

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

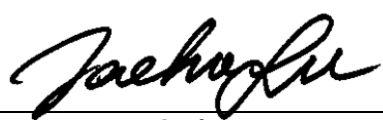
Test Report No. : W176R-D066
AGR No. : A173A-299R
Applicant : Charm Engineering Co.,Ltd
Address : 5, Hyeongje-ro, Namsa-myeon, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea, 17118
Manufacturer : Charm Engineering Co.,Ltd
Address : 5, Hyeongje-ro, Namsa-myeon, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea, 17118
Type of Equipment : CAI Monitoring System
FCC ID. : 2AMMLCAI001-BT33
Model Name : CAI
Multiple Model Name: N/A
Serial number : N/A
Total page of Report : 83 pages (including this page)
Date of Incoming : May 11, 2017
Date of issue : June 20, 2017

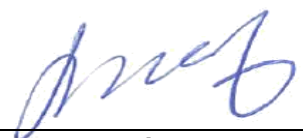
SUMMARY

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: 
 Jae-Ho Lee / Chief Engineer
 ONETECH Corp.

Approved by: 
 Keun-Young, Choi / Vice President
 ONETECH Corp.

CONTENTS

PAGE

1. VERIFICATION OF COMPLIANCE	6
2. TEST SUMMARY	7
2.1 TEST ITEMS AND RESULTS	7
2.2 ADDITIONS, DEVIATIONS, EXCLUSIONS FROM STANDARDS.....	7
2.3 RELATED SUBMITTAL(S) / GRANT(S)	7
2.4 PURPOSE OF THE TEST	7
2.5 TEST METHODOLOGY.....	7
2.6 TEST FACILITY.....	8
3. GENERAL INFORMATION	9
3.1 PRODUCT DESCRIPTION.....	9
3.2 ALTERNATIVE TYPE(S)/MODEL(S); ALSO COVERED BY THIS TEST REPORT.....	9
4. EUT MODIFICATIONS.....	9
5. SYSTEM TEST CONFIGURATION	10
5.1 JUSTIFICATION.....	10
5.2 PERIPHERAL EQUIPMENT	10
5.3 MODE OF OPERATION DURING THE TEST	11
5.4 CONFIGURATION OF TEST SYSTEM.....	11
5.5 ANTENNA REQUIREMENT	11
6. PRELIMINARY TEST	12
6.1 AC POWER LINE CONDUCTED EMISSIONS TESTS.....	12
6.2 GENERAL RADIATED EMISSIONS TESTS	12
7. MINIMUM 20 DB BANDWIDTH.....	13
7.1 OPERATING ENVIRONMENT	13
7.2 TEST SET-UP	13
7.3 TEST EQUIPMENT USED	13
7.4 TEST DATA FOR 1 MBPS	14
7.5 TEST DATA FOR 2 MBPS	16
7.6 TEST DATA FOR 3 MBPS	18
8. HOPPING FREQUENCY SEPARATION.....	20
8.1 OPERATING ENVIRONMENT	20
8.2 TEST SET-UP	20
8.3 TEST EQUIPMENT USED	20

8.4 TEST DATA FOR 1 MBPS	21
8.5 TEST DATA FOR 2 MBPS	22
8.6 TEST DATA FOR 3 MBPS	23
9. NUMBER OF HOPPING CHANNELS	24
9.1 OPERATING ENVIRONMENT	24
9.2 TEST SET-UP	24
9.3 TEST EQUIPMENT USED	24
9.4 TEST DATA FOR 1 MBPS	25
9.5 TEST DATA FOR 2 MBPS	28
9.6 TEST DATA FOR 3 MBPS	31
10. TIME OF OCCUPANCY	34
10.1 OPERATING ENVIRONMENT	34
10.2 TEST SET-UP	34
10.3 TEST EQUIPMENT USED	34
10.4 TEST DATA FOR 1 MBPS	35
10.5 TEST DATA FOR 2 MBPS	38
10.6 TEST DATA FOR 3 MBPS	41
11. MAXIMUM PEAK OUTPUT POWER	44
11.1 OPERATING ENVIRONMENT	44
11.2 TEST SET-UP	44
11.3 TEST EQUIPMENT USED	44
11.4 TEST DATA FOR 1 MBPS	45
11.5 TEST DATA FOR 2 MBPS	48
11.6 TEST DATA FOR 3 MBPS	51
12. 100 KHZ BANDWIDTH OUTSIDE THE FREQUENCY BAND	54
12.1 OPERATING ENVIRONMENT	54
12.2 TEST SET-UP FOR CONDUCTED MEASUREMENT	54
12.3 TEST SET-UP FOR RADIATED MEASUREMENT	54
12.4 TEST EQUIPMENT USED	54
12.5 TEST DATA FOR CONDUCTED EMISSION	55
12.5.1 Test data for 1 Mbps	55
12.5.2 Test data for 2 Mbps	61
12.5.3 Test data for 3 Mbps	67
12.6 TEST DATA FOR TRANSMITTING MODE RADIATED EMISSION	73
12.6.1 Radiated Emission which fall in the Restricted Band	73
12.6.2 Spurious & Harmonic Radiated Emission above 1 GHz	76

12.6.3 Spurious Radiated Emission.....	79
13. CONDUCTED EMISSION TEST.....	81
13.1 OPERATING ENVIRONMENT	81
13.2 TEST SET-UP	81
13.3 TEST EQUIPMENT USED	81
13.4 SOFTWARE USED	81
13.5 TEST DATA FOR CHARGING MODE.....	82

Revision History

Issued Report No.	Issued Date	Revisions	Effect Section
W176R-D066	June 20, 2017	Initial Issue	All

1. VERIFICATION OF COMPLIANCE

APPLICANT : Charm Engineering Co.,Ltd
 ADDRESS : 5, Hyeongje-ro, Namsa-myeon, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea, 17118
 CONTACT PERSON : Choi sangwoo / Research Engineer
 TELEPHONE NO : +82-31-330-8637
 FCC ID : 2AMMLCAI001-BT33
 MODEL NAME : CAI
 SERIAL NUMBER : N/A
 DATE : June 20, 2017

EQUIPMENT CLASS	<i>DSS – PART 15 SPREAD SPECTRUM TRANSMITTER</i>
KIND OF EQUIPMENT	CAI Monitoring 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	Met the Limit / PASS
15.203	Antenna Requirement	Met requirement / PASS

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-4617/ G-10666 / T-1842

IC (Industry Canada) – Registration No. Site# 3736A-3

-. Site Accreditation:

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 Charm Engineering Co.,Ltd, Model CAI (referred to as the EUT in this report) is a CAI Monitoring System. The product specification described herein was obtained from product data sheet or user's manual.

DEVICE TYPE	CAI Monitoring System	
OPERATING FREQUENCY	2 402 MHz ~ 2 480 MHz	
RF OUTPUT POWER	1 Mbps	3.79 dBm
	2 Mbps	1.27 dBm
	3 Mbps	1.32 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	Chip Antenna	
ANTENNA GAIN	-0.97 dBi	
LIST OF EACH OSC. OR CRYSTAL. FREQ.(FREQ. $\geq$ 1 MHz)	32.768 kHz, 13 MHz	
RATED SUPPLY VOLTAGE	DC 3.7 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	
Battery	N/A	CAL-WL-03-0011	

5.2 Peripheral equipment

Model	Manufacturer	Description	Connected to
BZQ92	Wendeng ANY Electronics Co.,Ltd	Adapter	EUT

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 “XZ” axis, but the worst data was recorded in this test report.

