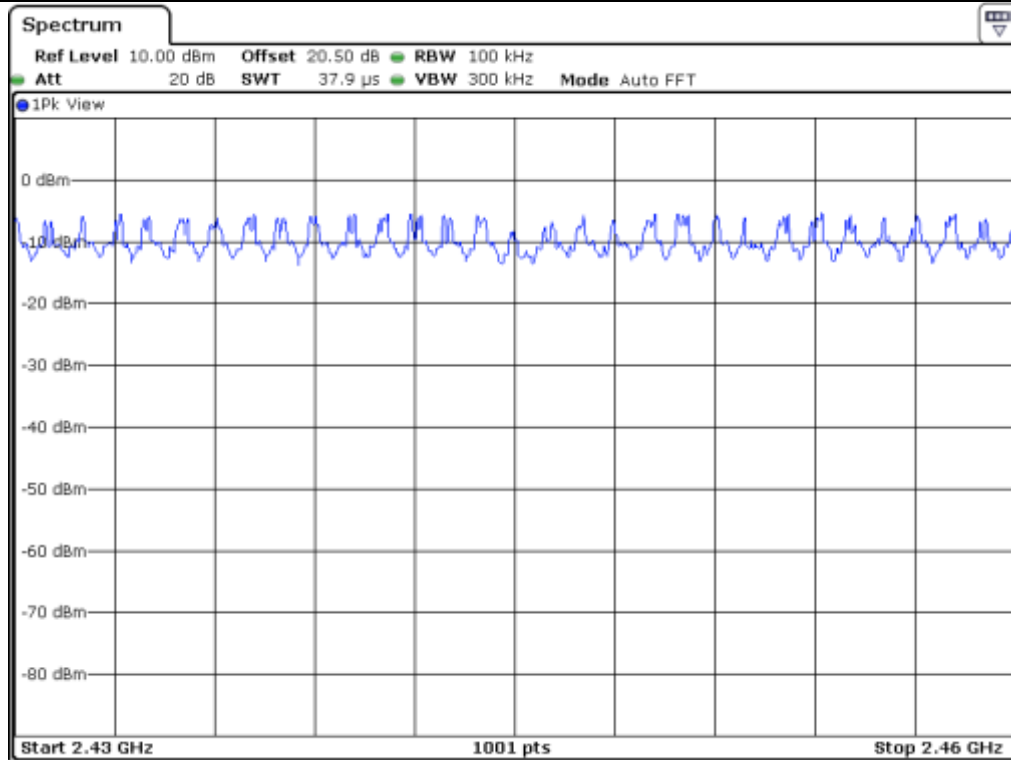


Tested by: Sieon Lee / Assistant Manager

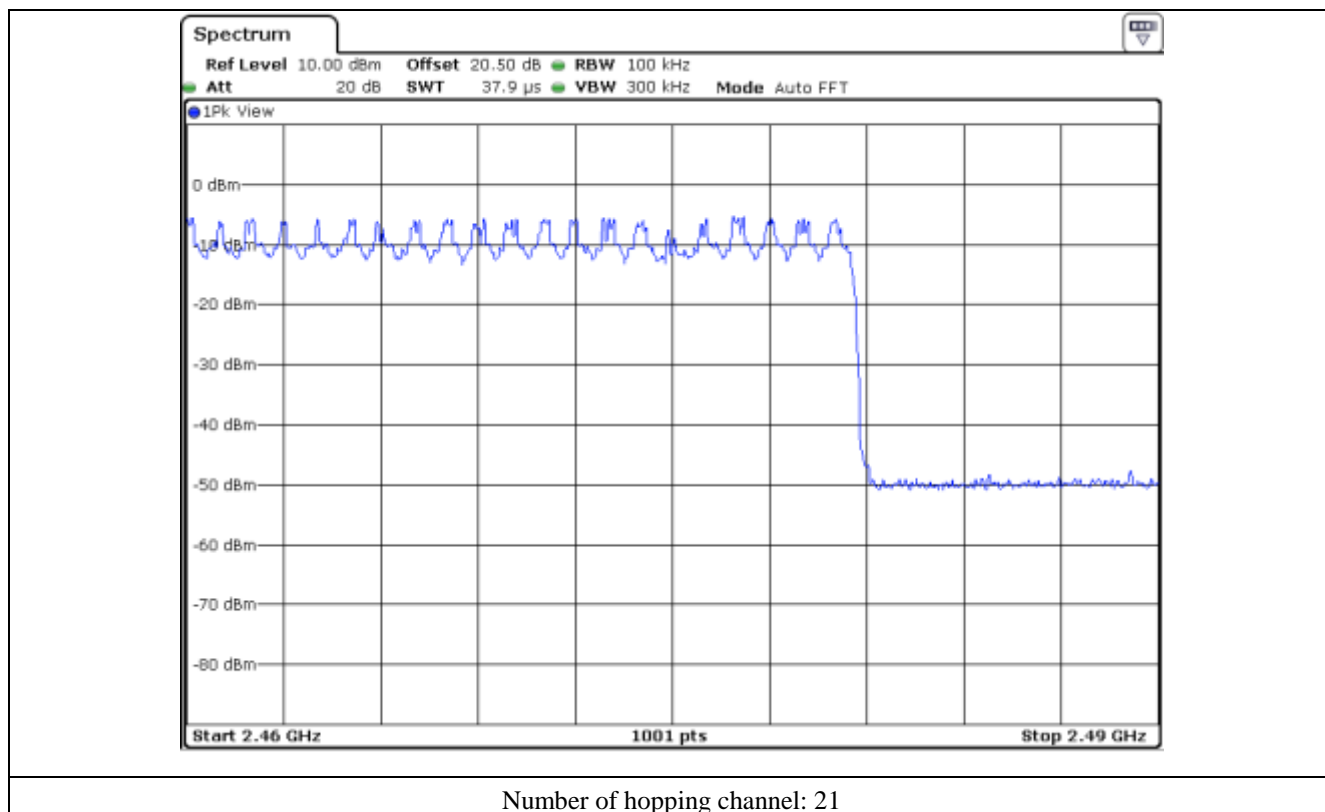




Number of hopping channel: 28



Number of hopping channel: 30



9.6 Test data for 3 Mbps

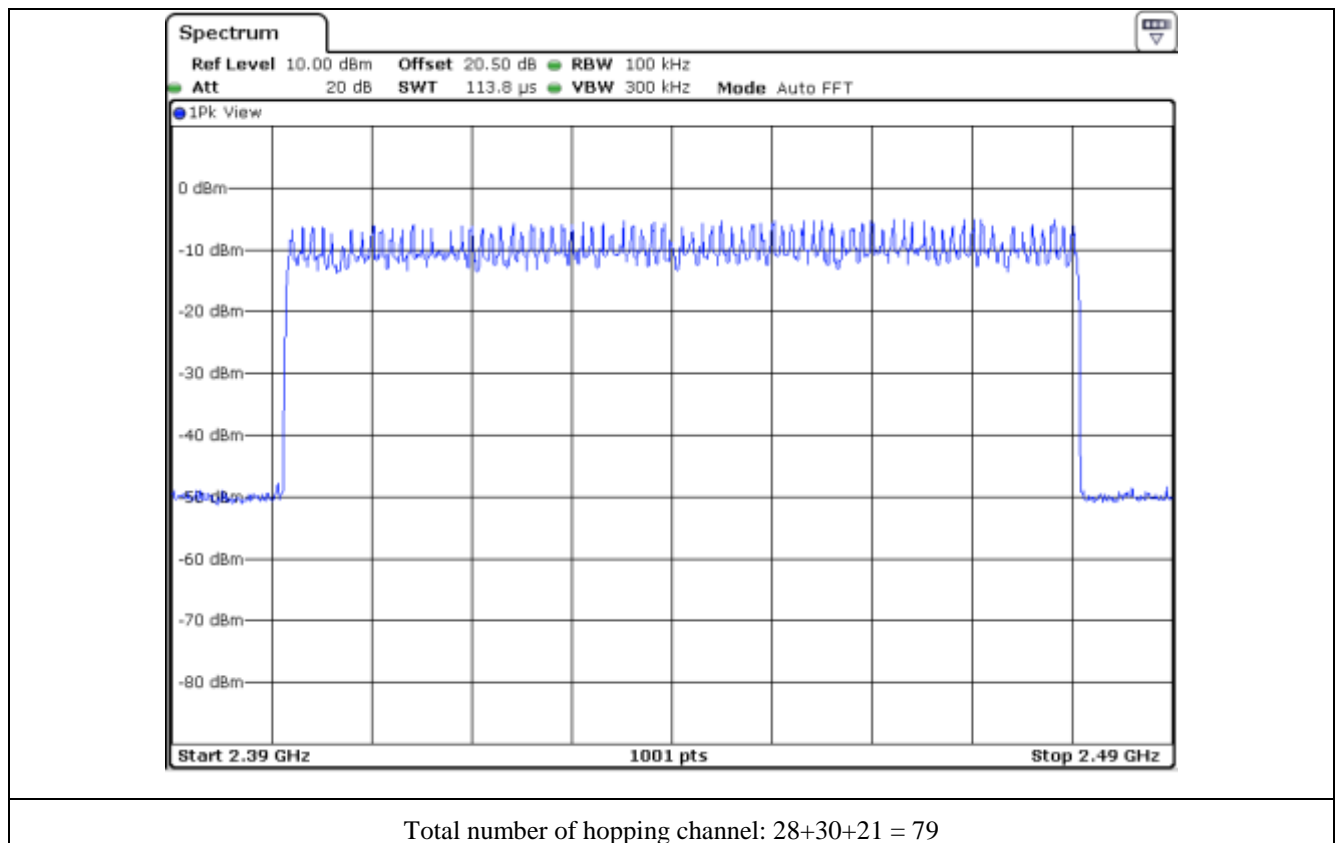
-. Test Date : November 28, 2019

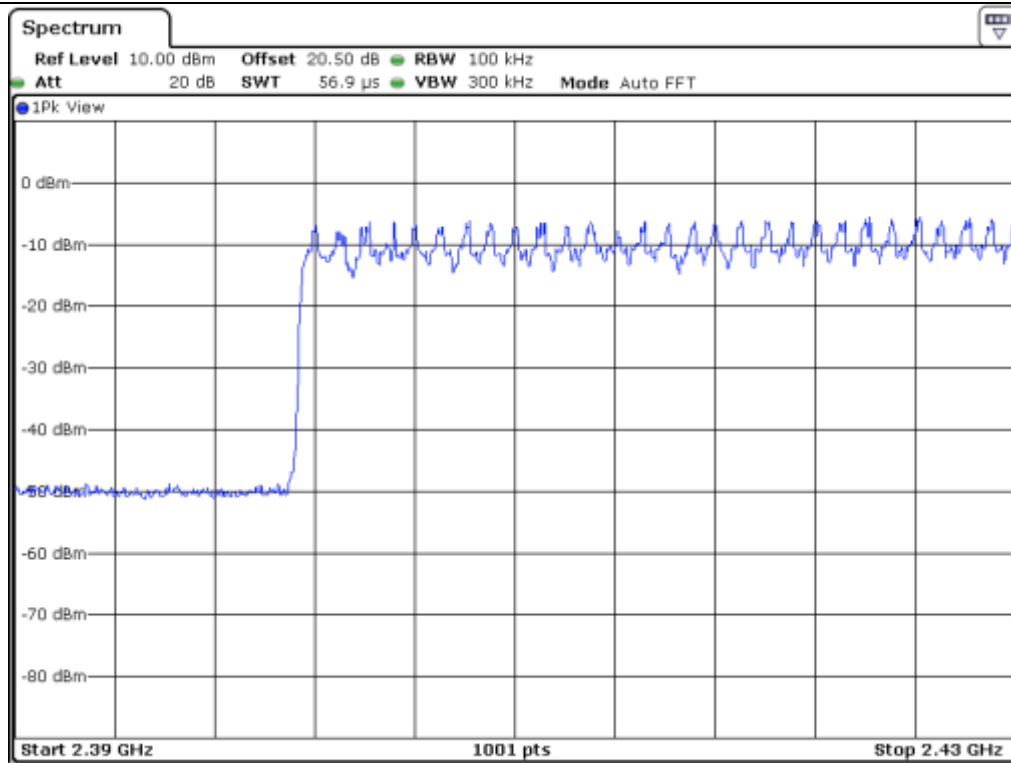
-. Test Result : Pass

| Data Transfer Rate | Measured value (Number) | Limit (Number) | Margin (Number) |
|--------------------|-------------------------|----------------|-----------------|
| 3 Mbps | 79 | Minimum of 15 | 64 |

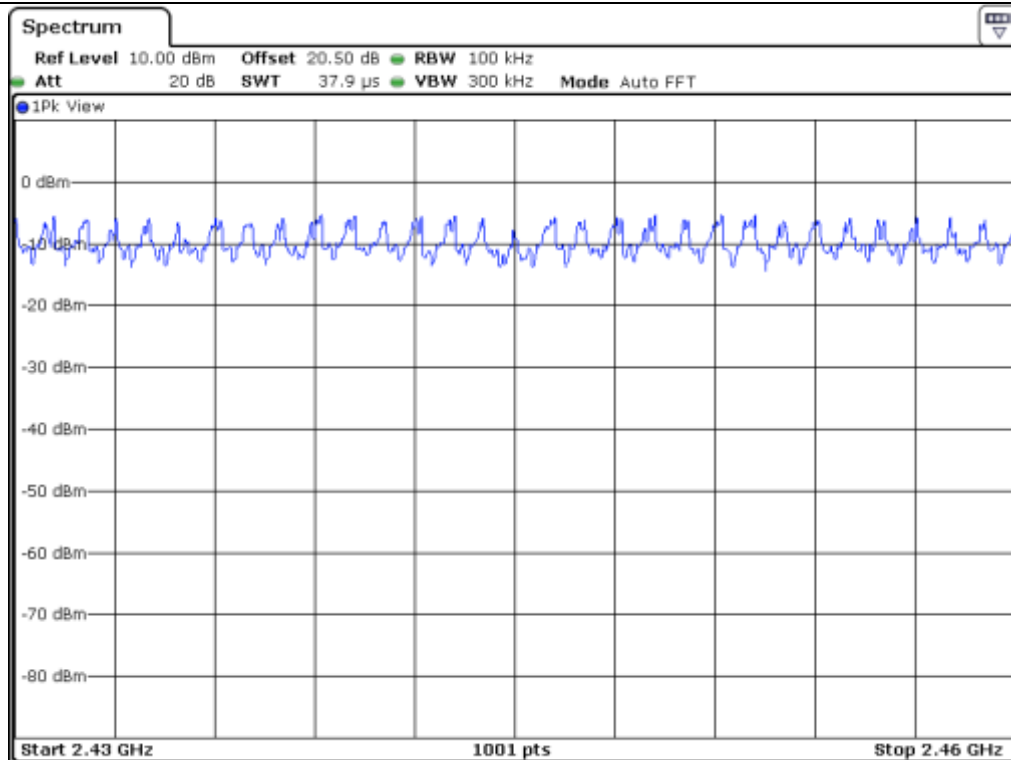


Tested by: Sieon Lee / Assistant Manager

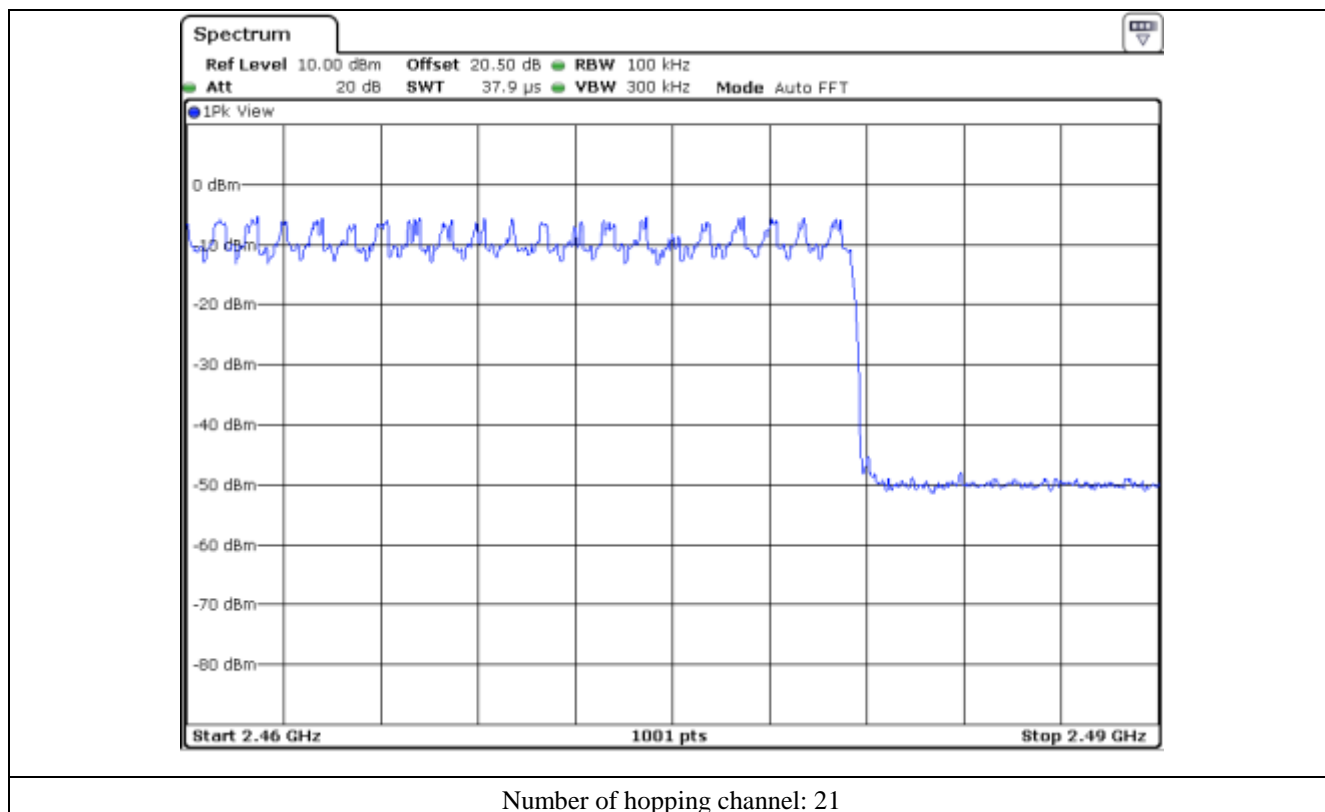




Number of hopping channel: 28



Number of hopping channel: 30



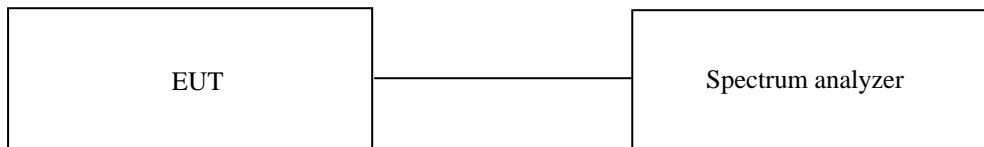
10. TIME OF OCCUPANCY

10.1 Operating environment

Temperature : 24 °C
Relative humidity : 48 % R.H.

10.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The transmitter is set to operate in its normal frequency hopping mode. The center frequency of the spectrum analyzer is set to one of hopping channels near the center of the operating band and span is set to zero Hz. The sweep time is set to display one complete pulse. The mark delta function is used to measure the duration of the pulses.



10.3 Test equipment used

| Model Number | Manufacturer | Description | Serial Number | Last Cal. |
|--------------|-----------------|-----------------|---------------|--------------------|
| ■ - FSV30 | Rohde & Schwarz | Signal Analyzer | 101199 | Mar. 11, 2019 (1Y) |

All test equipment used is calibrated on a regular basis.

10.4 Test data for 1 Mbps

-. Test Date : November 28, 2019

The system makes worst case 1 600 hops per second or 1 time slot has a length of 625 μ s with 79 channels.