5.4 Configuration of Test System

Line Conducted Test: The EUT was tested in a Charging mode. The EUT was connected to USB and the power of USB was connected to Adapter. All supporting equipments were connected to another LISN. Preliminary Power line Conducted Emission test was performed by using the procedure in ANSI C63.10: 2013 to determine the worse operating conditions.

Radiated Emission Test: The EUT was tested in a Transmitter mode. Preliminary radiated emissions test were 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 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 Chip Antenna, so no consideration of replacement by the user.

6. PRELIMINARY TEST

6.1 AC Power line Conducted Emissions Tests

During Preliminary Tests, the following operating mode was investigated

Operation Mode	The Worse operating condition (Please check one only)
Charging Mode	X

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)
Charging Mode	
Transmitting Mode	X

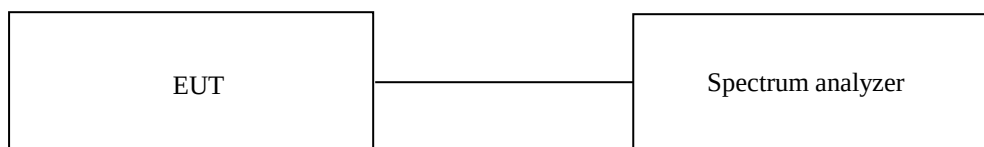
7. MINIMUM 20 dB BANDWIDTH

7.1 Operating environment

Temperature : 23 °C
Relative humidity : 44 % 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.
■ - FSV40	Rohde & Schwarz	Signal Analyzer	101009	Apr. 05, 2017 (1Y)

All test equipment used is calibrated on a regular basis.

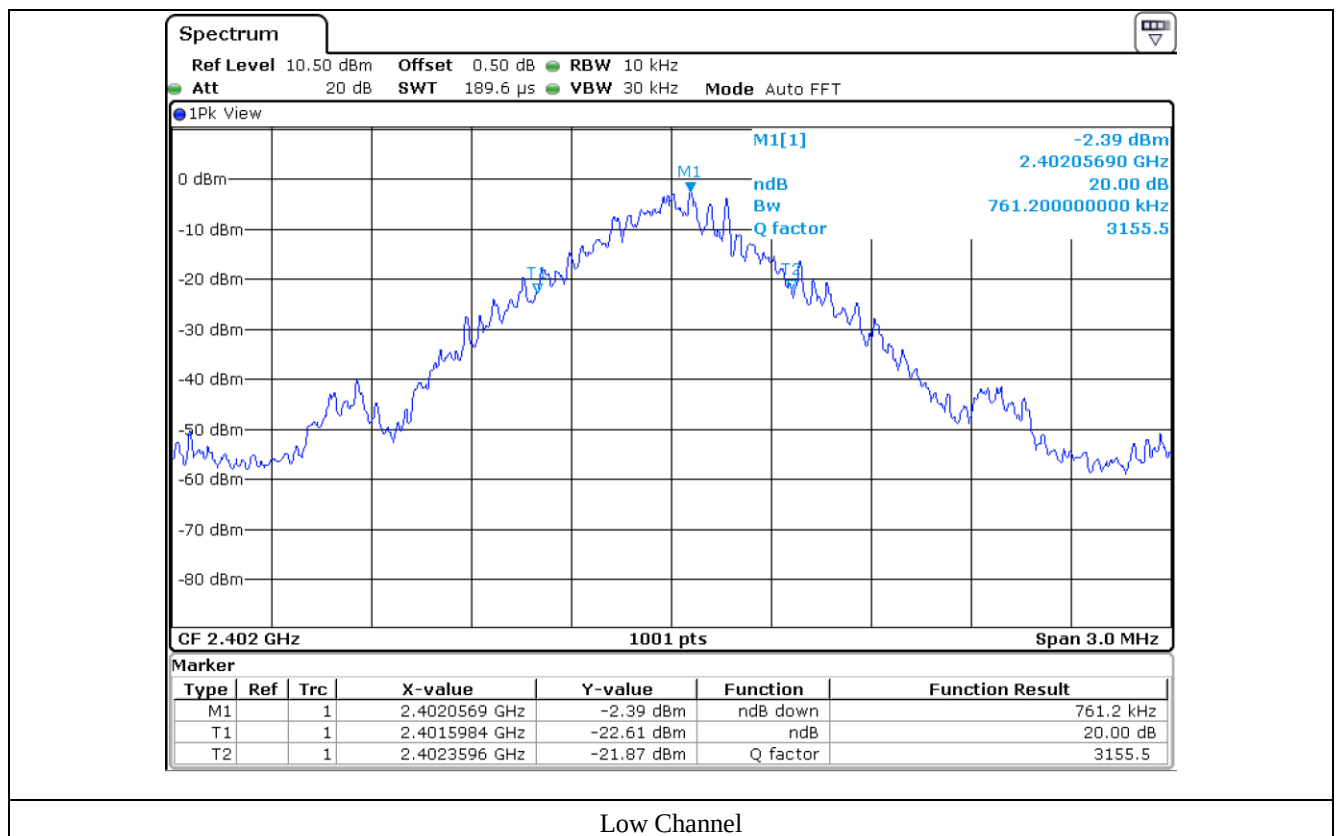
7.4 Test data for 1 Mbps

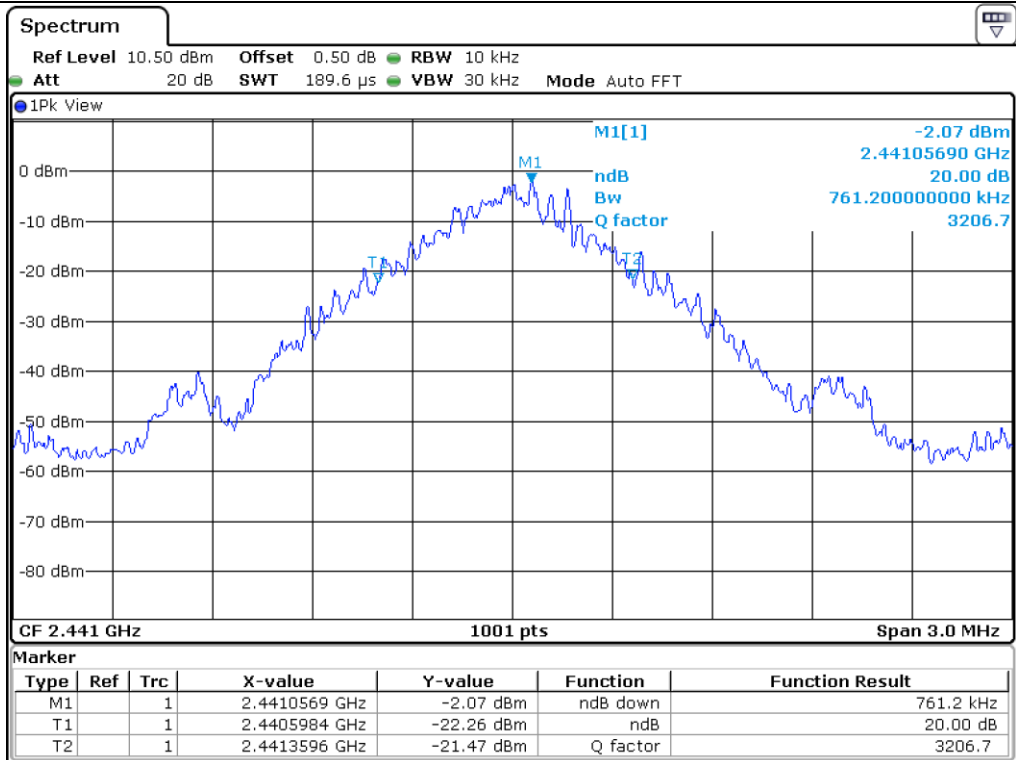
-. Test Date : June 08, 2017

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402	761.20
Middle	2 441	761.20
High	2 480	761.20

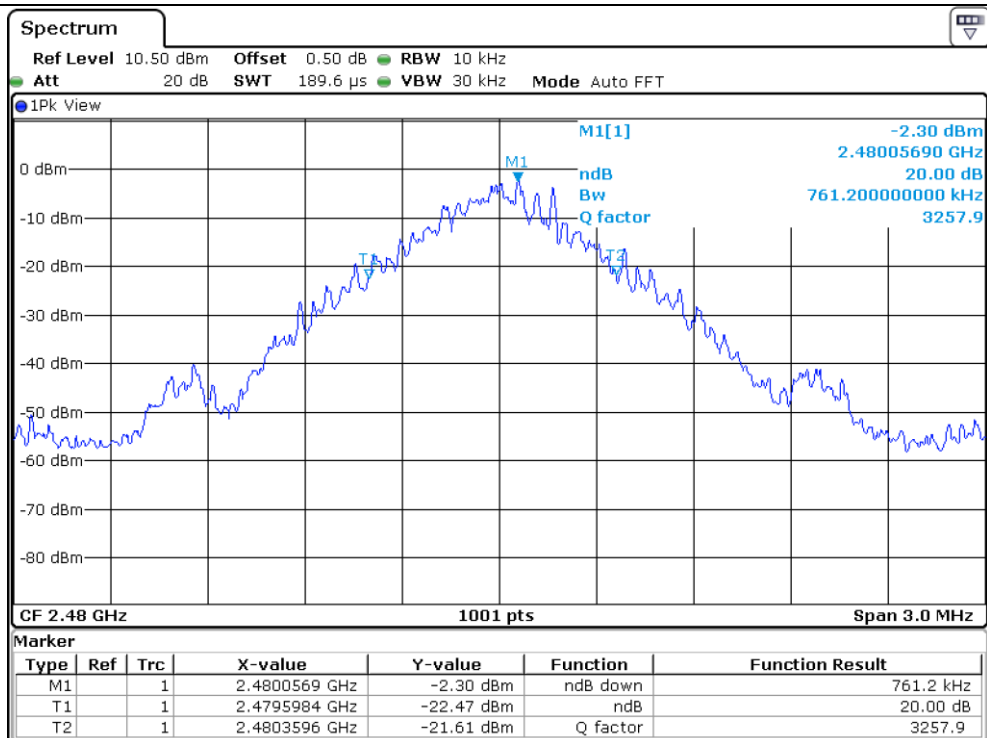


Tested by: Min-Gu Ji / Assistant Manager





Middle Channel



High Channel

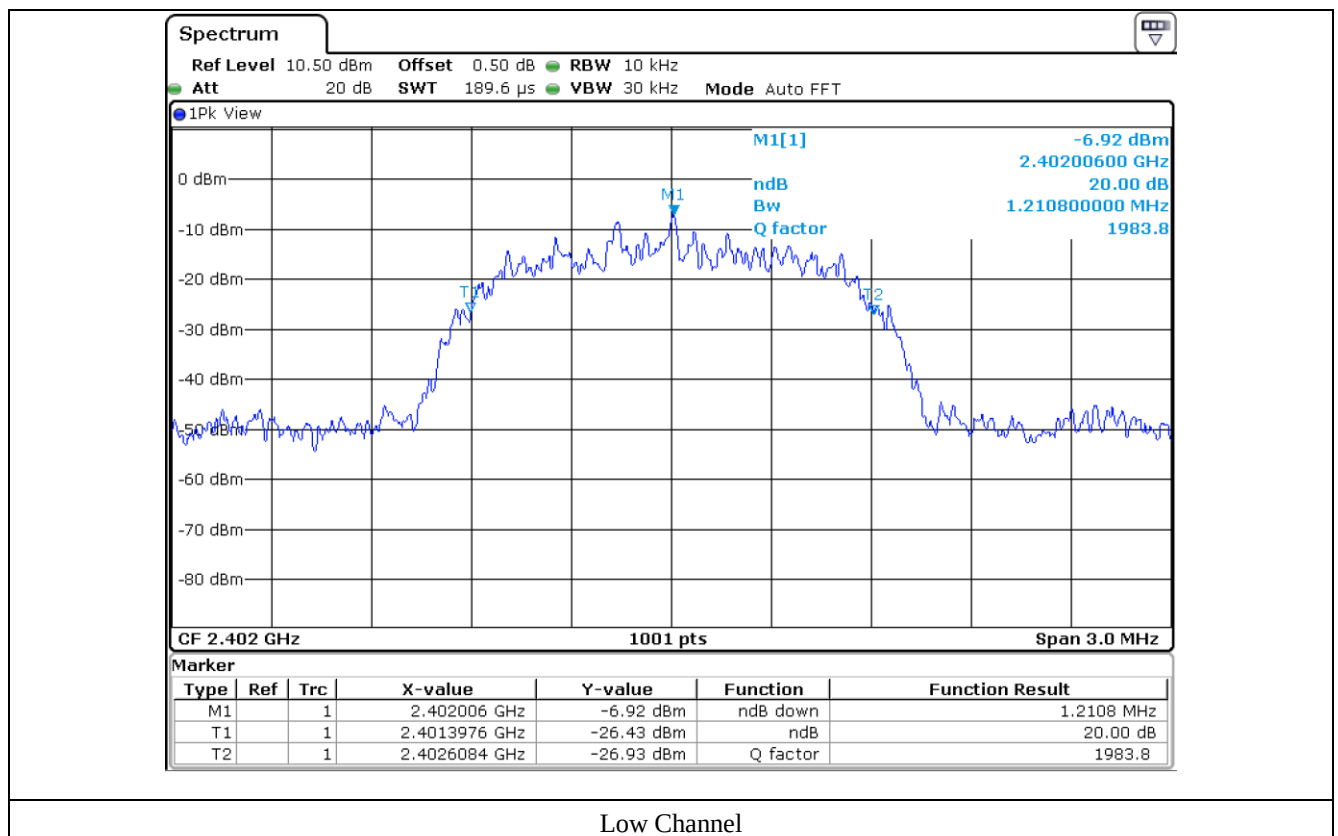
7.5 Test data for 2 Mbps

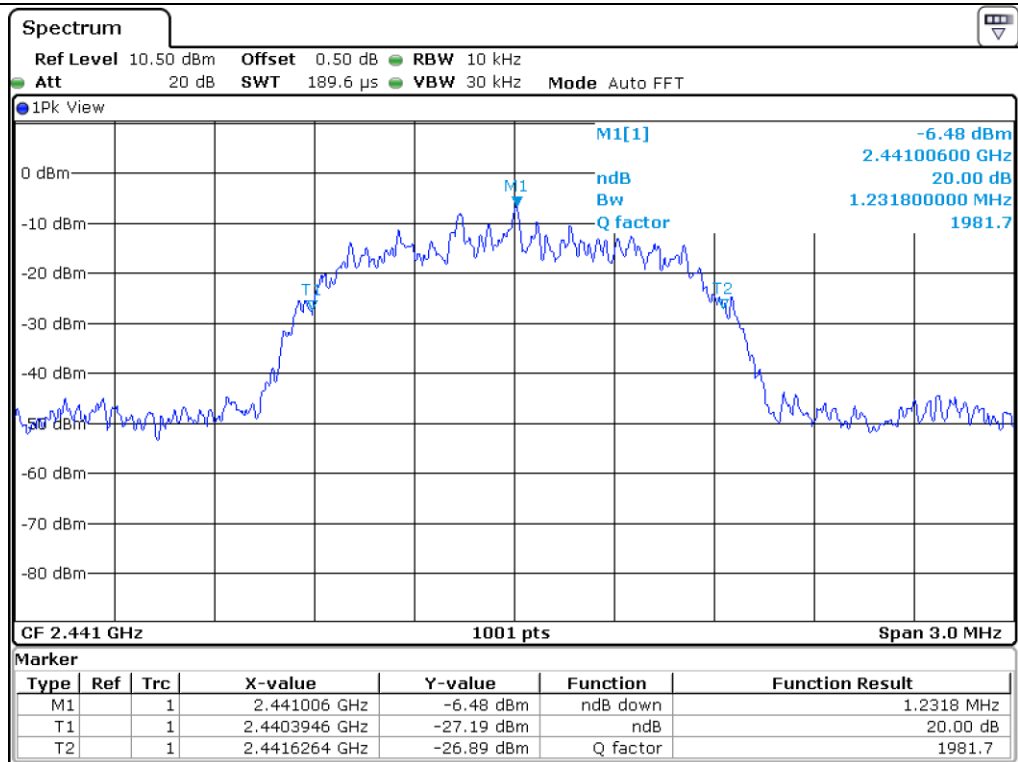
-. Test Date : June 08, 2017

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402	1 210.80
Middle	2 441	1 231.80
High	2 480	1 231.80