For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So The EUT has each channel for 10.13 times per second ($= 1\,600/2/79$) for DH1, and 5.06 times ($= 1\,600/4/79$) for DH3, and 3.38 times ($= 1\,600/6/79$) for DH5.

| Packet Type | Pulse Time (ms) | Hops per second with channels | Period Time (s) | Total Dwell Time (ms) | Limit (ms) | Test Result |
|-------------|--------------------|----------------------------------|--------------------|--------------------------|---------------|-------------|
| DH1 | 0.385 | 10.13 | 31.6 | 123.24 | 400 | PASS |
| DH3 | 1.640 | 5.060 | 31.6 | 262.23 | 400 | |
| DH5 | 2.880 | 3.38 | 31.6 | 307.61 | 400 | |

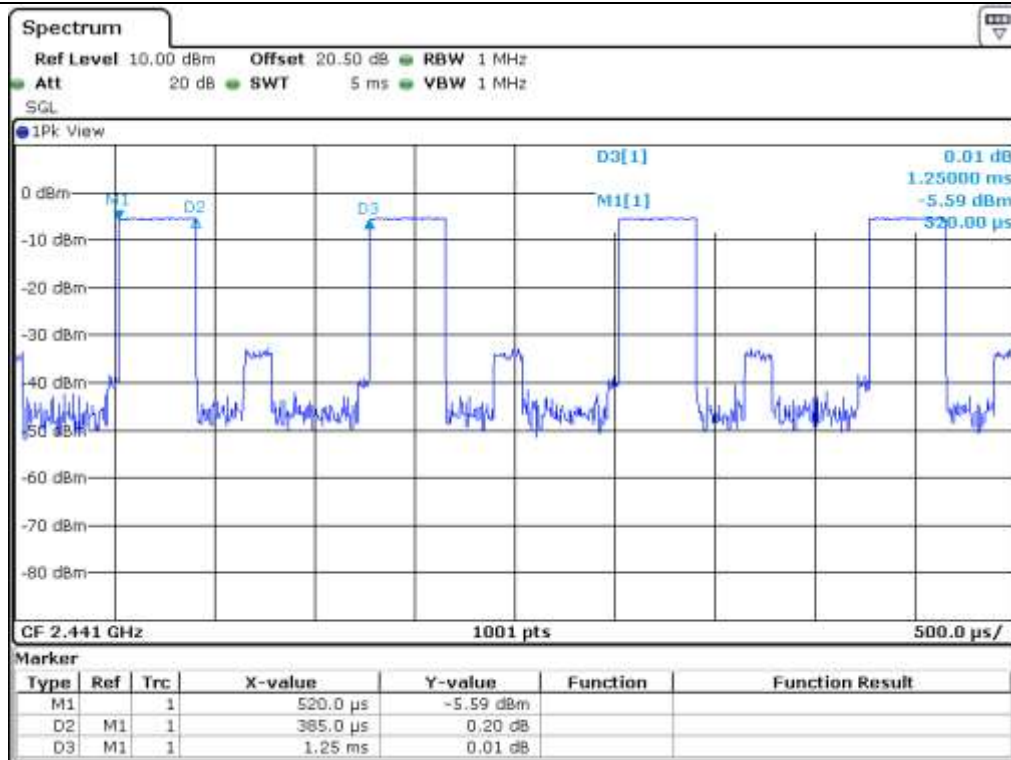
Total dwell time is calculated as following.

Total Dwell Time = Pulse time * Hops per second with channels * period time

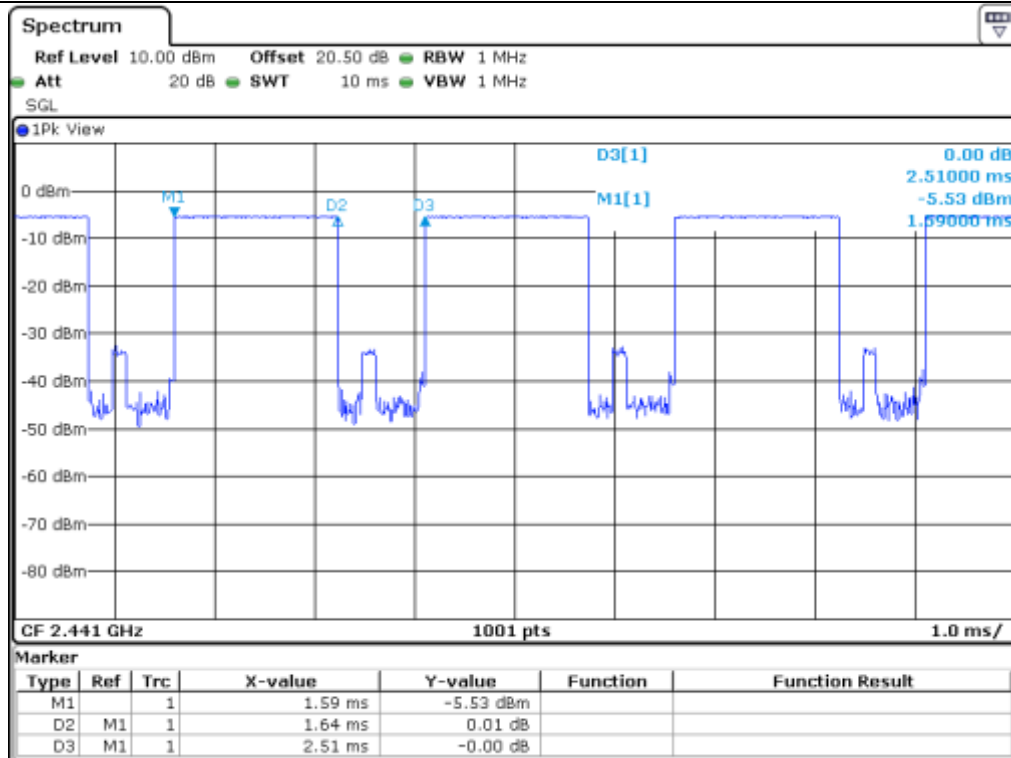
Remark: See next page for an overview sweep performed with peak detector.



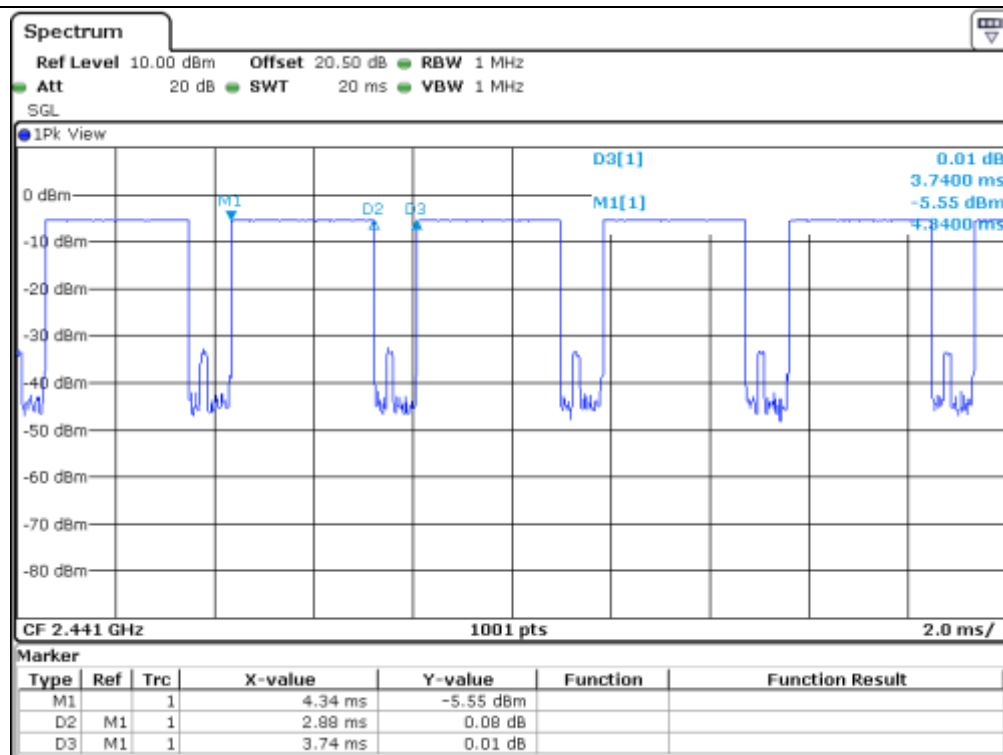
Tested by: Sieon Lee / Assistant Manager



DH1



DH3



DH5

10.5 Test data for 2 Mbps

-. Test Date : November 28, 2019

The system makes worst case 1 600 hops per second or 1 time slot has a length of 625 μ s with 79 channels.

For 2-DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for 2-DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and 2-DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So The EUT has each channel for 10.13 times per second ($= 1\,600/2/79$) for 2-DH1, and 5.06 times ($= 1\,600/4/79$) for 2-DH3, and 3.38 times ($= 1\,600/6/79$) for 2-DH5.

| Packet Type | Pulse Time (ms) | Hops per second with channels | Period Time (s) | Total Dwell Time (ms) | Limit (ms) | Test Result |
|-------------|--------------------|----------------------------------|--------------------|--------------------------|---------------|-------------|
| 2-DH1 | 0.390 | 10.13 | 31.6 | 124.84 | 400 | PASS |
| 2-DH3 | 1.645 | 5.060 | 31.6 | 263.03 | 400 | |
| 2-DH5 | 2.885 | 3.38 | 31.6 | 308.14 | 400 | |

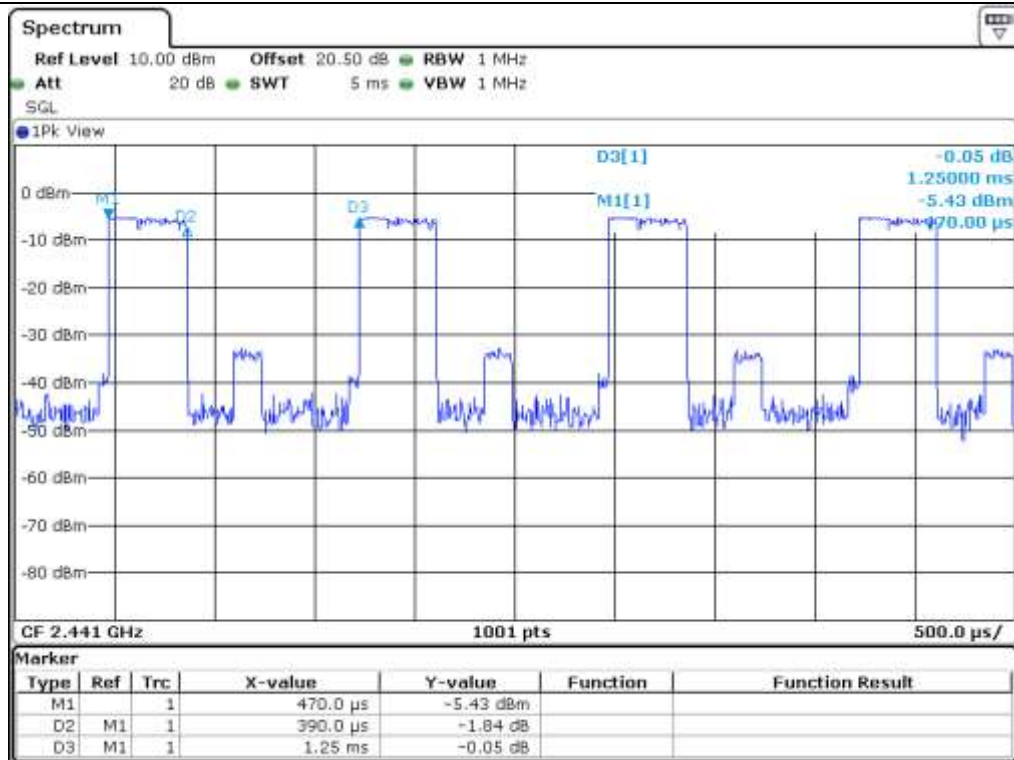
Total dwell time is calculated as following.

Total Dwell Time = Pulse time * Hops per second with channels * period time

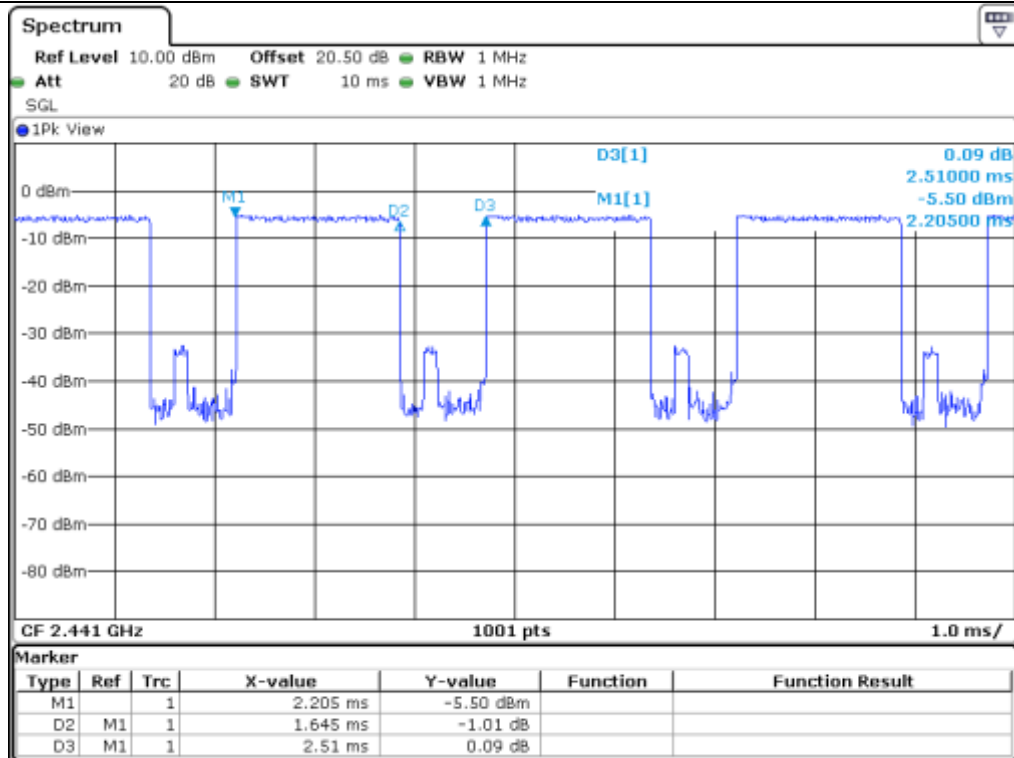
Remark: See next page for an overview sweep performed with peak detector.



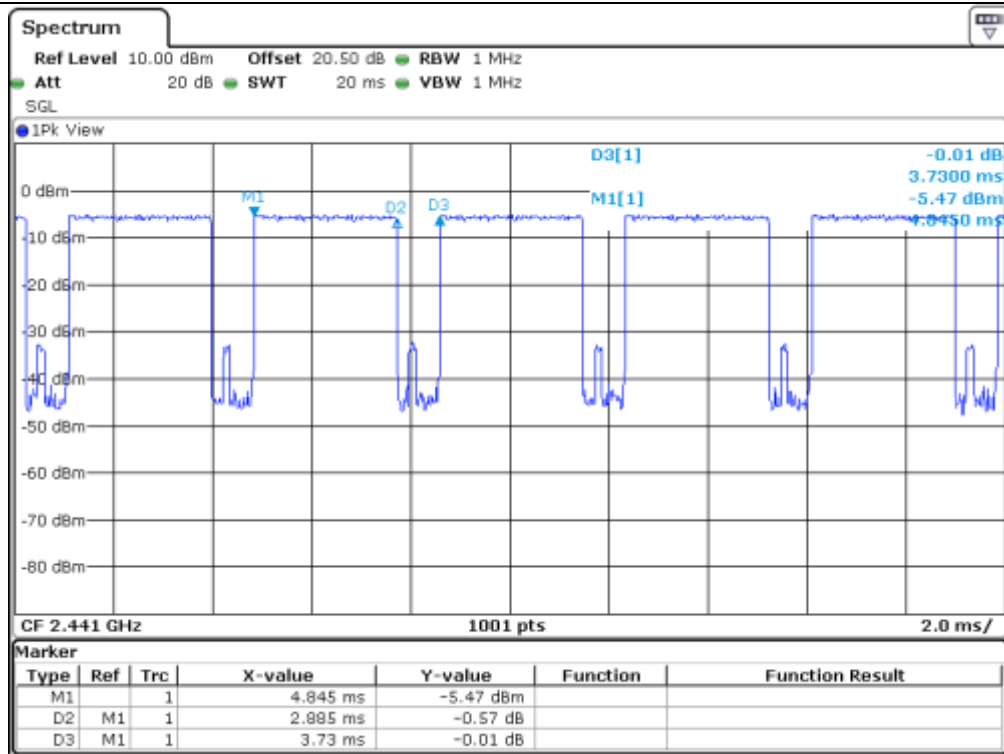
Tested by: Sieon Lee / Assistant Manager



2-DH1



2-DH3



2-DH5

10.6 Test data for 3 Mbps

-. Test Date : November 28, 2019

The system makes worst case 1 600 hops per second or 1 time slot has a length of 625 μ s with 79 channels.

For 3-DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for 3-DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and 3-DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So The EUT has each channel for 10.13 times per second ($= 1\,600/2/79$) for 3-DH1, and 5.06 times ($= 1\,600/4/79$) for 3-DH3, and 3.38 times ($= 1\,600/6/79$) for 3-DH5.

| Packet Type | Pulse Time (ms) | Hops per second with channels | Period Time (s) | Total Dwell Time (ms) | Limit (ms) | Test Result |
|-------------|--------------------|----------------------------------|--------------------|--------------------------|---------------|-------------|
| 3-DH1 | 0.385 | 10.13 | 31.6 | 123.24 | 400 | PASS |
| 3-DH3 | 1.645 | 5.060 | 31.6 | 263.03 | 400 | |
| 3-DH5 | 2.885 | 3.38 | 31.6 | 308.14 | 400 | |

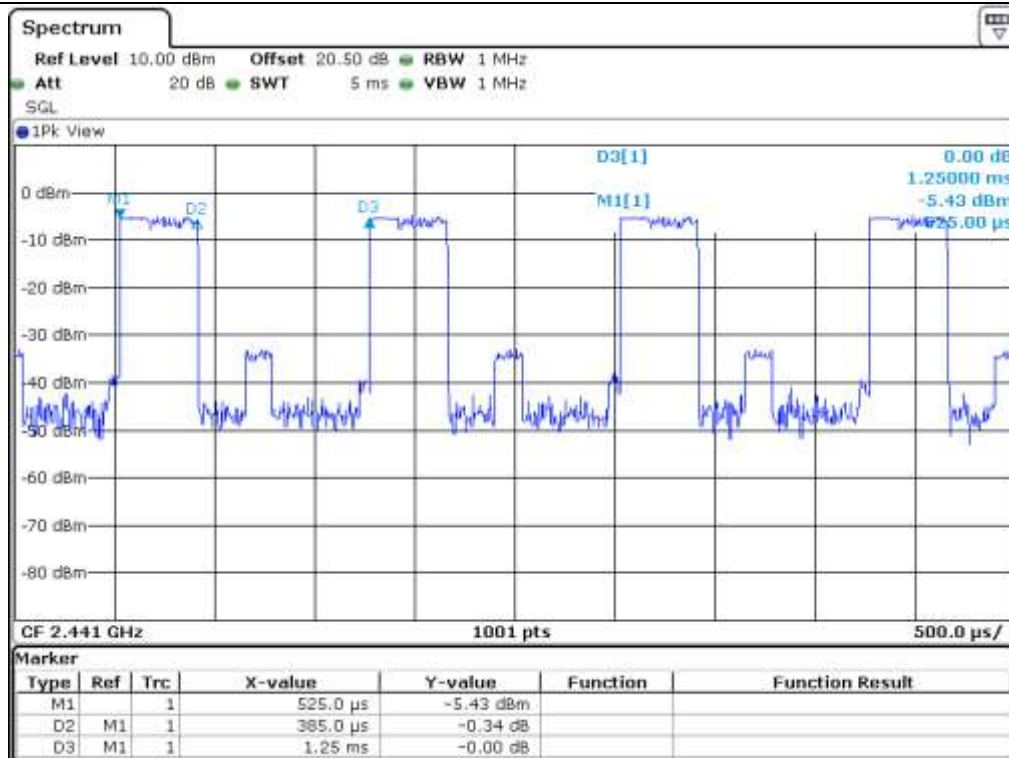
Total dwell time is calculated as following.