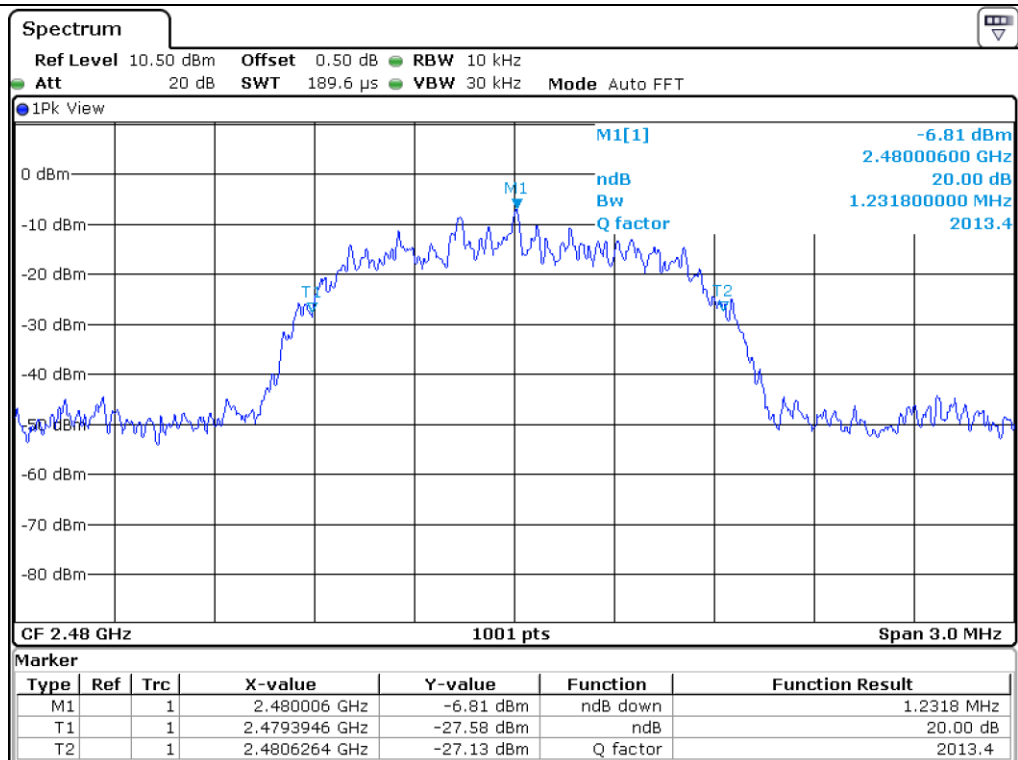


Tested by: Min-Gu Ji / Assistant Manager





Middle Channel



High Channel

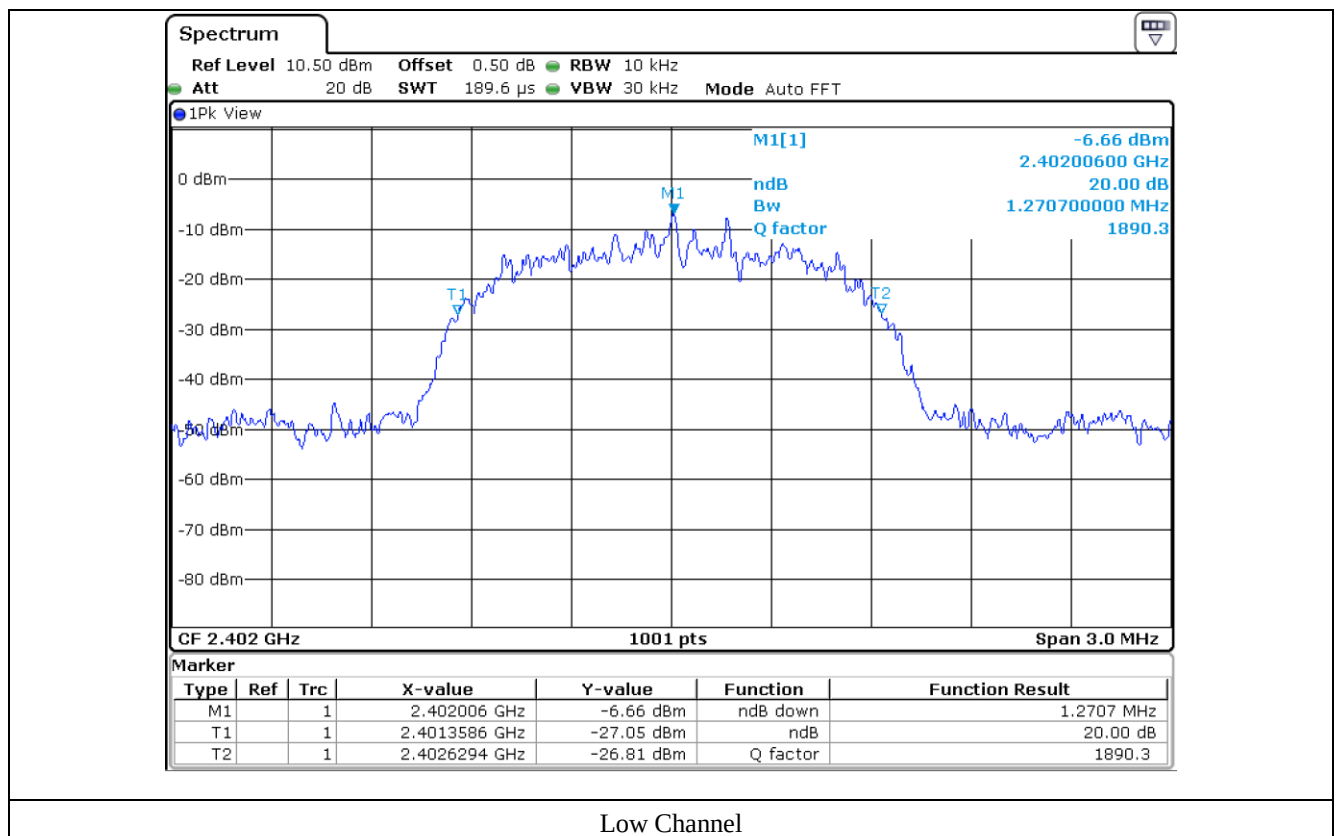
7.6 Test data for 3 Mbps

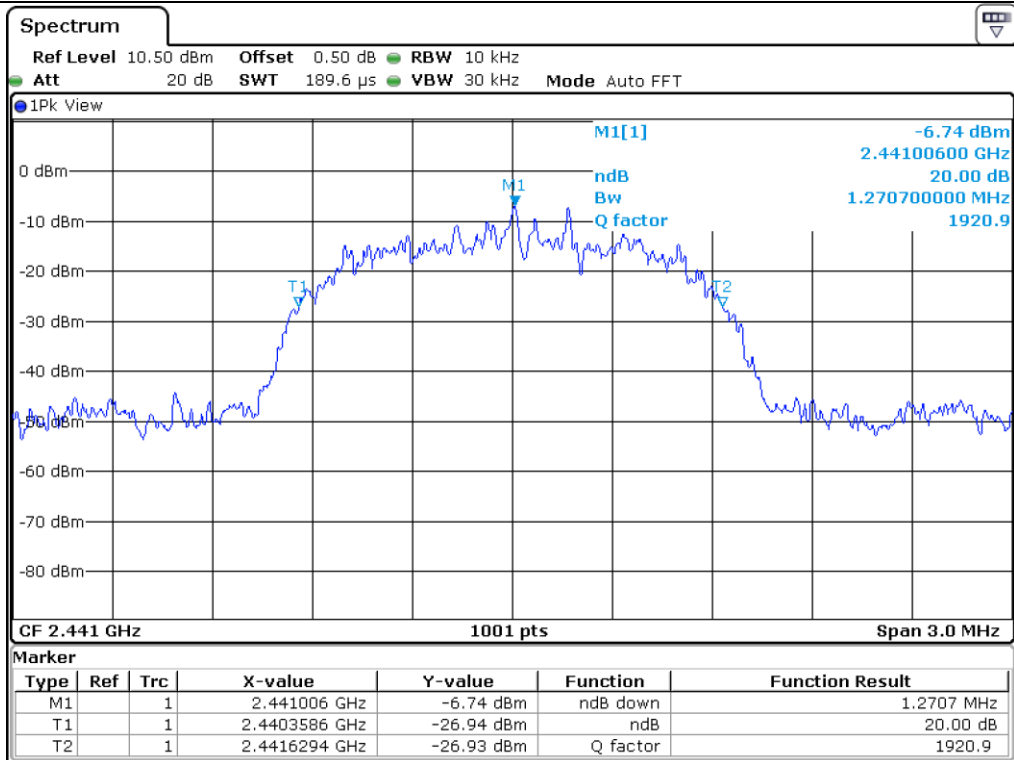
-. Test Date : June 08, 2017

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402	1 270.70
Middle	2 441	1 270.70
High	2 480	1 270.70

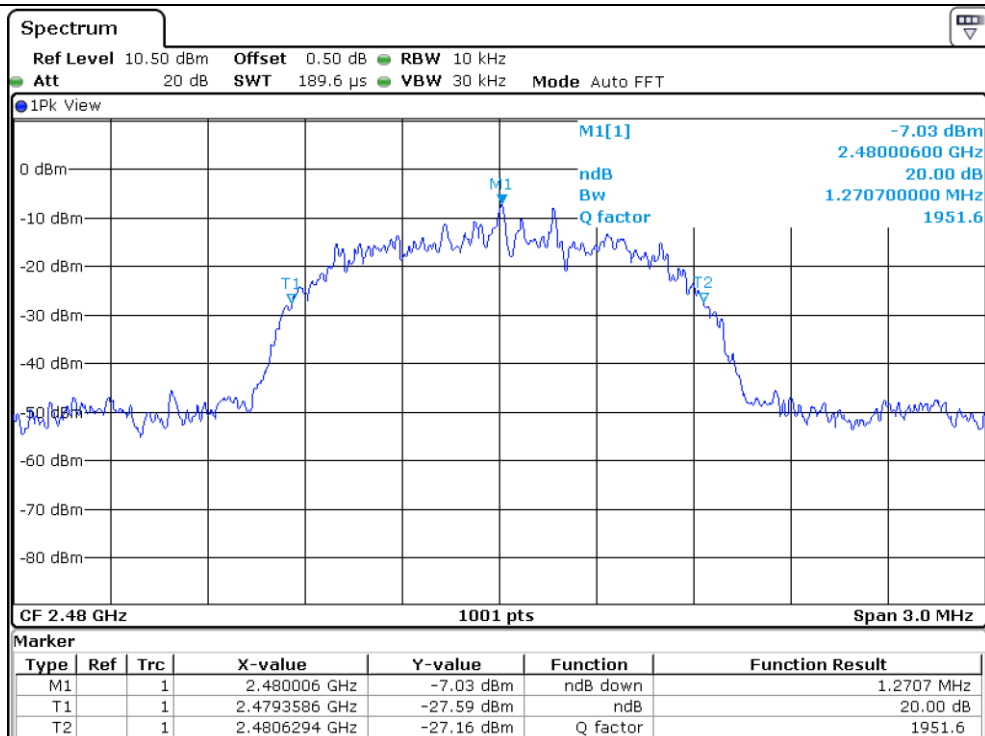


Tested by: Min-Gu Ji / Assistant Manager





Middle Channel



High Channel

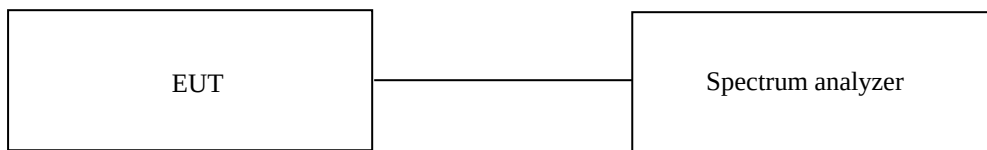
8. HOPPING FREQUENCY SEPARATION

8.1 Operating environment

Temperature : 23 °C
Relative humidity : 44 % 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.
■ -	FSV40	Rohde & Schwarz	Signal Analyzer	101009	Apr. 05, 2017 (1Y)

All test equipment used is calibrated on a regular basis.

8.4 Test data for 1 Mbps

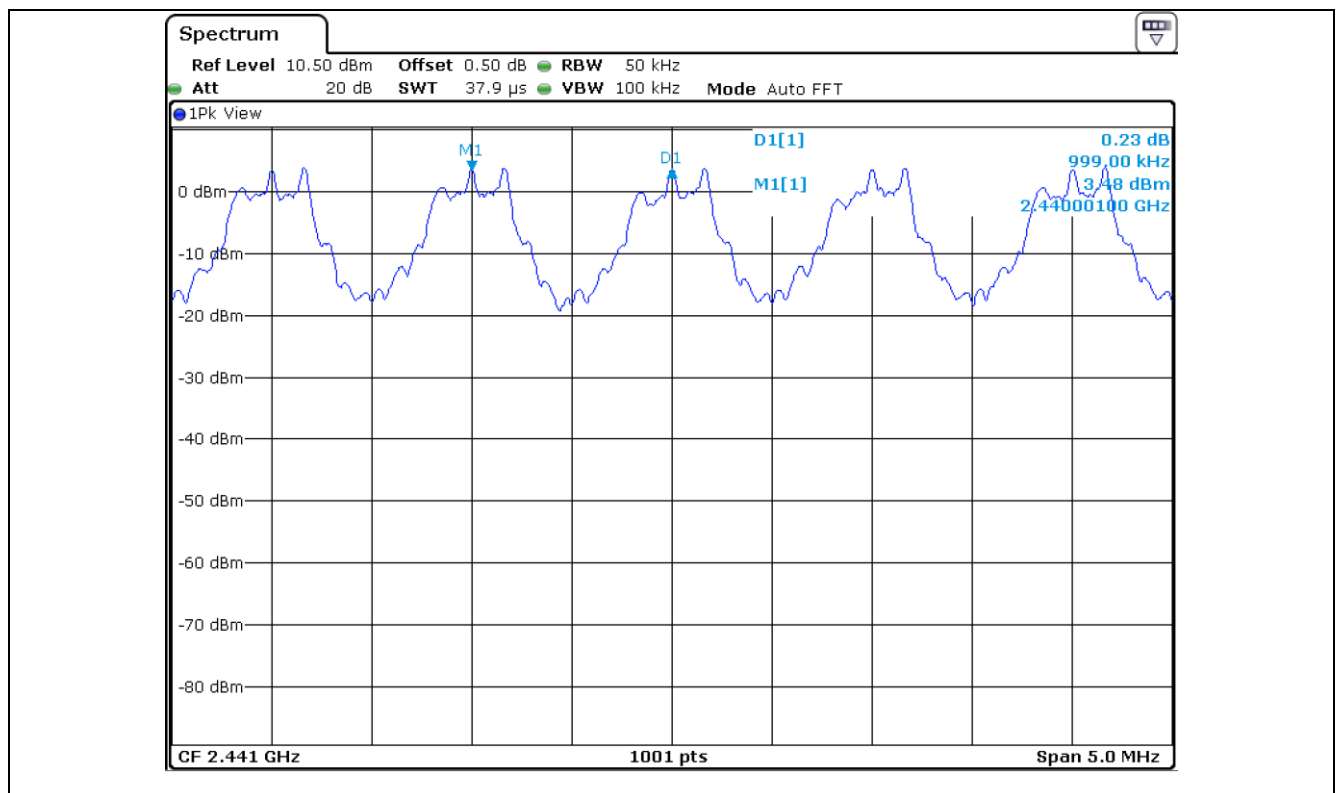
-. Test Date : June 08, 2017

-. Test Result : Pass

MEASURED VLAUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
999.00	507.47	Separated by a minimum of 25 kHz



Tested by: Min-Gu Ji / Assistant Manager



8.5 Test data for 2 Mbps

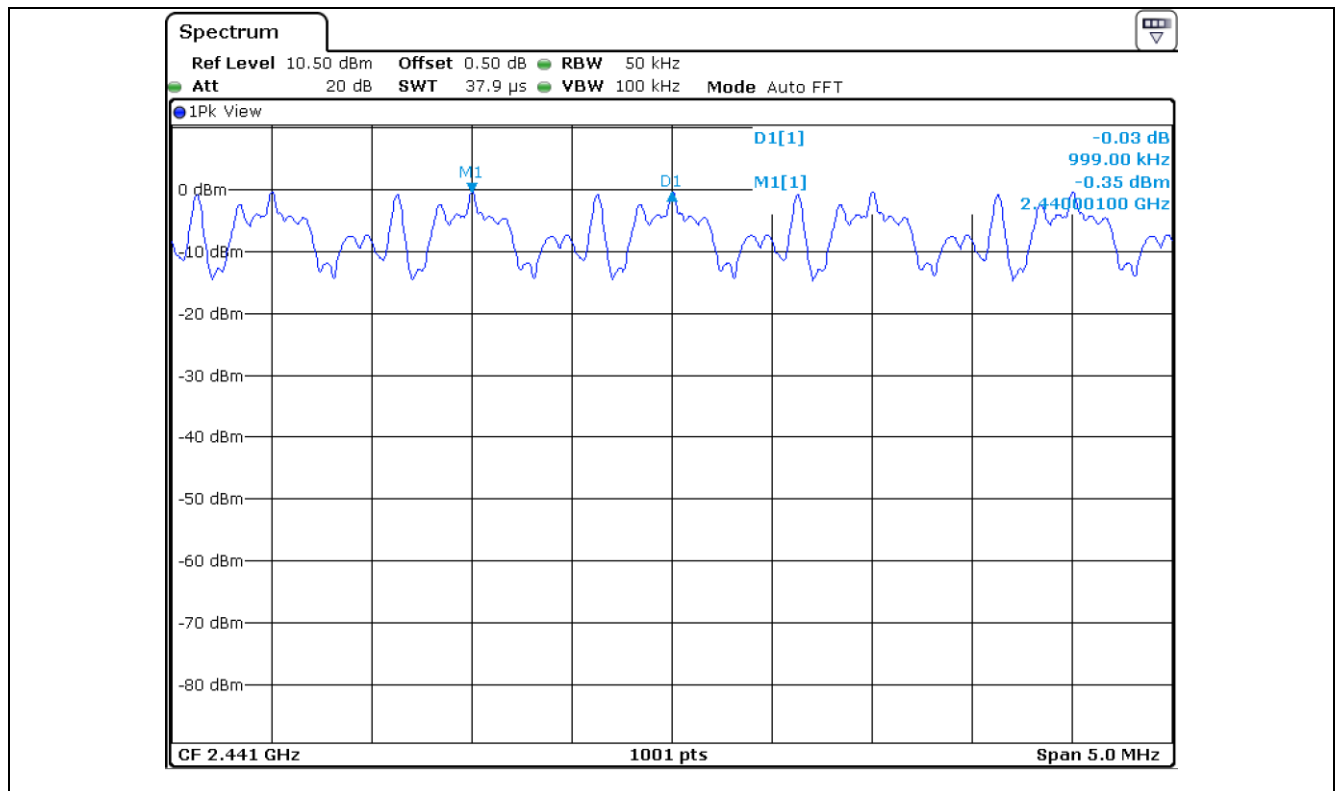
-. Test Date : June 08, 2017

-. Test Result : Pass

MEASURED VLAUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
999.00	821.20	Separated by a minimum of 25 kHz