Total Dwell Time = Pulse time * Hops per second with channels * period time

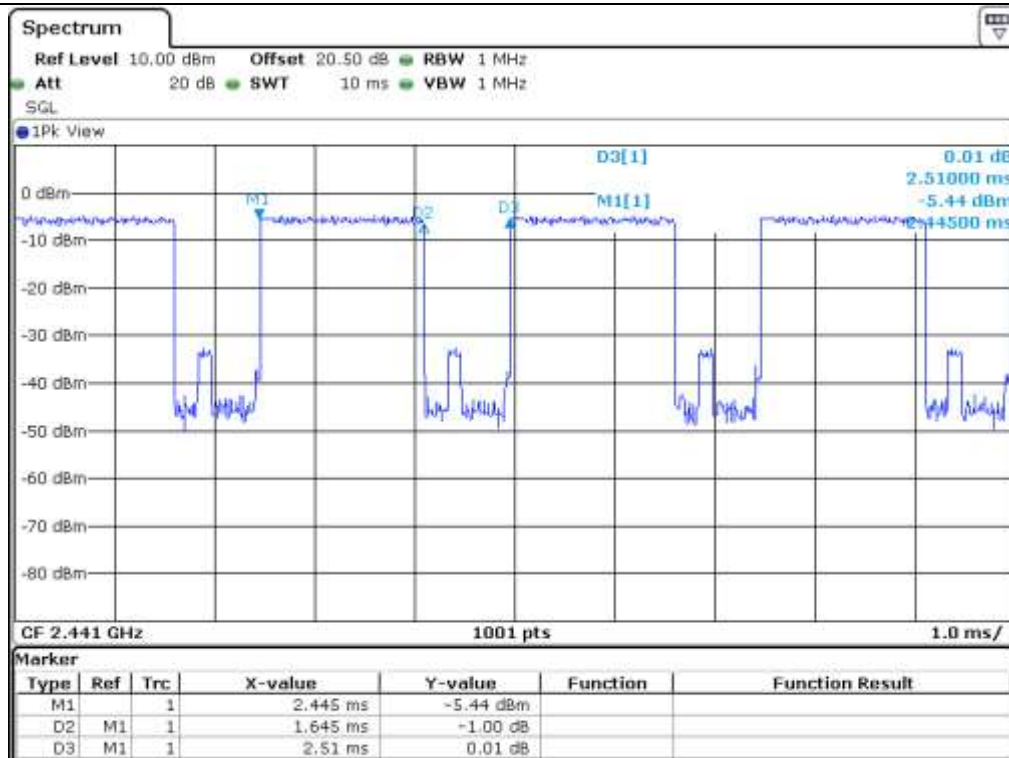
Remark: See next page for an overview sweep performed with peak detector.



Tested by: Sieon Lee / Assistant Manager



3-DH1



3-DH3



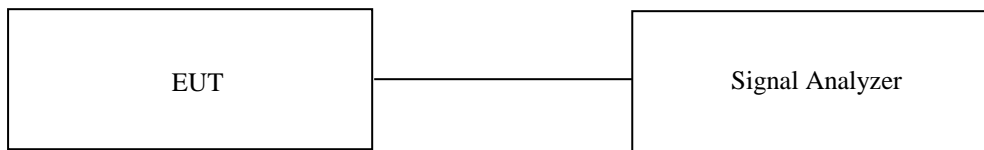
11. MAXIMUM PEAK OUTPUT POWER

11.1 Operating environment

Temperature : 24 °C
Relative humidity : 48 % R.H

11.2 Test set-up

The maximum peak output power was measured with the spectrum analyzer connected to the antenna output of the EUT.
The EUT was operating in transmit mode at the appropriate center frequency.



11.3 Test equipment used

| Model Number | Manufacturer | Description | Serial Number | Last Cal. |
|--------------|-----------------|-----------------|---------------|--------------------|
| ■ - FSV30 | Rohde & Schwarz | Signal Analyzer | 101199 | Mar. 11, 2019 (1Y) |

All test equipment used is calibrated on a regular basis.

11.4 Test data for 1 Mbps

-. Test Date : November 28, 2019

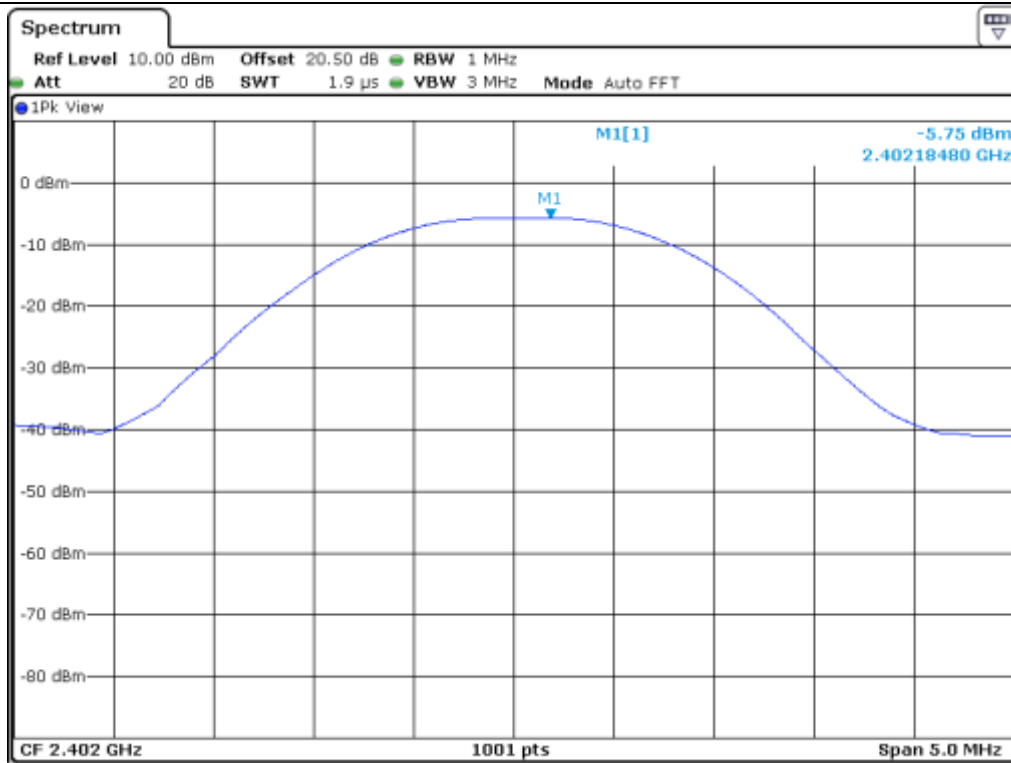
-. Test Result : Pass

| CHANNEL | FREQUENCY (MHz) | MEASURED VLAUE (dBm) | LIMIT (dBm) | MARGIN (dB) |
|---------|--------------------|-------------------------|----------------|----------------|
| LOW | 2 402 | -5.75 | 21.00 | 26.75 |
| MIDDLE | 2 441 | -4.89 | 21.00 | 25.89 |
| HIGH | 2 480 | -4.68 | 21.00 | 25.68 |

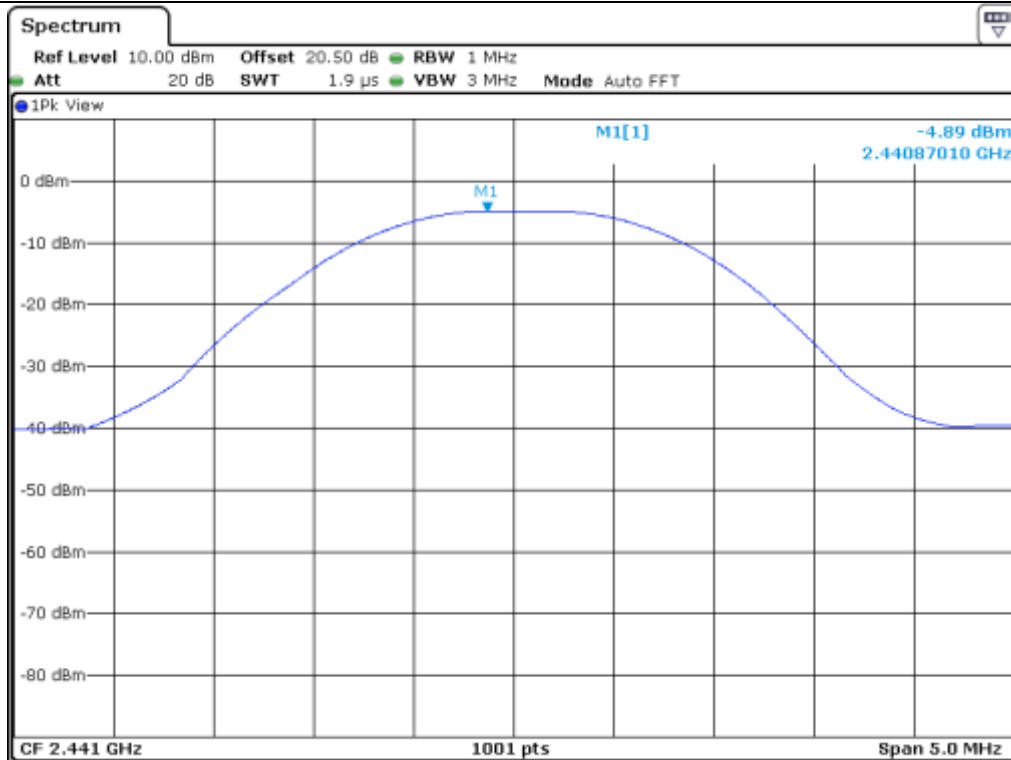
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



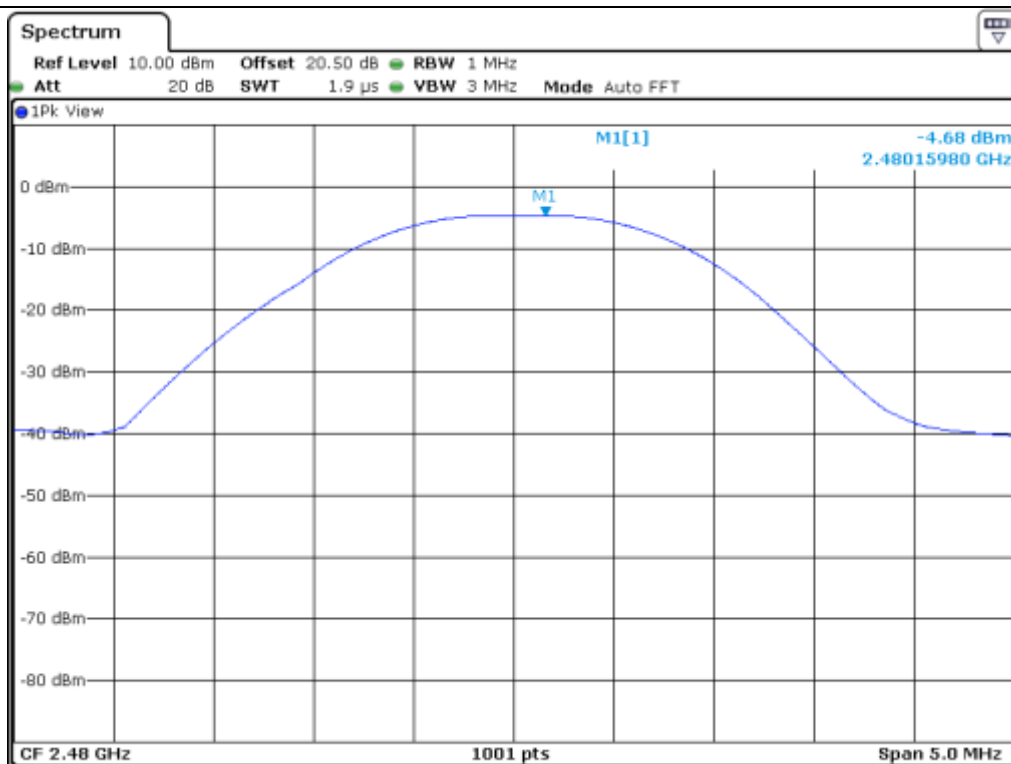
Tested by: Sieon Lee / Assistant Manager



Low Channel



Middle Channel



High Channel

11.5 Test data for 2 Mbps

-. Test Date : November 28, 2019

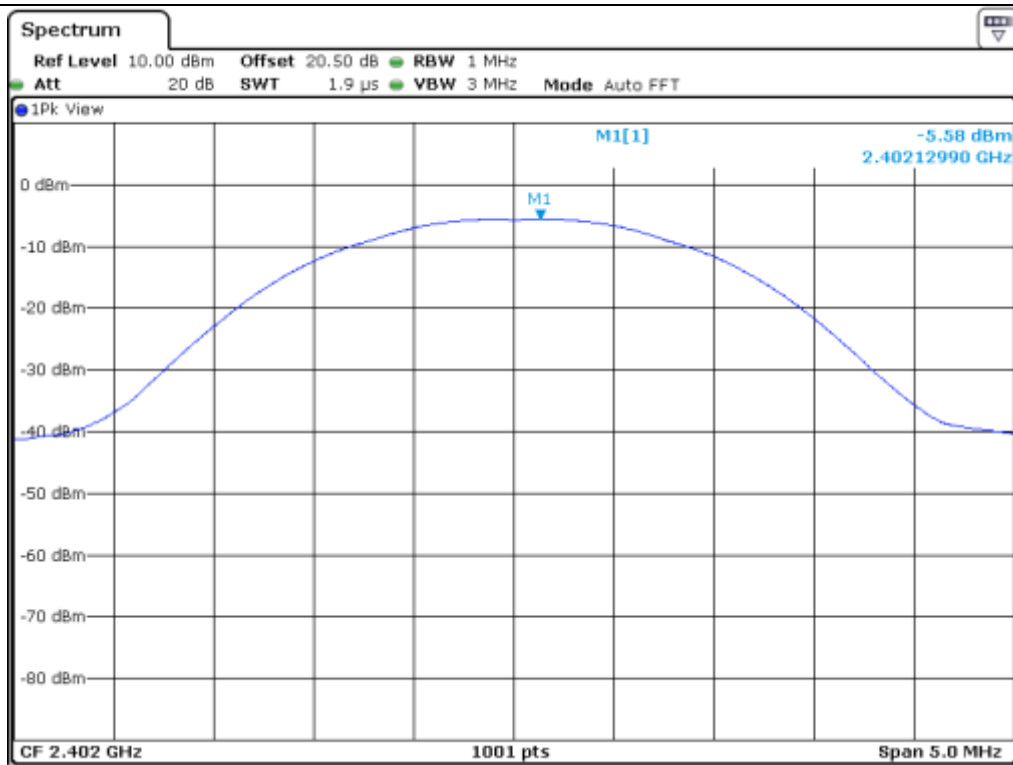
-. Test Result : Pass

| CHANNEL | FREQUENCY (MHz) | MEASURED VLAUE (dBm) | LIMIT (dBm) | MARGIN (dB) |
|---------|--------------------|-------------------------|----------------|----------------|
| LOW | 2 402 | -5.58 | 21.00 | 26.58 |
| MIDDLE | 2 441 | -4.67 | 21.00 | 25.67 |
| HIGH | 2 480 | -4.37 | 21.00 | 25.37 |

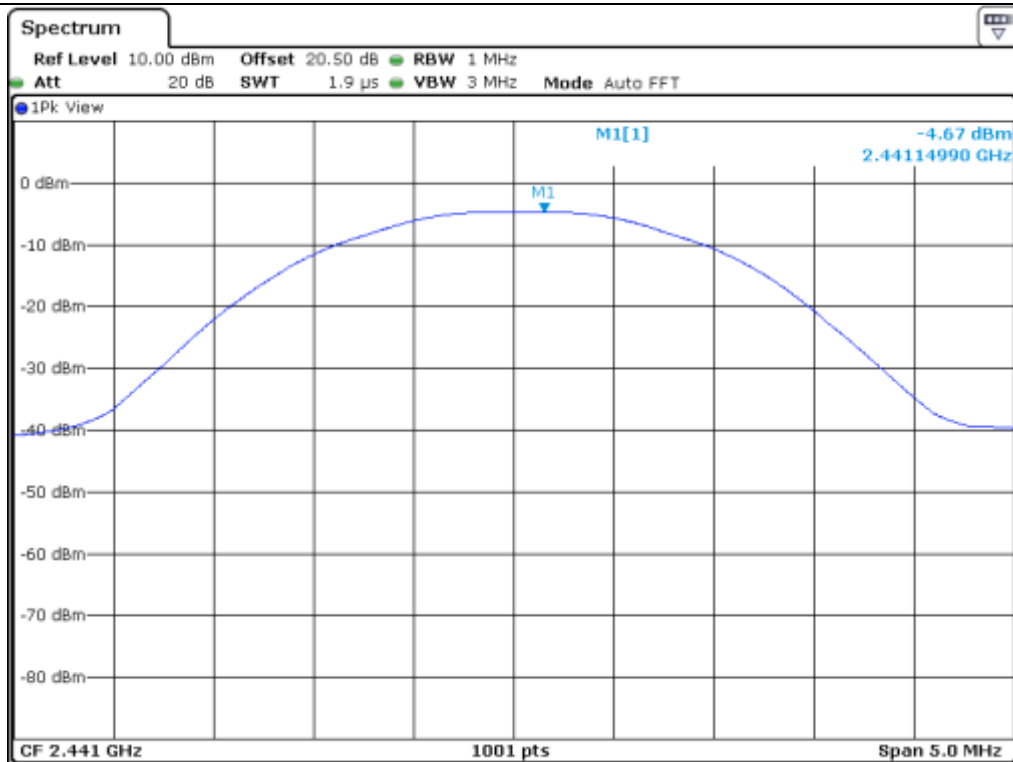
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



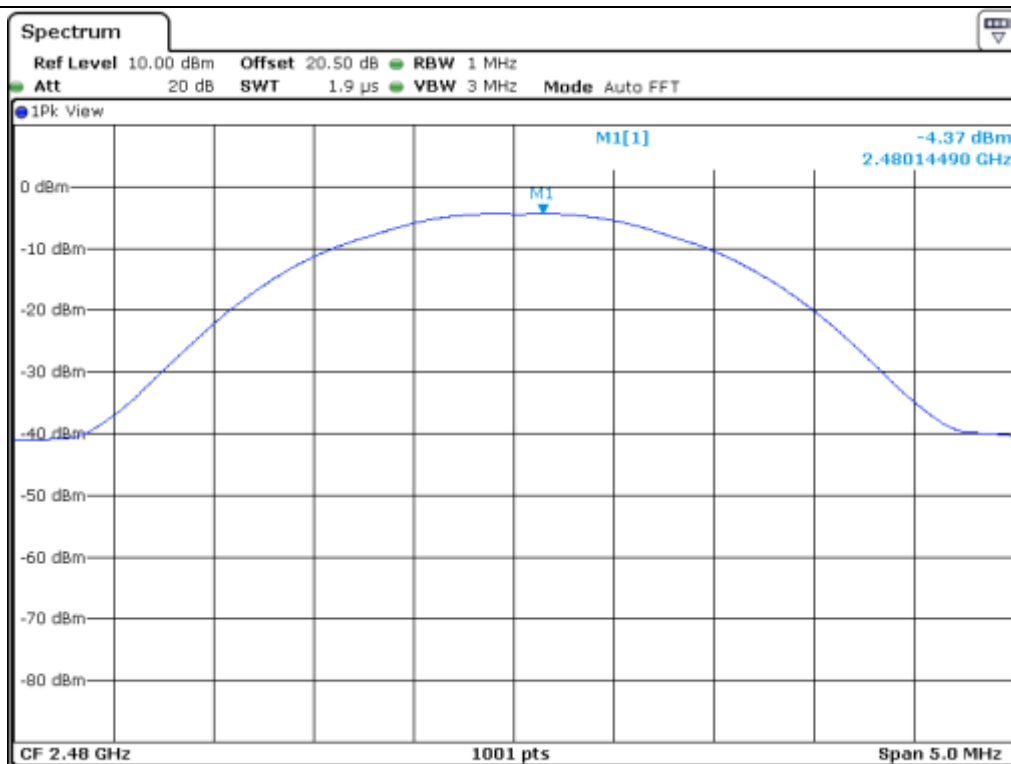
Tested by: Sieon Lee / Assistant Manager