Tested by: Min-Gu Ji / Assistant Manager



8.6 Test data for 3 Mbps

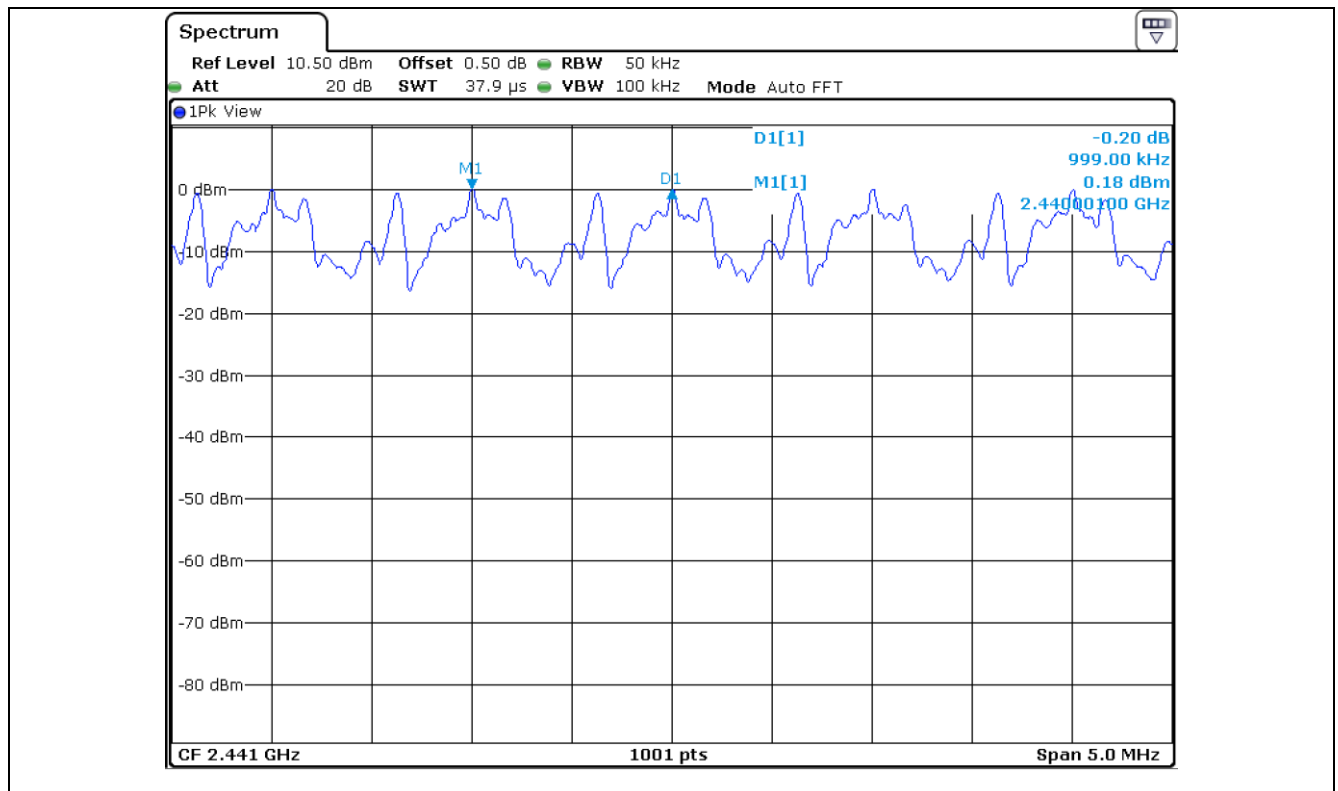
-. Test Date : June 08, 2017

-. Test Result : Pass

MEASURED VLAUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
999.00	847.13	Separated by a minimum of 25 kHz



Tested by: Min-Gu Ji / Assistant Manager



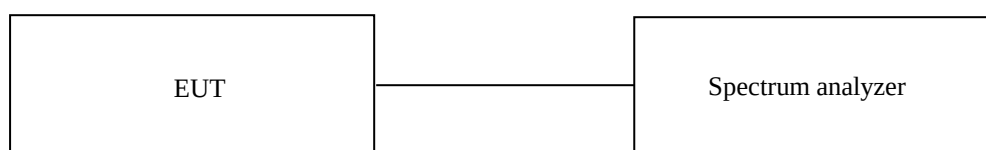
9. NUMBER OF HOPPING CHANNELS

9.1 Operating environment

Temperature : 23 °C
Relative humidity : 44 % R.H.

9.2 Test set-up

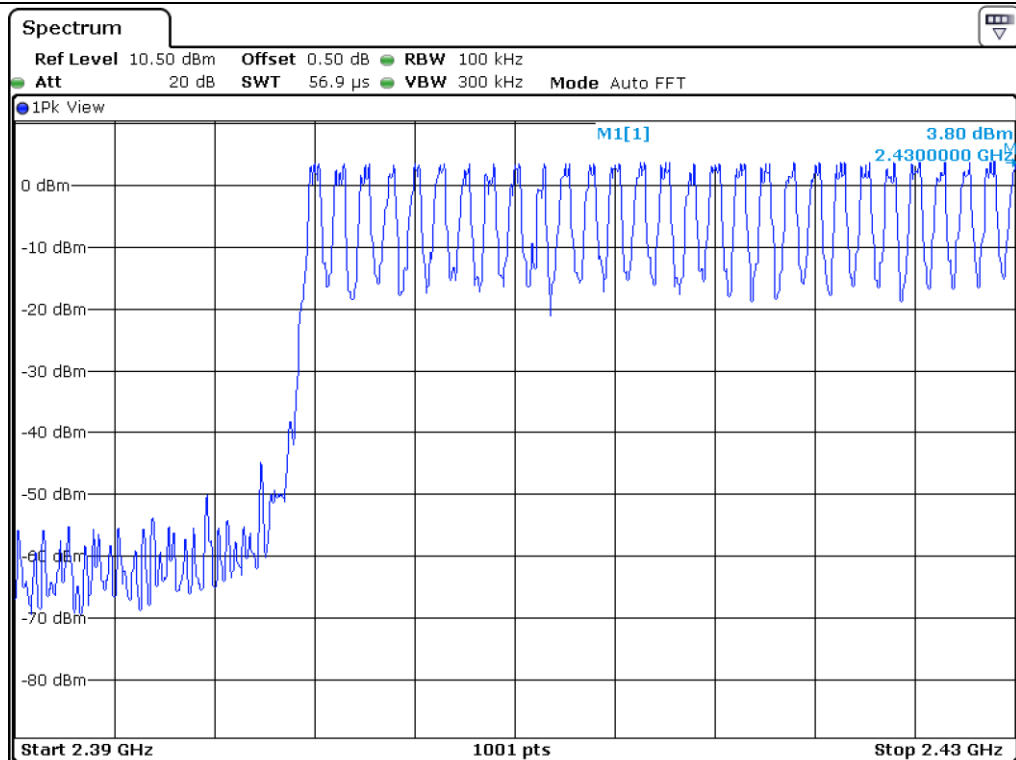
The antenna output of the EUT was connected to the spectrum analyzer. The frequency span is set to 100 MHz and the resolution bandwidth is set to 1 MHz. The analyzer is set to peak hold and then complete pseudo-random hopping sequence of the transmitter is captured.