Low Channel



Middle Channel



High Channel

11.6 Test data for 3 Mbps

-. Test Date : November 28, 2019

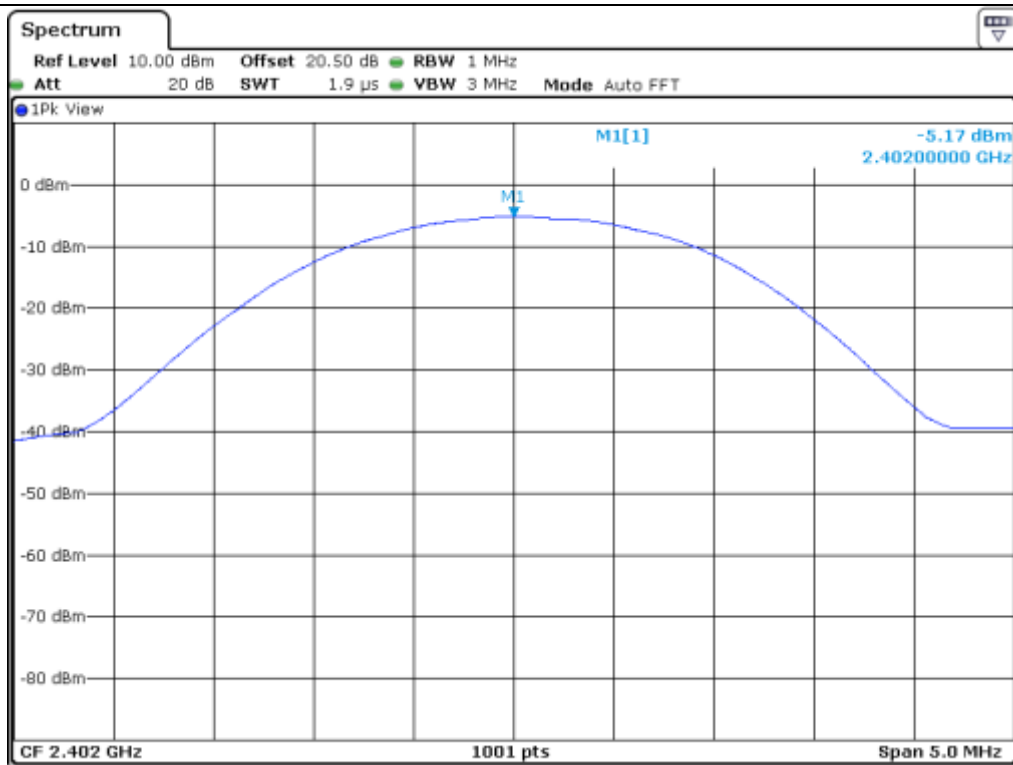
-. Test Result : Pass

| CHANNEL | FREQUENCY (MHz) | MEASURED VLAUE (dBm) | LIMIT (dBm) | MARGIN (dB) |
|---------|--------------------|-------------------------|----------------|----------------|
| LOW | 2 402 | -5.17 | 21.00 | 26.17 |
| MIDDLE | 2 441 | -4.31 | 21.00 | 25.31 |
| HIGH | 2 480 | -4.03 | 21.00 | 25.03 |

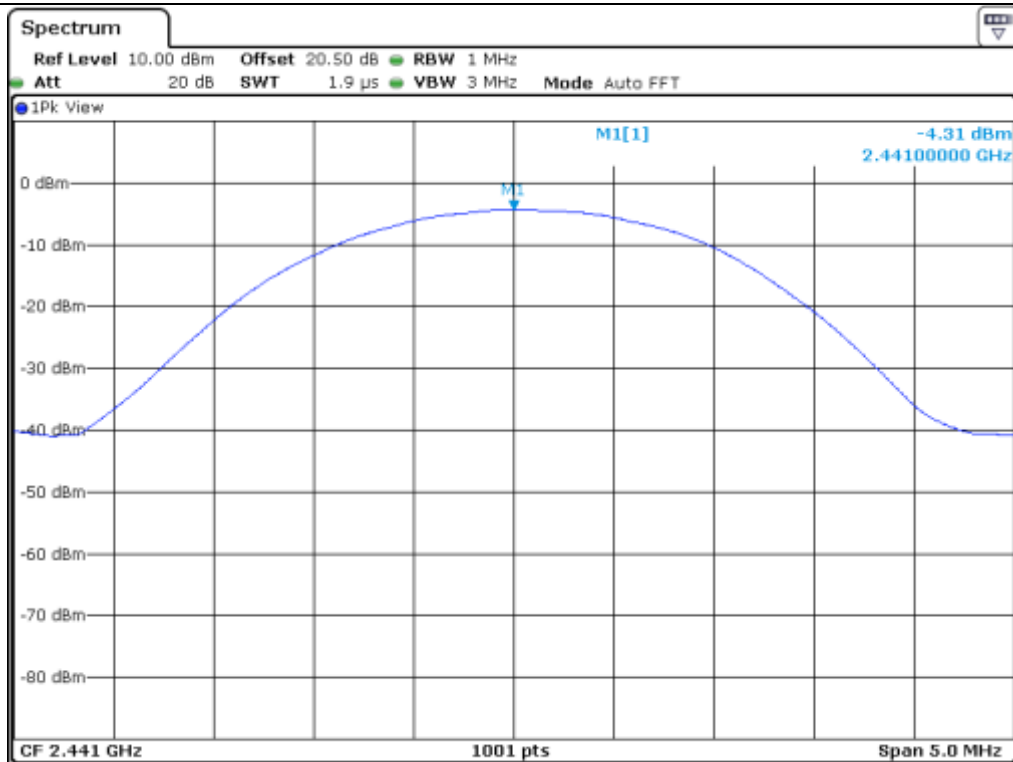
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



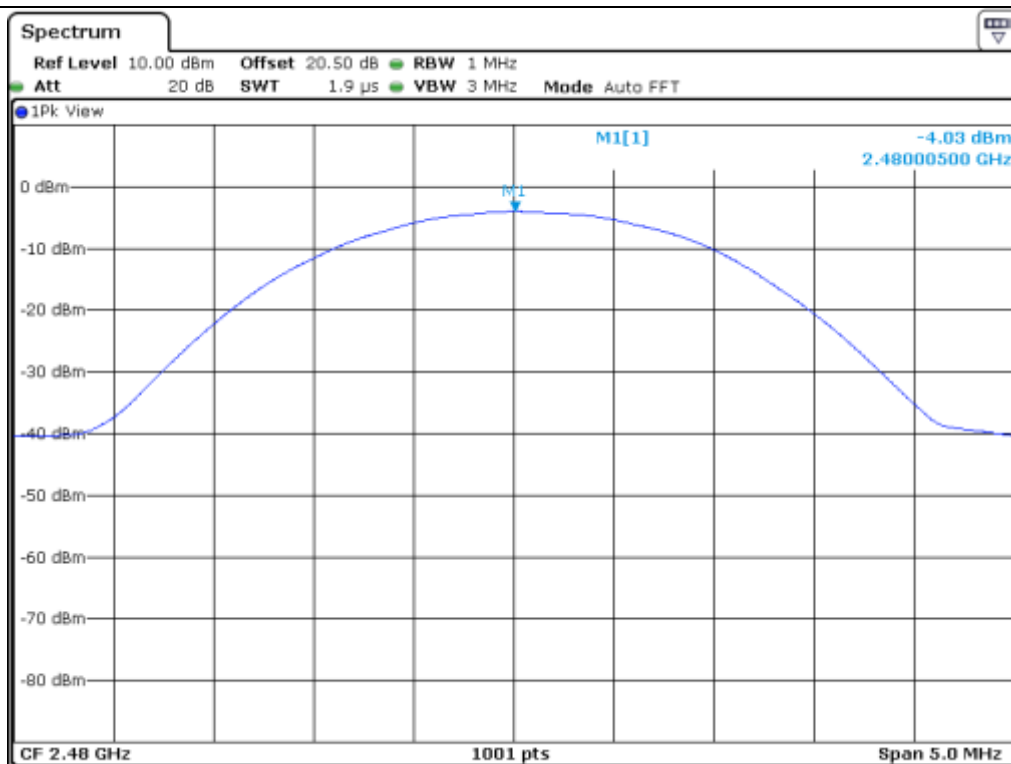
Tested by: Sieon Lee / Assistant Manager



Low Channel



Middle Channel



High Channel

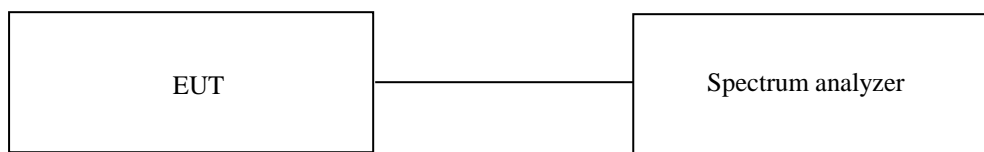
12. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

12.1 Operating environment

Temperature : 24 °C
Relative humidity : 48 % R.H

12.2 Test set-up for conducted measurement

The antenna output of the EUT was connected to the spectrum analyzer. The resolution and video bandwidth is set to 100 kHz, and peak detection was used.



12.3 Test set-up for radiated measurement

The radiated emissions measurements were performed on the 3 m, open-field test site. The EUT was placed on a non-conductive turntable approximately 0.8 m above the ground plane.

The frequency spectrum from 30 kHz to 26.5 GHz was scanned and maximum emission levels at each frequency recorded. The system was rotated 360°, and the antenna was varied in the height between 1.0 m and 4.0 ms in order to determine the maximum emission levels. This procedure was performed for horizontal and vertical polarization of the receiving antenna.

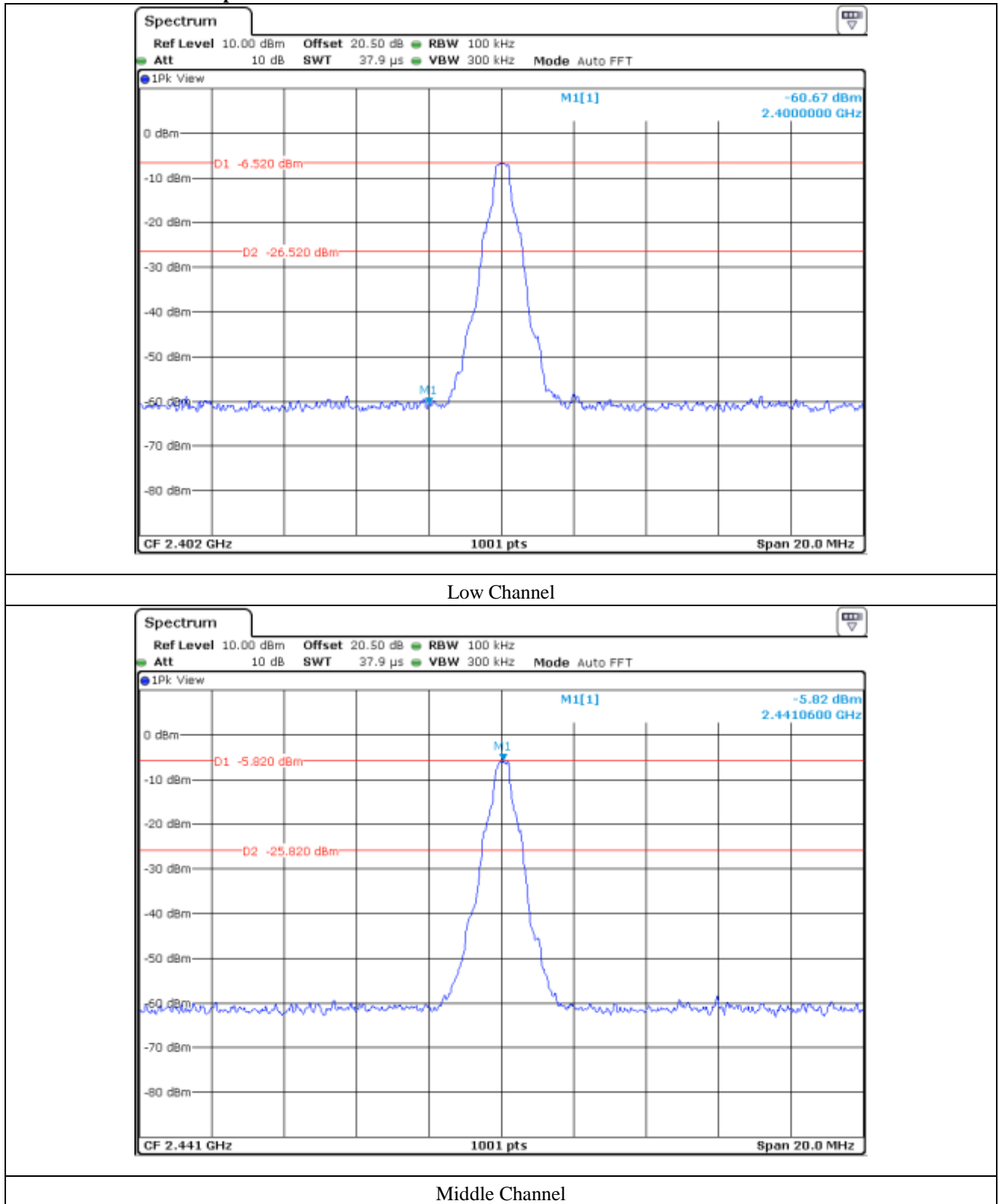
12.4 Test equipment used

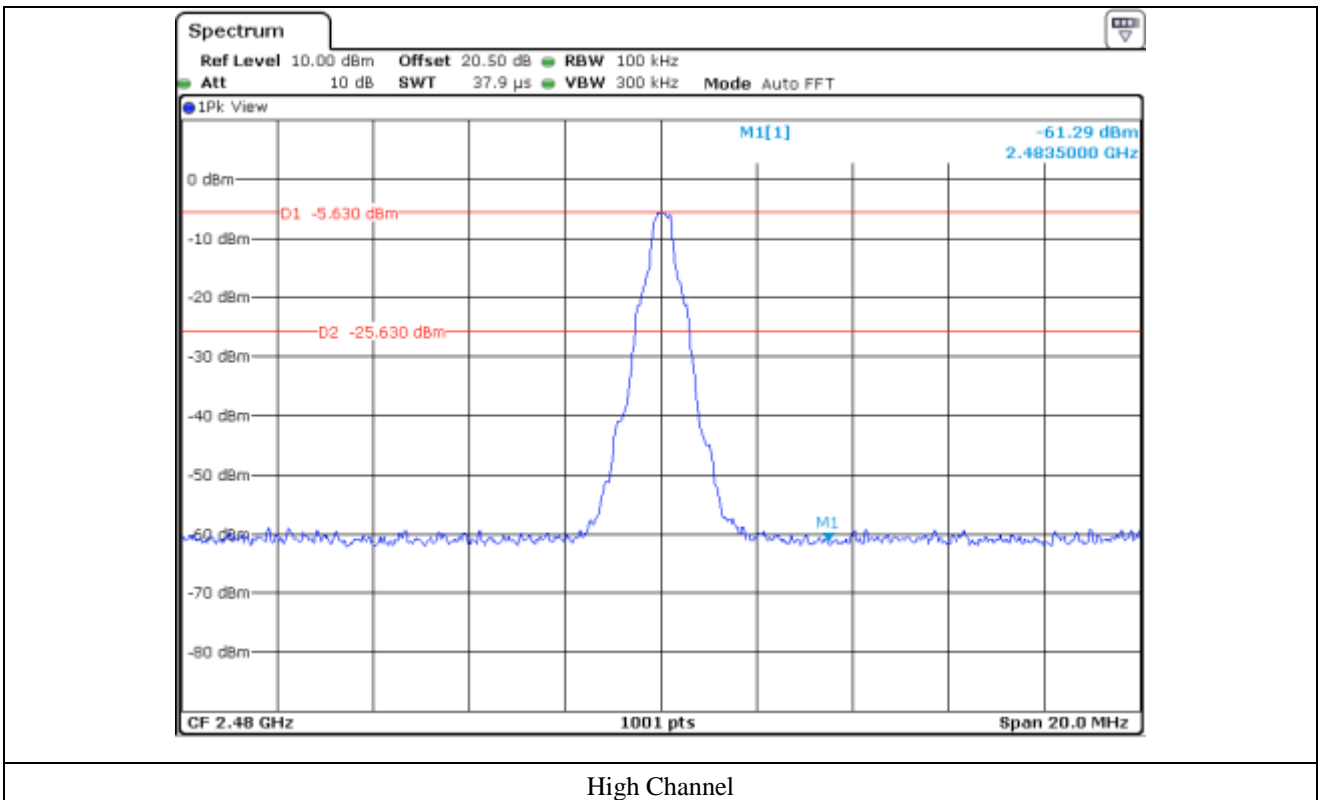
| | Model Number | Manufacturer | Description | Serial Number | Last Cal. (Interval) |
|---------------------------------------|--------------|-------------------|-------------------------------|---------------|----------------------|
| <input type="checkbox"/> - | ESCI | Rohde & Schwarz | EMI Test Receiver | 101012 | Oct. 22, 2019 (1Y) |
| <input checked="" type="checkbox"/> - | ESR | Rohde & Schwarz | EMI Test Receiver | 101470 | Oct. 22, 2019 (1Y) |
| <input checked="" type="checkbox"/> - | 310N | Sonoma Instrument | AMPLIFIER | 312544 | Mar. 18, 2019 (1Y) |
| <input type="checkbox"/> - | FSV30 | Rohde & Schwarz | Signal Analyzer | 101200 | Jul. 24, 2019 (1Y) |
| <input checked="" type="checkbox"/> - | BBV 9718 B | Schwarzbeck | Broadband Pre-Amplifier | 009 | Mar. 20, 2019 (1Y) |
| <input checked="" type="checkbox"/> - | MA240 | HD GmbH | Antenna Master | N/A | N/A |
| <input type="checkbox"/> - | HD100 | HD GmbH | Position Controller | N/A | N/A |
| <input checked="" type="checkbox"/> - | DS420S | HD GmbH | Turn Table | N/A | N/A |
| <input type="checkbox"/> - | FMZB 1513 | Schwarzbeck | LOOP ANTENNA | 1513-235 | May. 13, 2018 (2Y) |
| <input checked="" type="checkbox"/> - | VULB9163 | Schwarzbeck | TRILOG Broadband Antenna | 9163-255 | Jun. 05, 2018 (2Y) |
| <input checked="" type="checkbox"/> - | BBHA9120D | Schwarzbeck | Horn Antenna | BBHA9120D295 | Jul. 16, 2019 (1Y) |
| <input type="checkbox"/> - | BBHA9170 | Schwarzbeck | Horn Antenna | BBHA9170178 | Jan. 16, 2019 (1Y) |
| <input type="checkbox"/> - | 83051A | Agilent | Microwave System Preamplifier | 3950M00201 | Mar. 12, 2019 (1Y) |

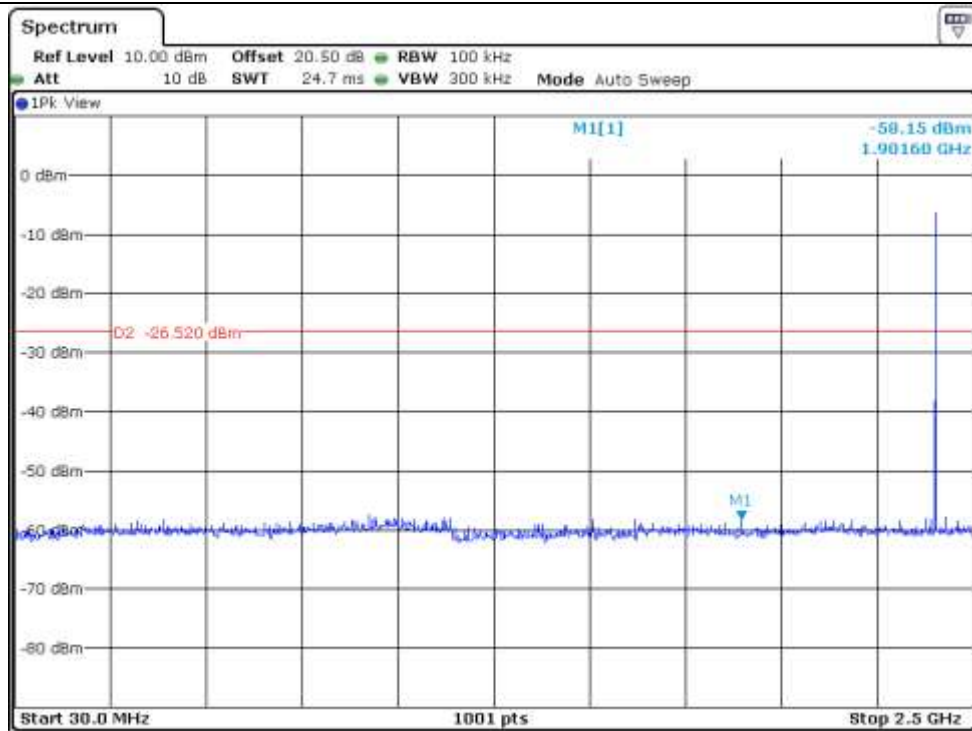
All test equipment used is calibrated on a regular basis.

12.5 Test data for conducted emission

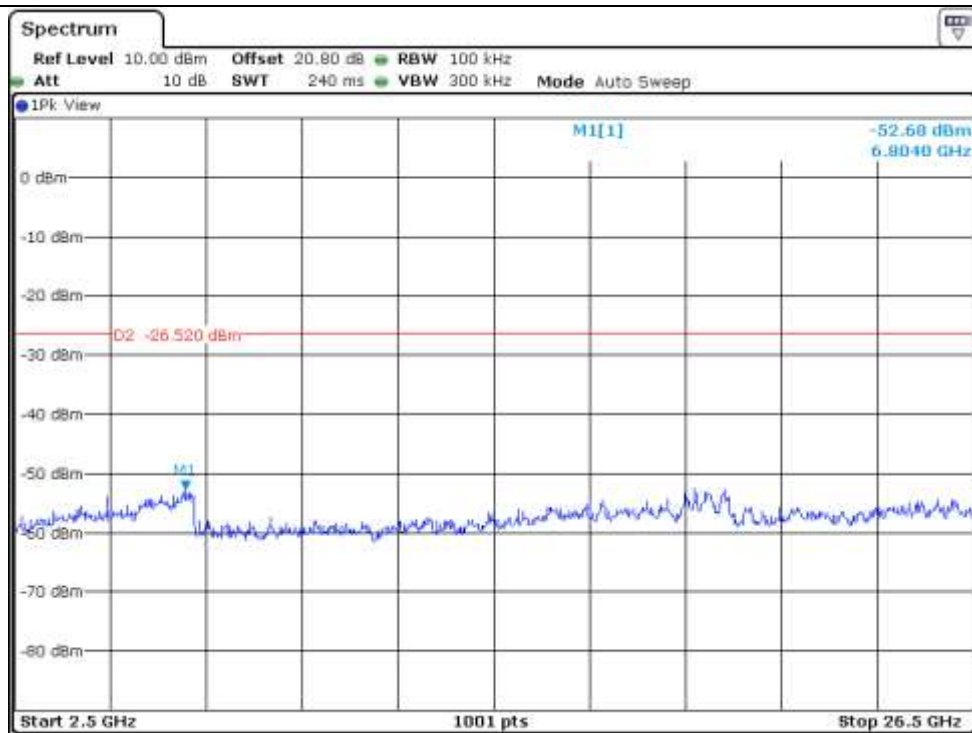
12.5.1 Test data for 1 Mbps



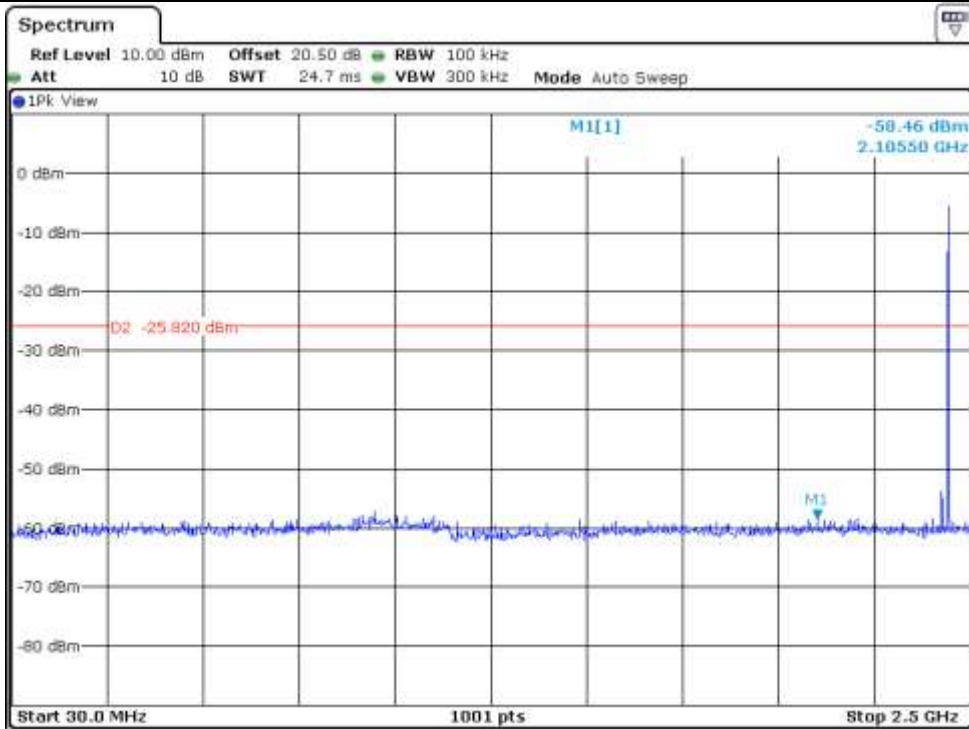




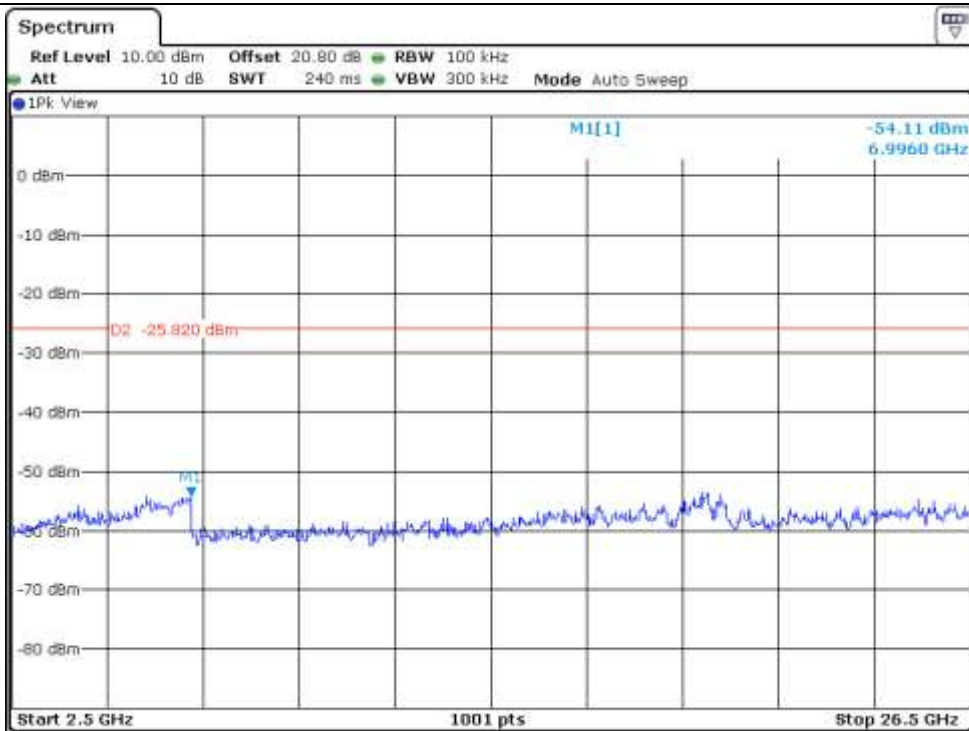
Low Channel



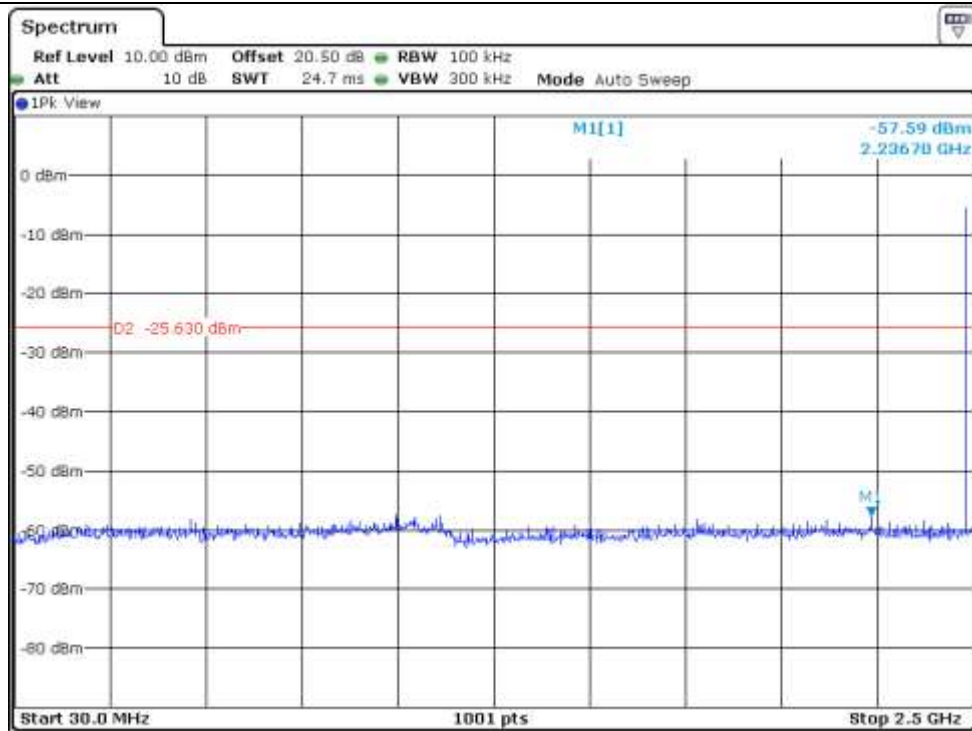
Low Channel



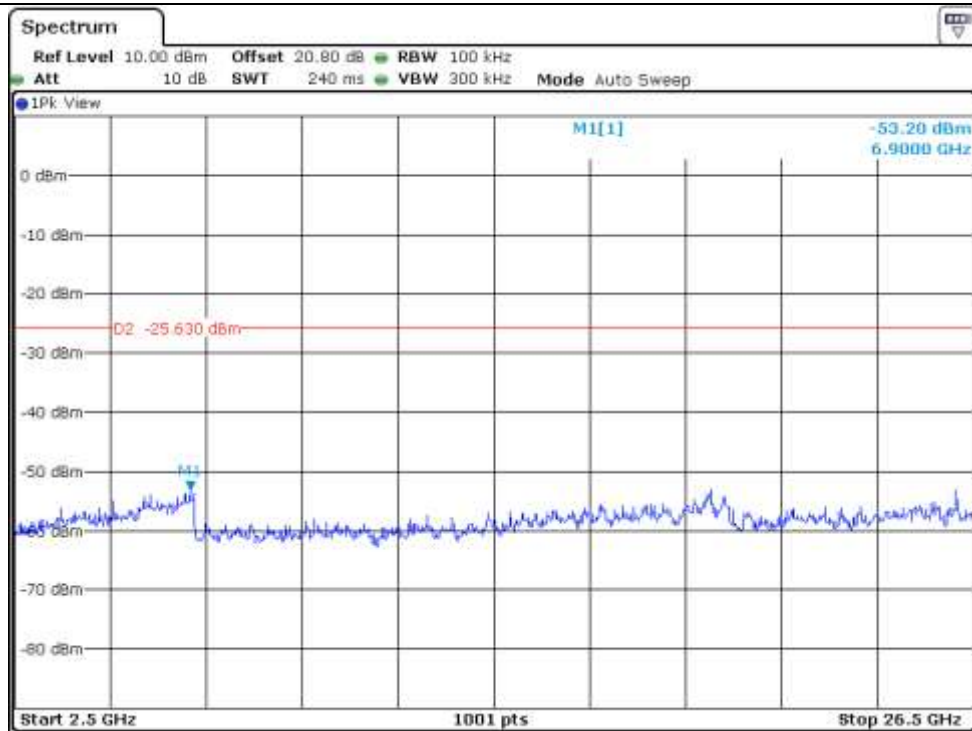
Middle Channel



Middle Channel

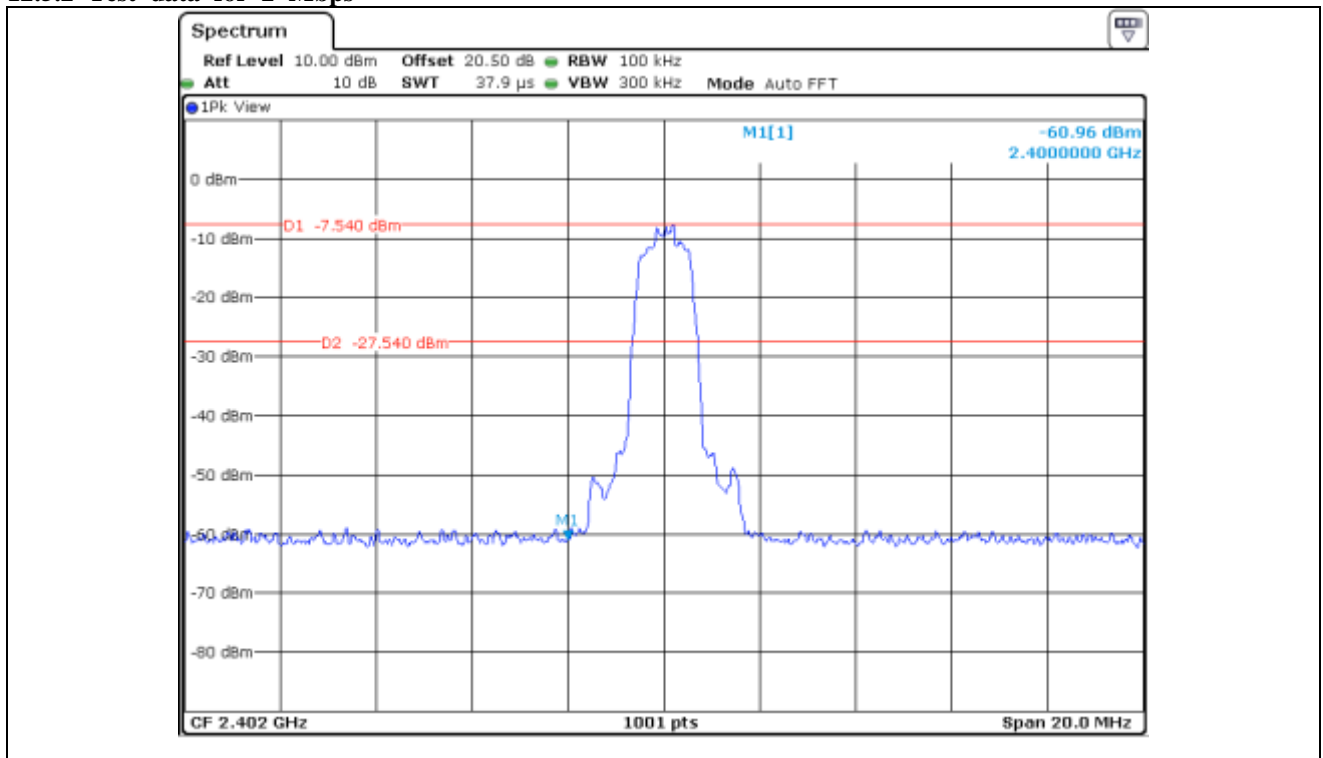


High Channel

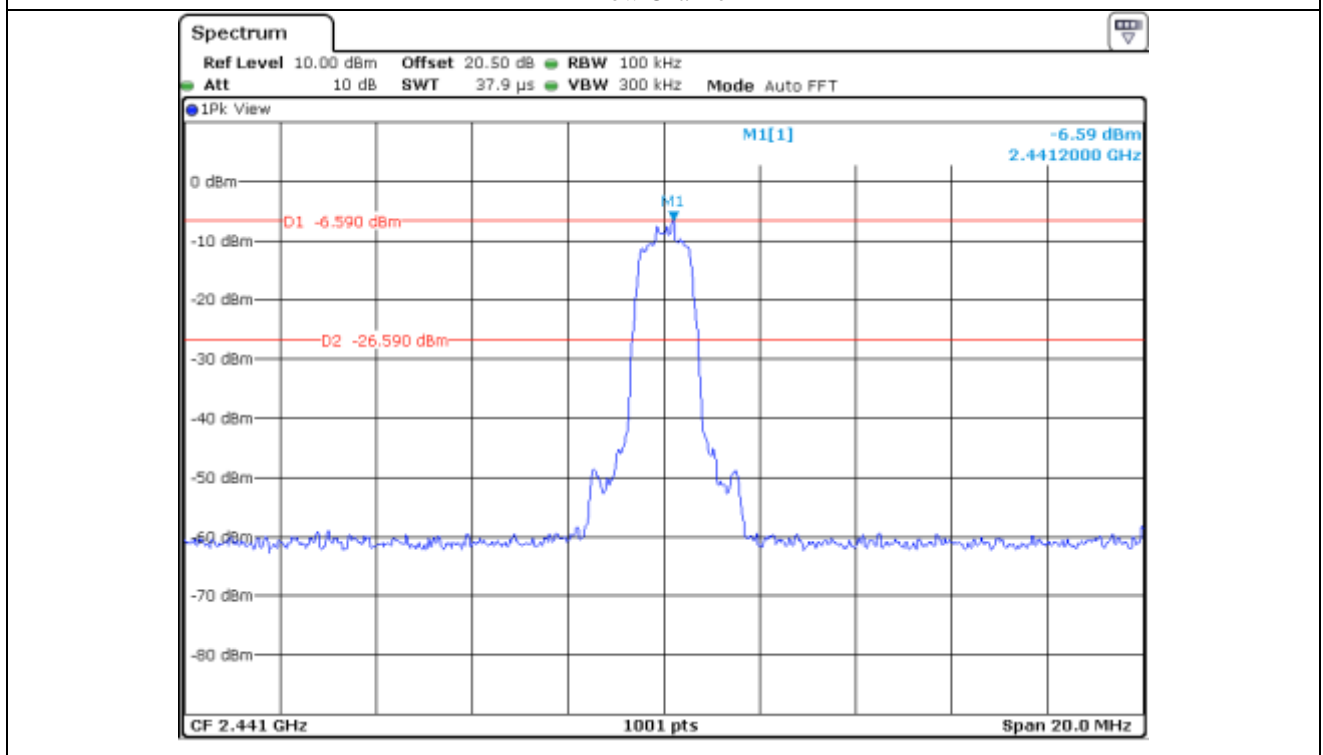


High Channel

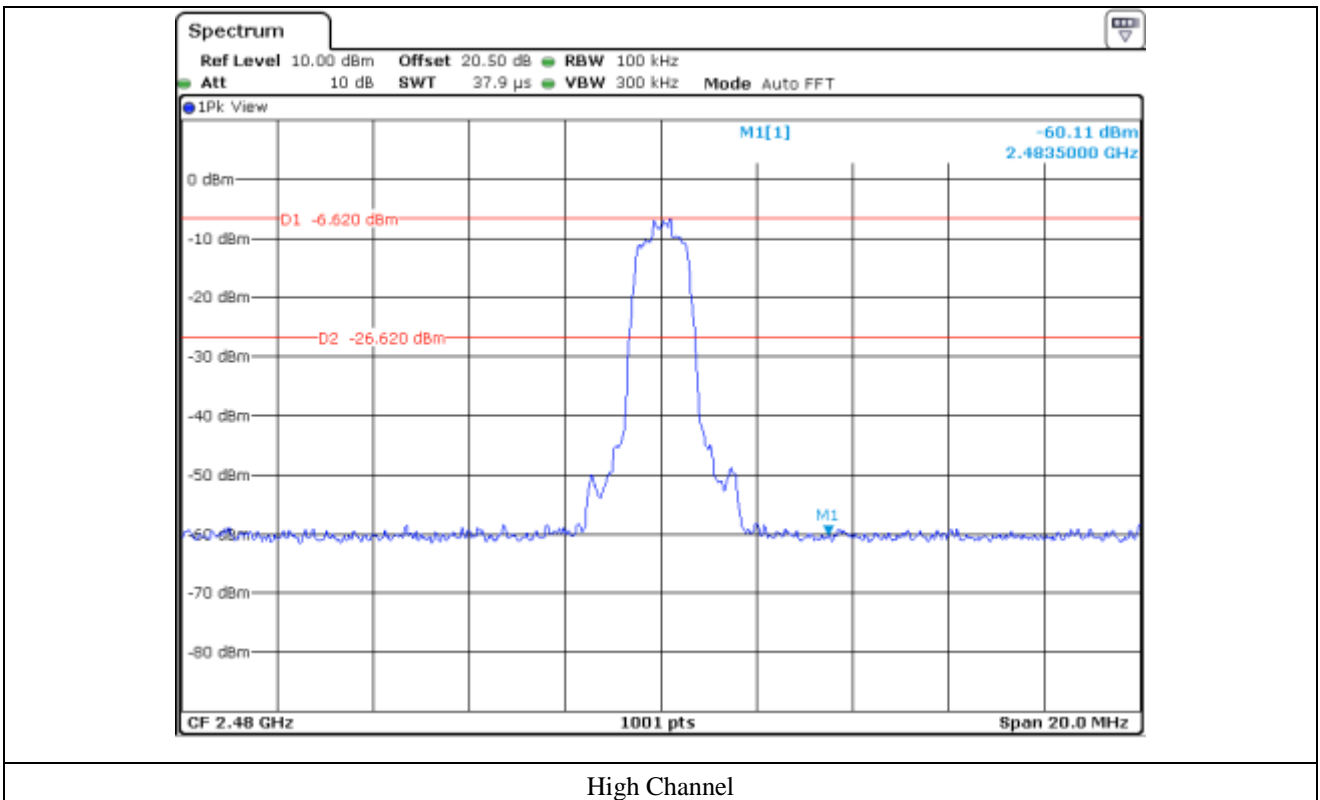
12.5.2 Test data for 2 Mbps

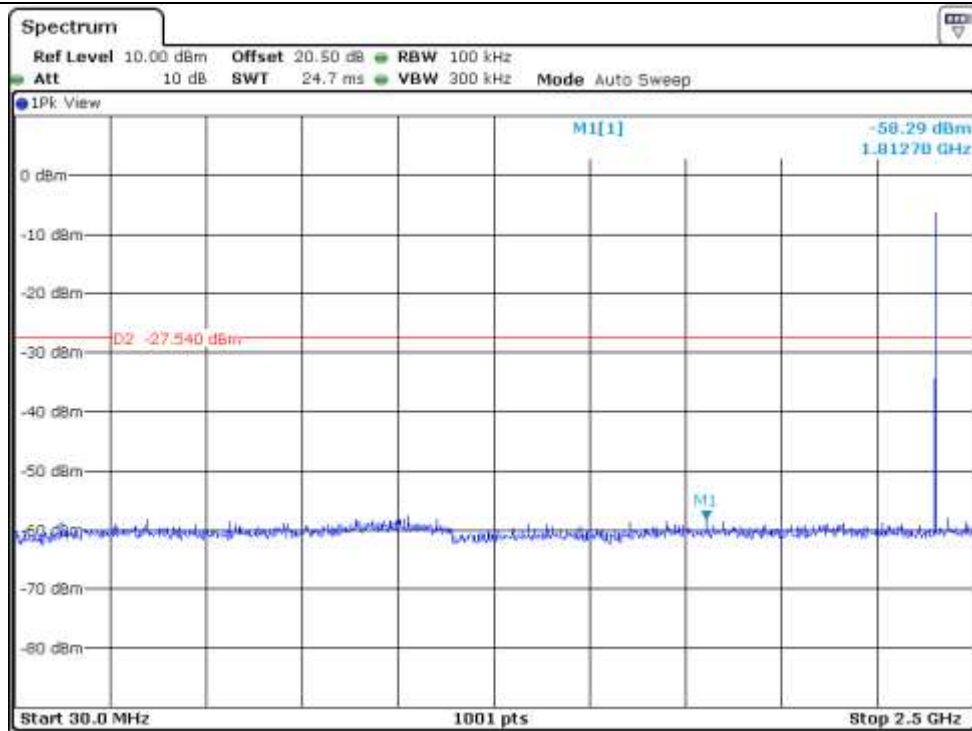


Low Channel

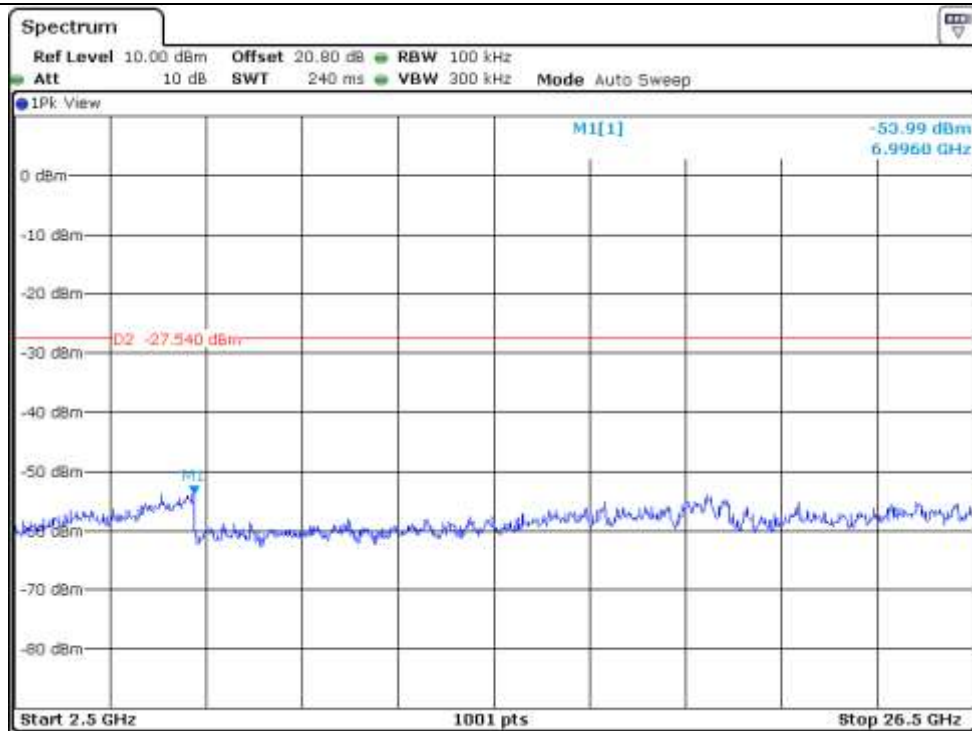


Middle Channel

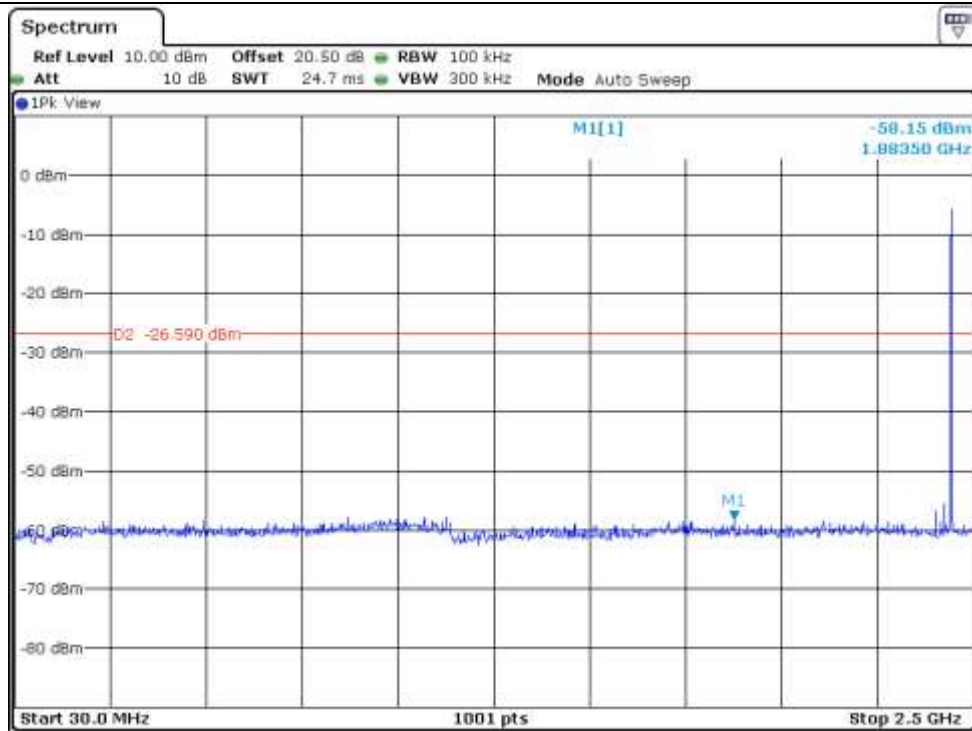




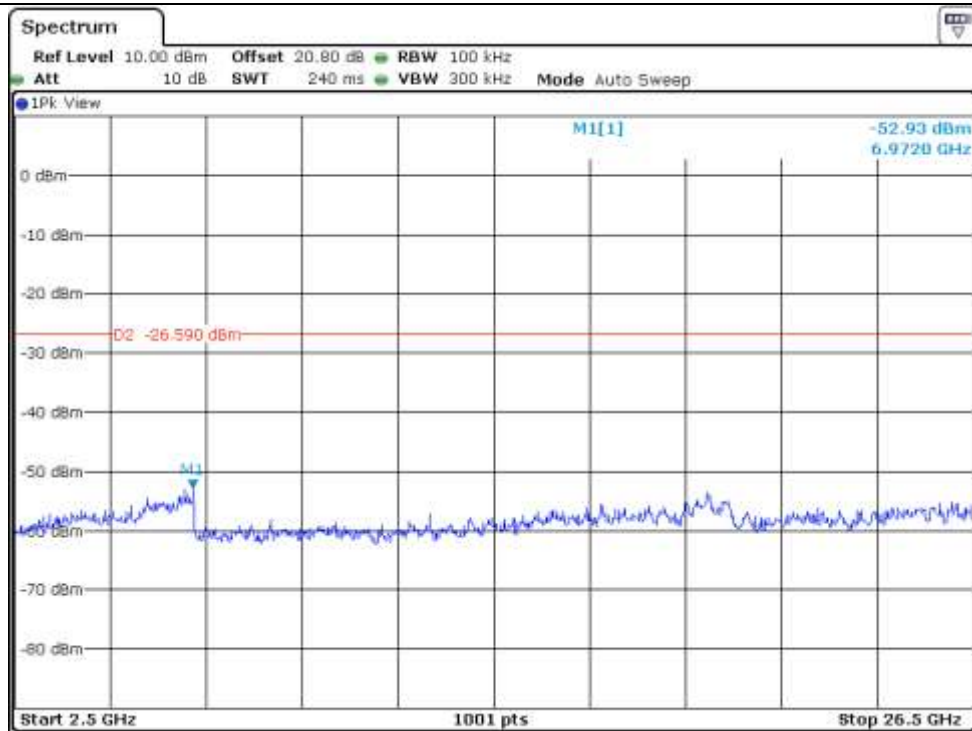
Low Channel



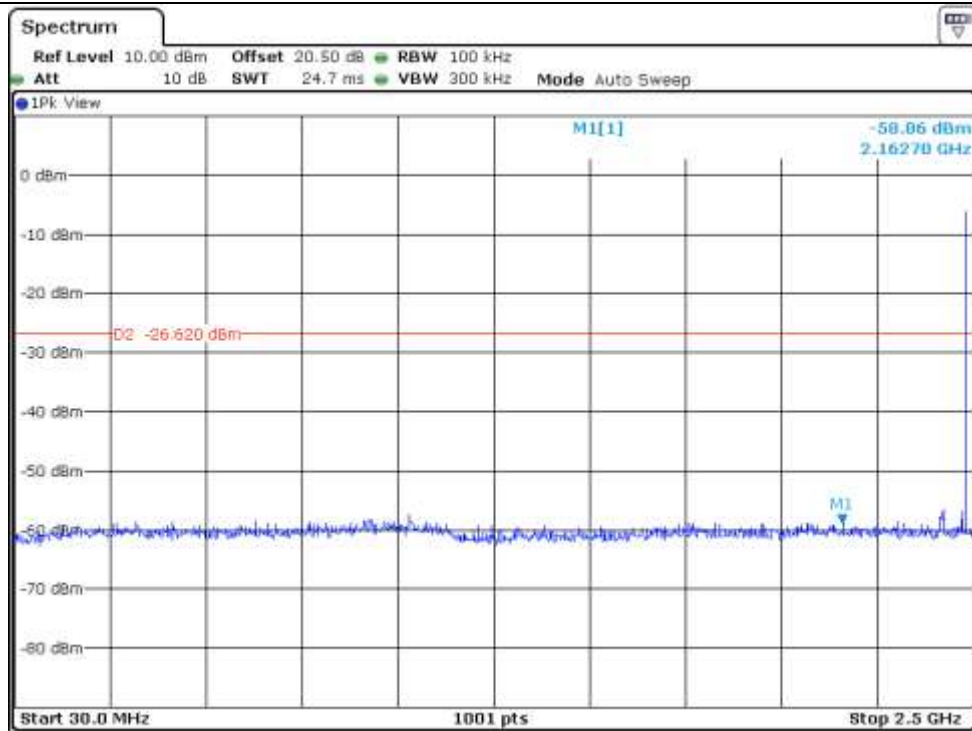
Low Channel



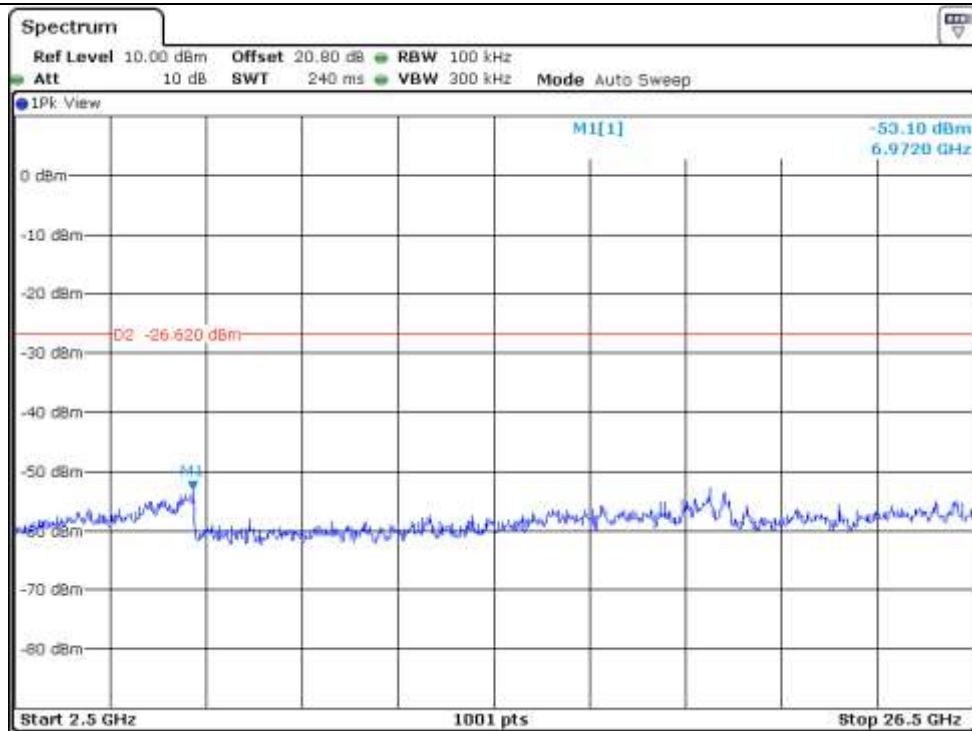
Middle Channel



Middle Channel

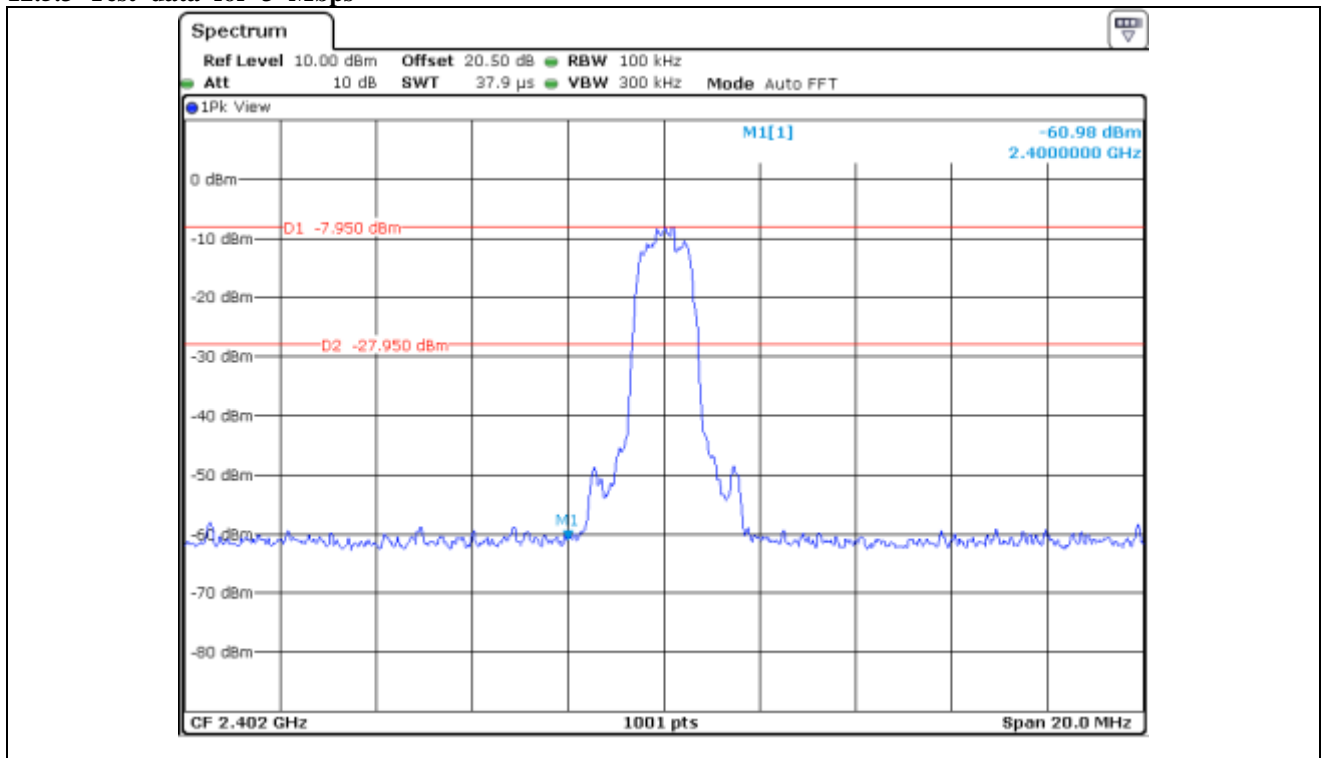


High Channel

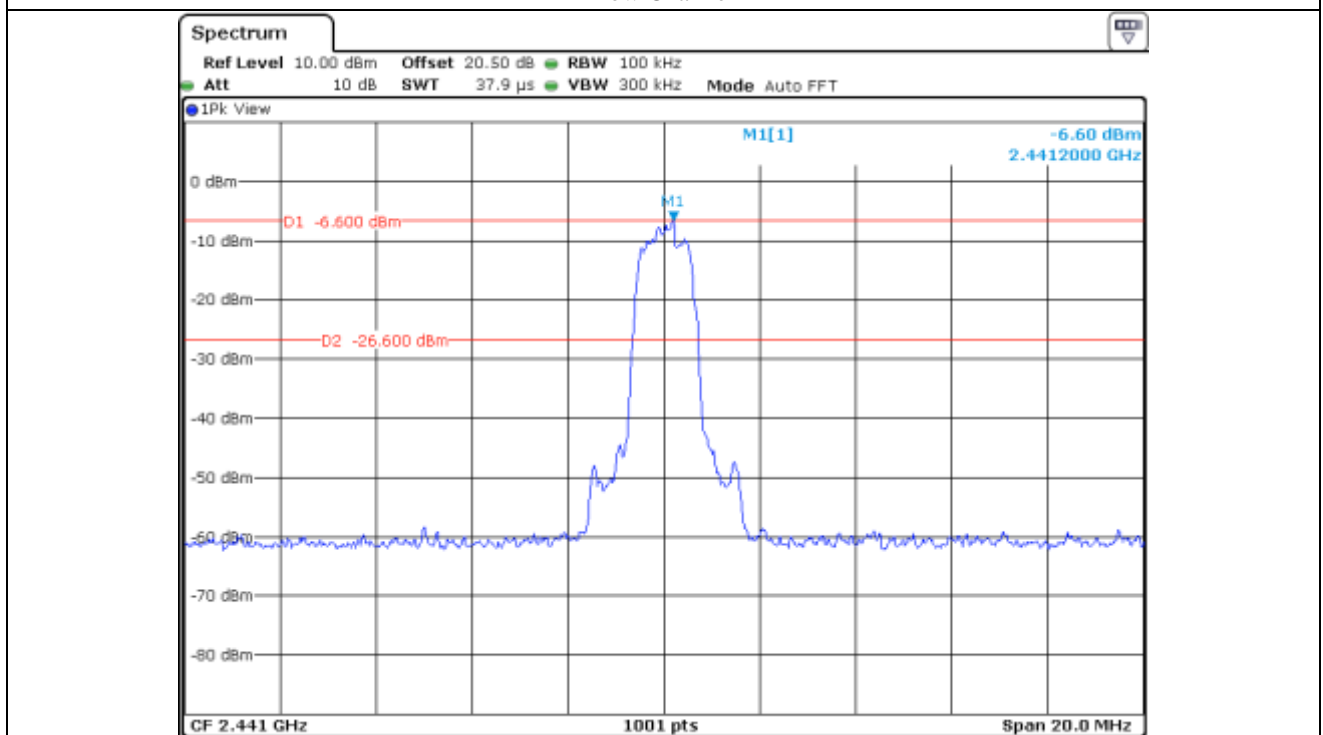


High Channel

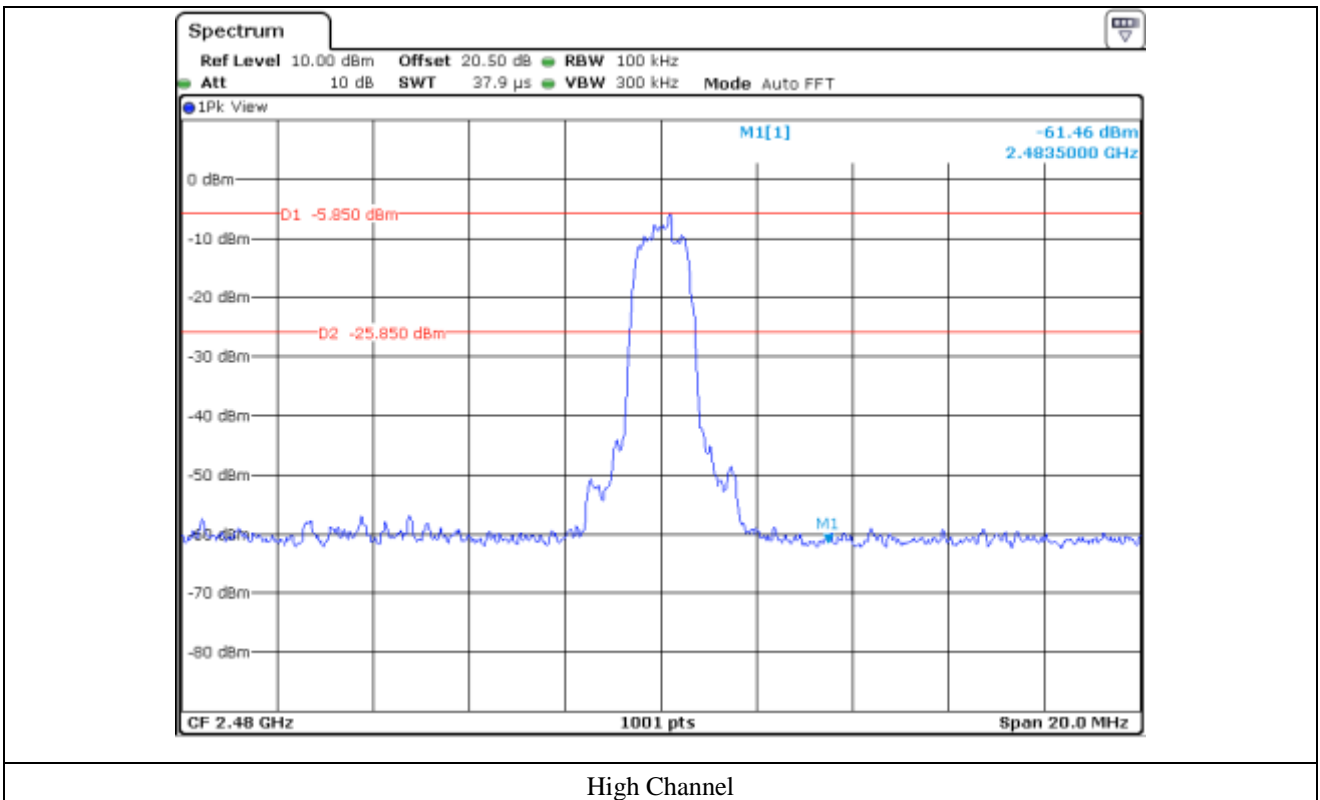
12.5.3 Test data for 3 Mbps

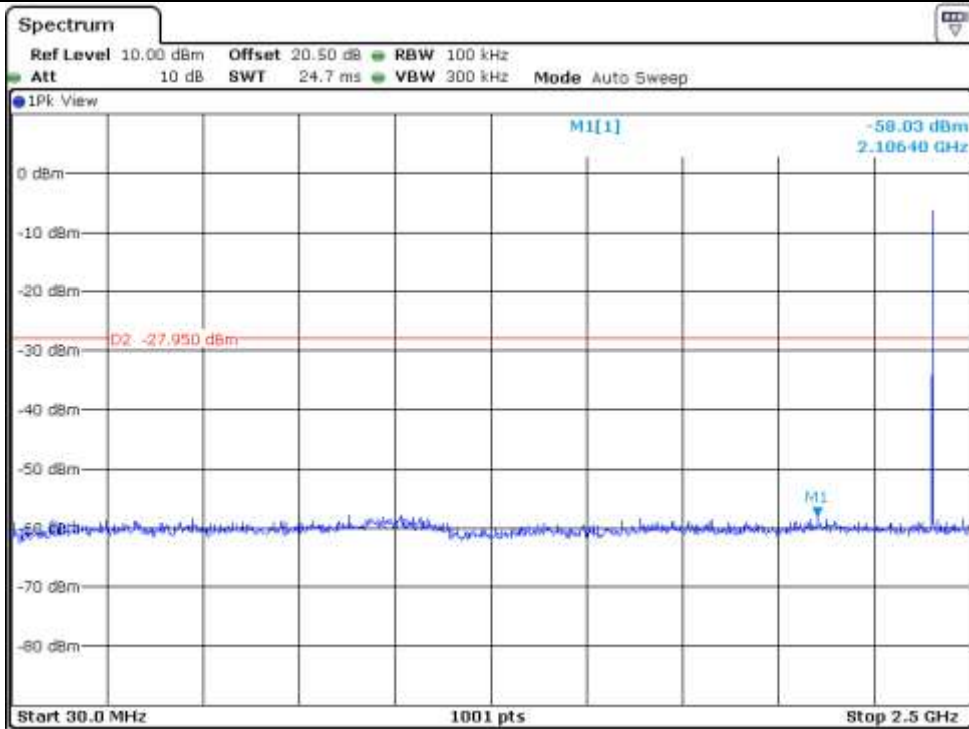


Low Channel

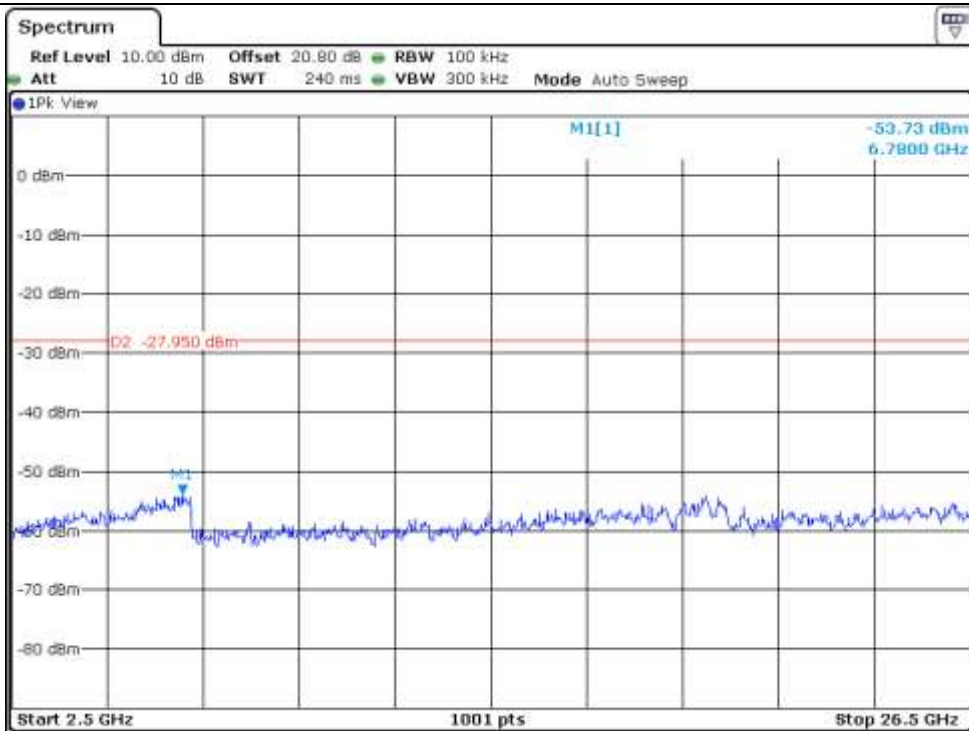


Middle Channel

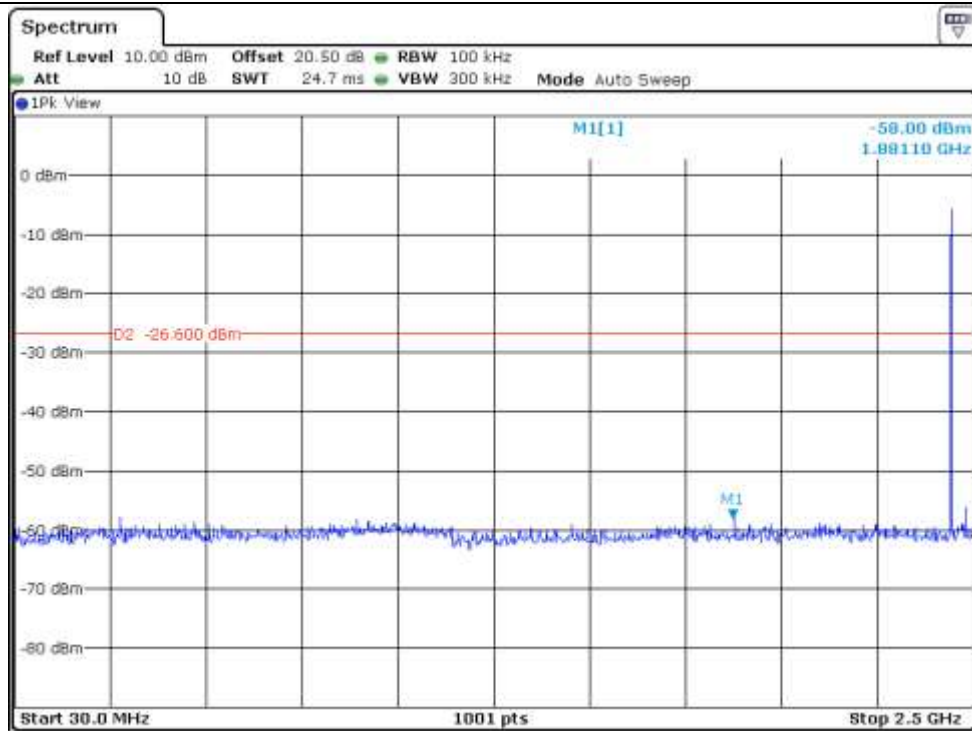




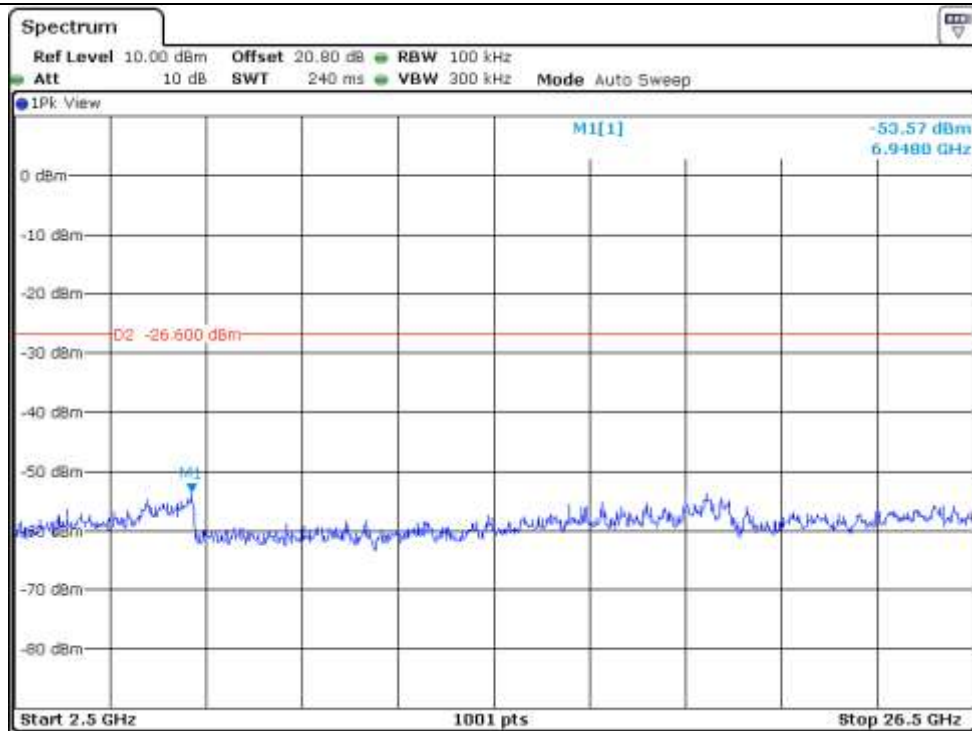
Low Channel



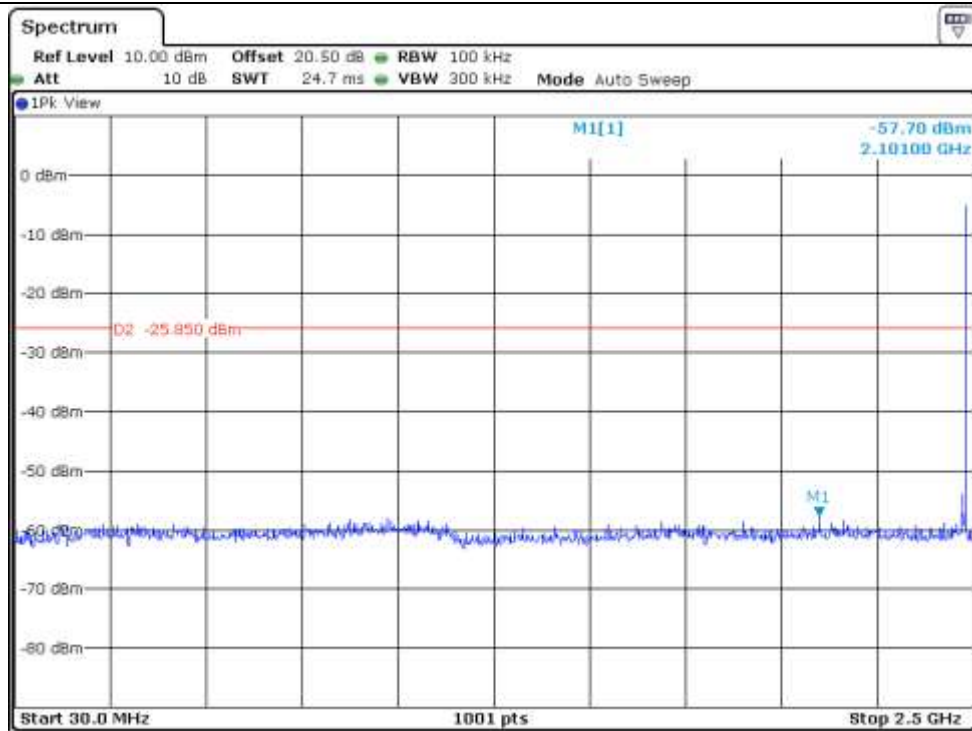
Low Channel



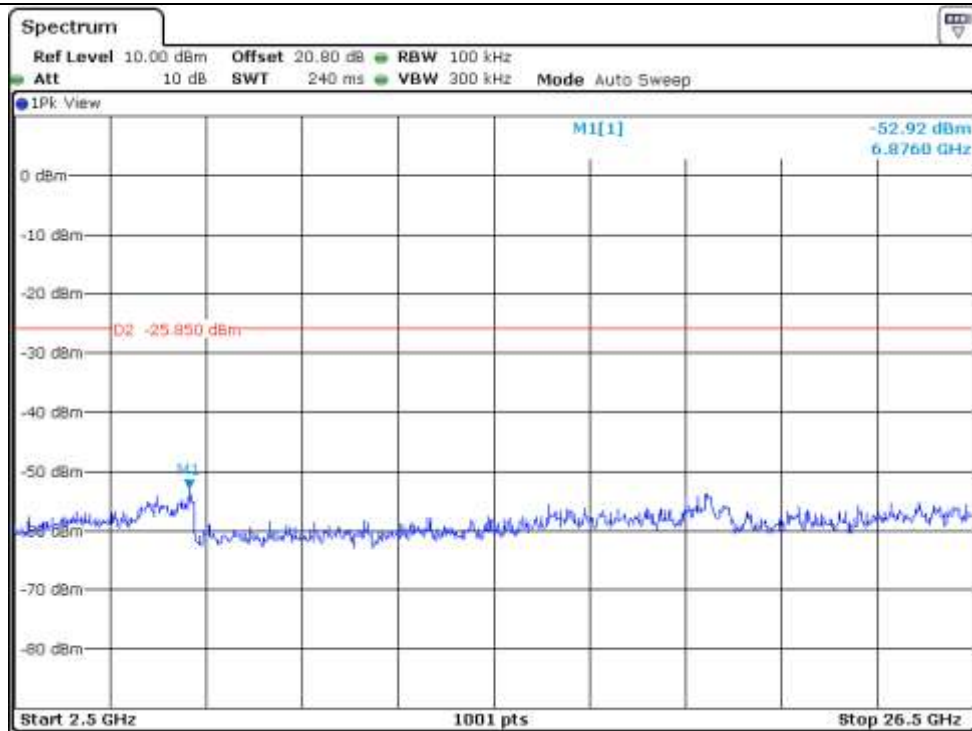
Middle Channel



Middle Channel



High Channel



High Channel

12.6 Test data for Transmitting Mode radiated emission

12.6.1 Radiated Emission which fall in the Restricted Band

12.6.1.1 Test data for 1 Mbps

- . Test Date : November 28, 2019
- . Resolution bandwidth : 1 MHz for Peak and Average Mode
- . Video bandwidth : 3 MHz for Peak and Average Mode
- . Detector : Peak Mode(Peak), Average Mode(RMS)
- . Measurement distance : 3 m
- . Operating Condition : Highest Output Power Transmitting Mode(Low Channel and High Channel)
- . Result : PASSED

| Frequency (MHz) | Reading (dBμV) | Detector Mode | Ant. Pol. (H/V) | Ant. Factor | Cable Loss | Amp Gain | C.F (dB) | Total (dBμV/m) | Limits (dBμV/m) | Margin (dB) |
|--------------------|----------------------------|------------------|--------------------|----------------|---------------|-------------|-------------|-------------------|--------------------|----------------|
| | Test Data for Low Channel | | | | | | | | | |
| 2 340.49 | 47.63 | Peak | H | 27.30 | 6.60 | 45.80 | | 35.73 | 74.00 | 38.27 |
| 2 388.02 | 37.34 | Average | H | | | | 1.13 | 26.57 | 54.00 | 27.43 |
| 2 375.97 | 46.81 | Peak | V | | | | | 34.91 | 74.00 | 39.09 |
| 2 325.54 | 37.51 | Average | V | | | | 1.13 | 26.74 | 54.00 | 27.26 |
| | Test Data for High Channel | | | | | | | | | |
| 2 498.23 | 46.43 | Peak | H | 27.50 | 6.80 | 45.80 | | 34.93 | 74.00 | 39.07 |
| 2 485.35 | 36.21 | Average | H | | | | 1.13 | 25.84 | 54.00 | 28.16 |
| 2 488.75 | 46.48 | Peak | V | | | | | 34.98 | 74.00 | 39.02 |
| 2 491.34 | 36.71 | Average | V | | | | 1.13 | 26.34 | 54.00 | 27.66 |

Tabulated test data for Restricted Band

Remark: "H": Horizontal, "V": Vertical



Tested by: Sieon Lee / Assistant Manager

12.6.1.2 Test data for 2 Mbps

- . Test Date : November 28, 2019
- . Resolution bandwidth : 1 MHz for Peak and Average Mode
- . Video bandwidth : 3 MHz for Peak and Average Mode
- . Detector : Peak Mode(Peak), Average Mode(RMS)
- . Measurement distance : 3 m
- . Operating Condition : Highest Output Power Transmitting Mode(Low Channel and High Channel)
- . Result : PASSED

| Frequency (MHz) | Reading (dBμV) | Detector Mode | Ant. Pol. (H/V) | Ant. Factor | Cable Loss | Amp Gain | C.F (dB) | Total (dBμV/m) | Limits (dBμV/m) | Margin (dB) |
|--------------------|----------------------------|------------------|--------------------|----------------|---------------|-------------|-------------|-------------------|--------------------|----------------|
| | Test Data for Low Channel | | | | | | | | | |
| 2 325.23 | 47.69 | Peak | H | 27.30 | 6.60 | 45.80 | | 35.79 | 74.00 | 38.21 |
| 2 341.37 | 37.31 | Average | H | | | | 1.12 | 26.53 | 54.00 | 27.47 |
| 2 388.68 | 47.19 | Peak | V | | | | | 35.29 | 74.00 | 38.71 |
| 2 348.24 | 37.60 | Average | V | | | | 1.12 | 26.82 | 54.00 | 27.18 |
| | Test Data for High Channel | | | | | | | | | |
| 2 487.58 | 46.13 | Peak | H | 27.50 | 6.80 | 45.80 | | 34.63 | 74.00 | 39.37 |
| 2 490.76 | 36.82 | Average | H | | | | 1.12 | 26.44 | 54.00 | 27.56 |
| 2 491.22 | 46.93 | Peak | V | | | | | 35.43 | 74.00 | 38.57 |
| 2 486.05 | 36.58 | Average | V | | | | 1.12 | 26.20 | 54.00 | 27.80 |

Tabulated test data for Restricted Band

Remark: "H": Horizontal, "V": Vertical



Tested by: Sieon Lee / Assistant Manager

12.6.1.3 Test data for 3 Mbps

- . Test Date : November 28, 2019
- . Resolution bandwidth : 1 MHz for Peak and Average Mode
- . Video bandwidth : 3 MHz for Peak and Average Mode
- . Detector : Peak Mode(Peak), Average Mode(RMS)
- . Measurement distance : 3 m
- . Operating Condition : Highest Output Power Transmitting Mode(Low Channel and High Channel)
- . Result : PASSED

| Frequency (MHz) | Reading (dBμV) | Detector Mode | Ant. Pol. (H/V) | Ant. Factor | Cable Loss | Amp Gain | C.F (dB) | Total (dBμV/m) | Limits (dBμV/m) | Margin (dB) |
|--------------------|----------------------------|------------------|--------------------|----------------|---------------|-------------|-------------|-------------------|--------------------|----------------|
| | Test Data for Low Channel | | | | | | | | | |
| 2 340.57 | 47.40 | Peak | H | 27.30 | 6.60 | 45.80 | | 35.50 | 74.00 | 38.50 |
| 2 354.40 | 37.35 | Average | H | | | | 1.12 | 26.57 | 54.00 | 27.43 |
| 2 387.64 | 47.59 | Peak | V | | | | | 35.69 | 74.00 | 38.31 |
| 2 340.01 | 37.37 | Average | V | | | | 1.12 | 26.59 | 54.00 | 27.41 |
| | Test Data for High Channel | | | | | | | | | |
| 2 492.56 | 46.30 | Peak | H | 27.50 | 6.80 | 45.80 | | 34.80 | 74.00 | 39.20 |
| 2 489.13 | 36.53 | Average | H | | | | 1.12 | 26.15 | 54.00 | 27.85 |
| 2 497.93 | 46.05 | Peak | V | | | | | 34.55 | 74.00 | 39.45 |
| 2 488.68 | 36.70 | Average | V | | | | 1.12 | 26.32 | 54.00 | 27.68 |

Tabulated test data for Restricted Band

Remark: "H": Horizontal, "V": Vertical



Tested by: Sieon Lee / Assistant Manager

12.6.2 Spurious & Harmonic Radiated Emission above 1 GHz

12.6.2.1 Test data for 1 Mbps

- . Test Date : November 28, 2019
- . Resolution bandwidth : 1 MHz for Peak and Average Mode
- . Video bandwidth : 3 MHz for Peak and Average Mode
- . Detector : Peak Mode(Peak), Average Mode(RMS)
- . Frequency range : 1 GHz ~ 26.5 GHz
- . Measurement distance : 3 m
- . Operating Condition : Highest Output Power Transmitting Mode
- . Result : PASSED

| Frequency (GHz) | Reading (dBμV) | Detector Mode | Ant. Pol. (H/V) | Ant. Factor | Cable Loss | Amp Gain | C.F (dB) | Total (dBμV/m) | Limits (dBμV/m) | Margin (dB) |
|--------------------|------------------------------|------------------|--------------------|----------------|---------------|-------------|-------------|-------------------|--------------------|----------------|
| | Test Data for Low Channel | | | | | | | | | |
| 4 804.00 | 49.97 | Peak | H | 31.20 | 9.80 | 45.30 | | 45.67 | 74.00 | 28.33 |
| | 44.68 | Average | H | | | | 1.13 | 40.38 | 54.00 | 13.62 |
| | 50.57 | Peak | V | | | | | 46.27 | 74.00 | 27.73 |
| | 43.53 | Average | V | | | | 1.13 | 39.23 | 54.00 | 14.77 |
| | Test Data for Middle Channel | | | | | | | | | |
| 4 882.00 | 49.29 | Peak | H | 31.40 | 9.80 | 45.30 | | 45.19 | 74.00 | 28.81 |
| | 43.28 | Average | H | | | | 1.13 | 39.18 | 54.00 | 14.82 |
| | 50.21 | Peak | V | | | | | 46.11 | 74.00 | 27.89 |
| | 42.32 | Average | V | | | | 1.13 | 38.22 | 54.00 | 15.78 |
| | Test Data for High Channel | | | | | | | | | |
| 4 960.00 | 48.99 | Peak | H | 31.60 | 9.90 | 45.30 | | 45.19 | 74.00 | 28.81 |
| | 41.44 | Average | H | | | | 1.13 | 37.64 | 54.00 | 16.36 |
| | 49.01 | Peak | V | | | | | 45.21 | 74.00 | 28.79 |
| | 40.69 | Average | V | | | | 1.13 | 36.89 | 54.00 | 17.11 |

Tabulated test data for Restricted Band

Remark: "H": Horizontal, "V": Vertical, "*" Frequency fall in restricted band



Tested by: Sieon Lee / Assistant Manager

12.6.2.2 Test data for 2 Mbps

- Test Date : November 28, 2019
- Resolution bandwidth : 1 MHz for Peak and Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Detector : Peak Mode(Peak), Average Mode(RMS)
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Operating Condition : Highest Output Power Transmitting Mode
- Result : PASSED

| Frequency (GHz) | Reading (dBμV) | Detector Mode | Ant. Pol. (H/V) | Ant. Factor | Cable Loss | Amp Gain | C.F (dB) | Total (dBμV/m) | Limits (dBμV/m) | Margin (dB) |
|--------------------|------------------------------|------------------|--------------------|----------------|---------------|-------------|-------------|-------------------|--------------------|----------------|
| | Test Data for Low Channel | | | | | | | | | |
| 4 804.00 | 49.91 | Peak | H | 31.20 | 9.80 | 45.30 | | 45.61 | 74.00 | 28.39 |
| | 41.07 | Average | H | | | | 1.12 | 37.07 | 54.00 | 16.93 |
| | 49.95 | Peak | V | | | | | 45.65 | 74.00 | 28.35 |
| | 40.44 | Average | V | | | | 1.12 | 36.14 | 54.00 | 17.86 |
| | Test Data for Middle Channel | | | | | | | | | |
| 4 882.00 | 48.57 | Peak | H | 31.40 | 9.80 | 45.30 | | 44.47 | 74.00 | 29.53 |
| | 40.61 | Average | H | | | | 1.12 | 36.51 | 54.00 | 17.49 |
| | 49.08 | Peak | V | | | | | 44.98 | 74.00 | 29.02 |
| | 40.42 | Average | V | | | | 1.12 | 36.32 | 54.00 | 17.68 |
| | Test Data for High Channel | | | | | | | | | |
| 4 960.00 | 48.39 | Peak | H | 31.60 | 9.90 | 45.30 | | 44.59 | 74.00 | 29.41 |
| | 39.96 | Average | H | | | | 1.12 | 36.16 | 54.00 | 17.84 |
| | 48.70 | Peak | V | | | | | 44.90 | 74.00 | 29.10 |
| | 38.70 | Average | V | | | | 1.12 | 34.90 | 54.00 | 19.10 |

Tabulated test data for Restricted Band

Remark: "H": Horizontal, "V": Vertical, "*" Frequency fall in restricted band



Tested by: Sieon Lee / Assistant Manager

12.6.2.3 Test data for 3 Mbps

- . Test Date : November 28, 2019
- . Resolution bandwidth : 1 MHz for Peak and Average Mode
- . Video bandwidth : 3 MHz for Peak and Average Mode
- . Detector : Peak Mode(Peak), Average Mode(RMS)
- . Frequency range : 1 GHz ~ 26.5 GHz
- . Measurement distance : 3 m
- . Operating Condition : Highest Output Power Transmitting Mode
- . Result : PASSED

| Frequency (GHz) | Reading (dBμV) | Detector Mode | Ant. Pol. (H/V) | Ant. Factor | Cable Loss | Amp Gain | C.F (dB) | Total (dBμV/m) | Limits (dBμV/m) | Margin (dB) |
|--------------------|------------------------------|------------------|--------------------|----------------|---------------|-------------|-------------|-------------------|--------------------|----------------|
| | Test Data for Low Channel | | | | | | | | | |
| 4 804.00 | 49.28 | Peak | H | 31.20 | 9.80 | 45.30 | | 44.98 | 74.00 | 29.02 |
| | 40.93 | Average | H | | | | 1.12 | 36.93 | 54.00 | 17.07 |
| | 49.31 | Peak | V | | | | | 45.01 | 74.00 | 28.99 |
| | 40.81 | Average | V | | | | 1.12 | 36.51 | 54.00 | 17.49 |
| | Test Data for Middle Channel | | | | | | | | | |
| 4 882.00 | 49.31 | Peak | H | 31.40 | 9.80 | 45.30 | | 45.21 | 74.00 | 28.79 |
| | 39.96 | Average | H | | | | 1.12 | 35.86 | 54.00 | 18.14 |
| | 49.80 | Peak | V | | | | | 45.70 | 74.00 | 28.30 |
| | 39.52 | Average | V | | | | 1.12 | 35.42 | 54.00 | 18.58 |
| | Test Data for High Channel | | | | | | | | | |
| 4 960.00 | 48.26 | Peak | H | 31.60 | 9.90 | 45.30 | | 44.46 | 74.00 | 29.54 |
| | 38.49 | Average | H | | | | 1.12 | 34.69 | 54.00 | 19.31 |
| | 48.43 | Peak | V | | | | | 44.63 | 74.00 | 29.37 |
| | 38.04 | Average | V | | | | 1.12 | 34.24 | 54.00 | 19.76 |

Tabulated test data for Restricted Band

Remark: "H": Horizontal, "V": Vertical, "*" Frequency fall in restricted band



Tested by: Sieon Lee / Assistant Manager

12.6.3 Spurious Radiated Emission

12.6.3.1 Test Data for 30 MHz ~ 1 GHz

Humidity Level : 48 % R.H.

Temperature: 24 °C

Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247

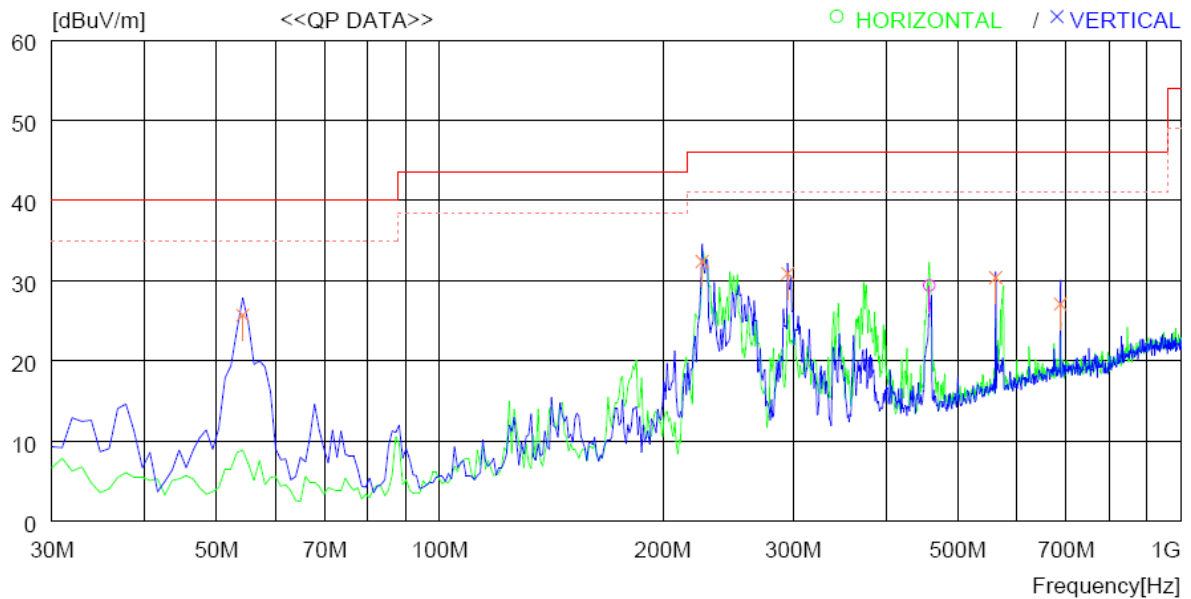
Result : PASSED

EUT : DIGITAL CAR AUDIO SYSTEM

Date: November 28, 2019

Detector : CISPR Quasi-Peak (6 dB Bandwidth: 120 kHz)

Operating mode : Transmitting mode



| No. | FREQ | READING | ANT | LOSS | GAIN | RESULT | LIMIT | MARGIN | ANTENNA | TABLE |
|------------------------|---------|---------|--------|------|------|----------|----------|--------|---------|-------|
| | [MHz] | QP | FACTOR | [dB] | [dB] | [dBuV/m] | [dBuV/m] | [dB] | [cm] | [DEG] |
| ----- Horizontal ----- | | | | | | | | | | |
| 1 | 457.771 | 42.9 | 17.2 | 2.1 | 32.8 | 29.4 | 46.0 | 16.6 | 100 | 359 |
| ----- Vertical ----- | | | | | | | | | | |
| 2 | 54.250 | 48.2 | 9.6 | 0.6 | 32.7 | 25.7 | 40.0 | 14.3 | 100 | 110 |
| 3 | 225.940 | 52.3 | 11.3 | 1.4 | 32.6 | 32.4 | 46.0 | 13.6 | 200 | 359 |
| 4 | 294.810 | 48.8 | 13.2 | 1.6 | 32.7 | 30.9 | 46.0 | 15.1 | 100 | 344 |
| 5 | 562.529 | 42.0 | 19.1 | 2.3 | 33.0 | 30.4 | 46.0 | 15.6 | 200 | 72 |
| 6 | 687.655 | 36.7 | 20.8 | 2.5 | 32.9 | 27.1 | 46.0 | 18.9 | 200 | 359 |



Tested by: Sieon Lee / Assistant Manager

12.6.3.2 Test Data for Below 30 MHz

- . Test Date : November 28, 2019
- . Resolution bandwidth : 200 Hz (from 9 kHz to 0.15 MHz), 9 kHz (from 0.15 MHz to 30 MHz)
- . Frequency range : 9 kHz ~ 30 MHz
- . Measurement distance : 3 m
- . Operating mode : Transmitting mode
- . Result : PASSED

| Frequency (MHz) | Reading (dB μ V) | Ant. Pol. (H/V) | Ant. Factor (dB/m) | Cable Loss | Amp Gain | Emission Level(dB μ V/m) | Limits (dB μ V/m) | Margin (dB) |
|--|-------------------------|--------------------|-----------------------|---------------|-------------|---------------------------------|--------------------------|----------------|
| Not sufficient to state emissions were not detected, emissions detected were 20 dB below the limit | | | | | | | | |

12.6.3.3 Test Data for above 1 GHz

- . Test Date : November 28, 2019
- . Resolution bandwidth : 1 MHz for Peak and Average Mode
- . Frequency range : 1 GHz ~ 26.5 GHz
- . Measurement distance : 3 m
- . Operating mode : Transmitting mode
- . Result : PASSED

| Frequency (MHz) | Reading (dB μ V) | Ant. Pol. (H/V) | Ant. Factor (dB/m) | Cable Loss | Amp Gain | Emission Level(dB μ V/m) | Limits (dB μ V/m) | Margin (dB) |
|--|-------------------------|--------------------|-----------------------|---------------|-------------|---------------------------------|--------------------------|----------------|
| Not sufficient to state emissions were not detected, emissions detected were 20 dB below the limit | | | | | | | | |



Tested by: Sieon Lee / Assistant Manager