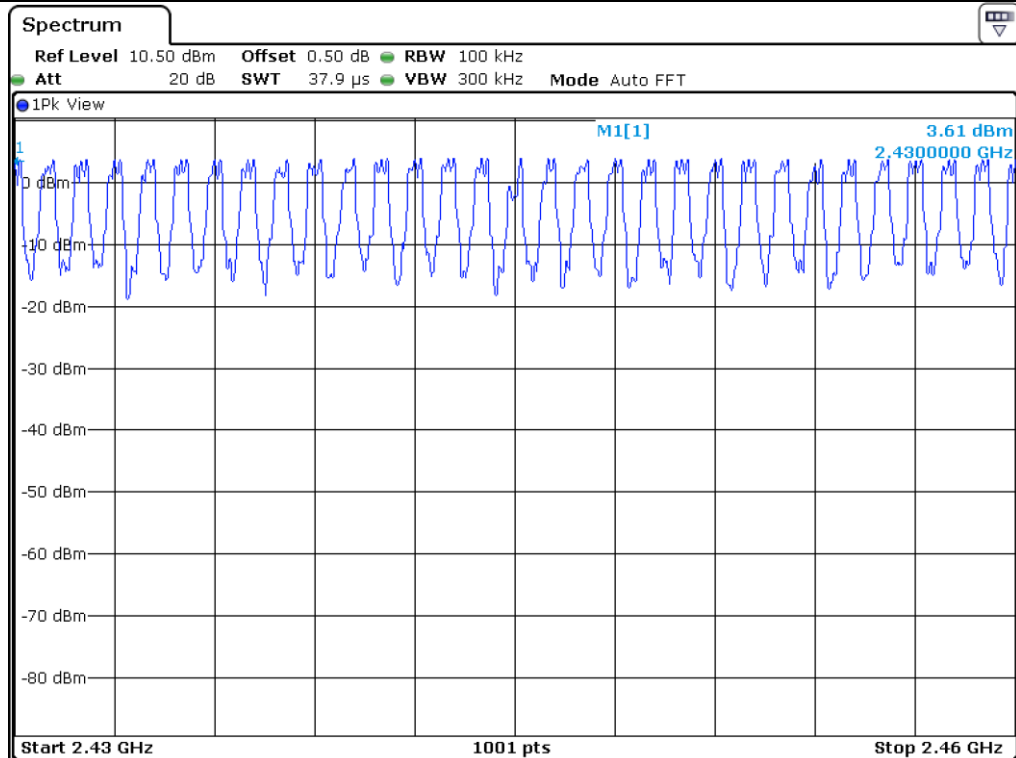
9.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal.
■ -	FSV40	Rohde & Schwarz	Signal Analyzer	101009	Apr. 05, 2017 (1Y)

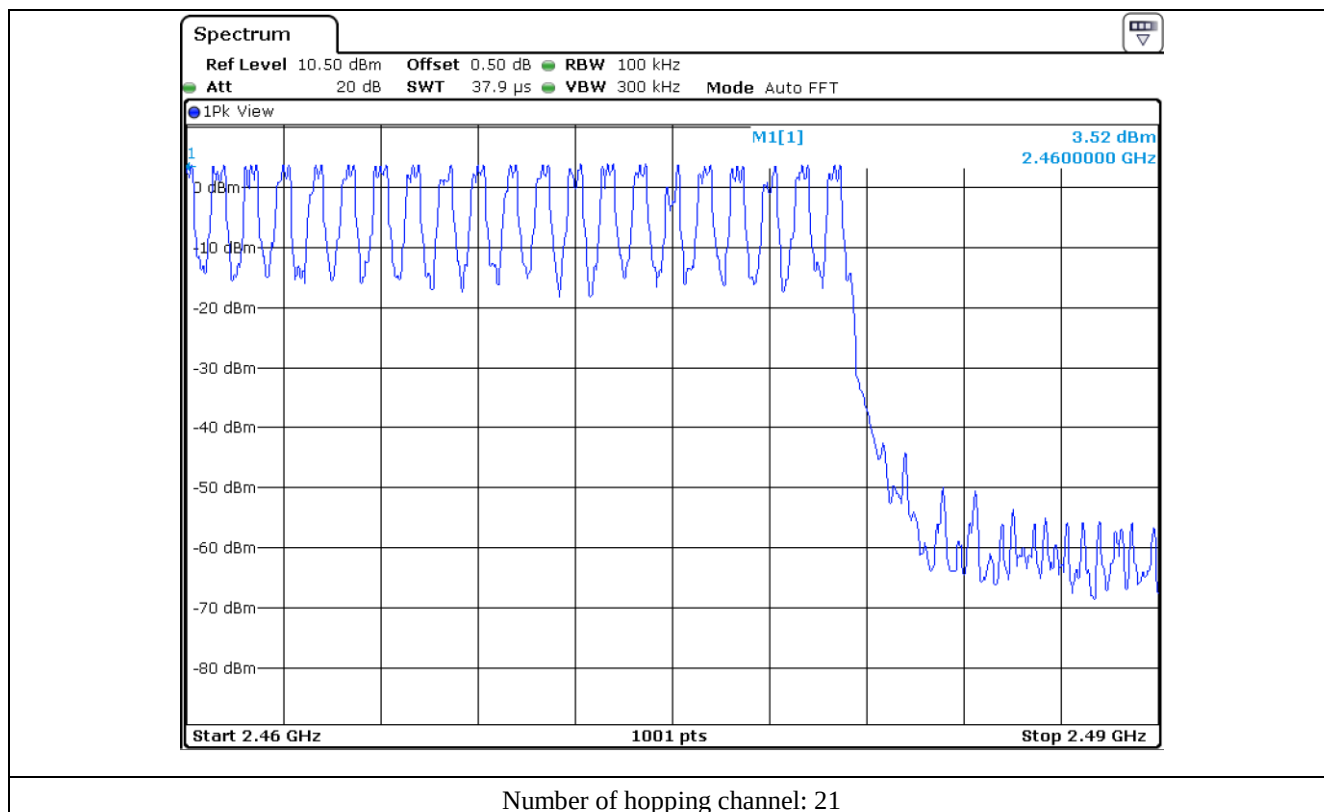
All test equipment used is calibrated on a regular basis.



Number of hopping channel: 28



Number of hopping channel: 30



9.5 Test data for 2 Mbps

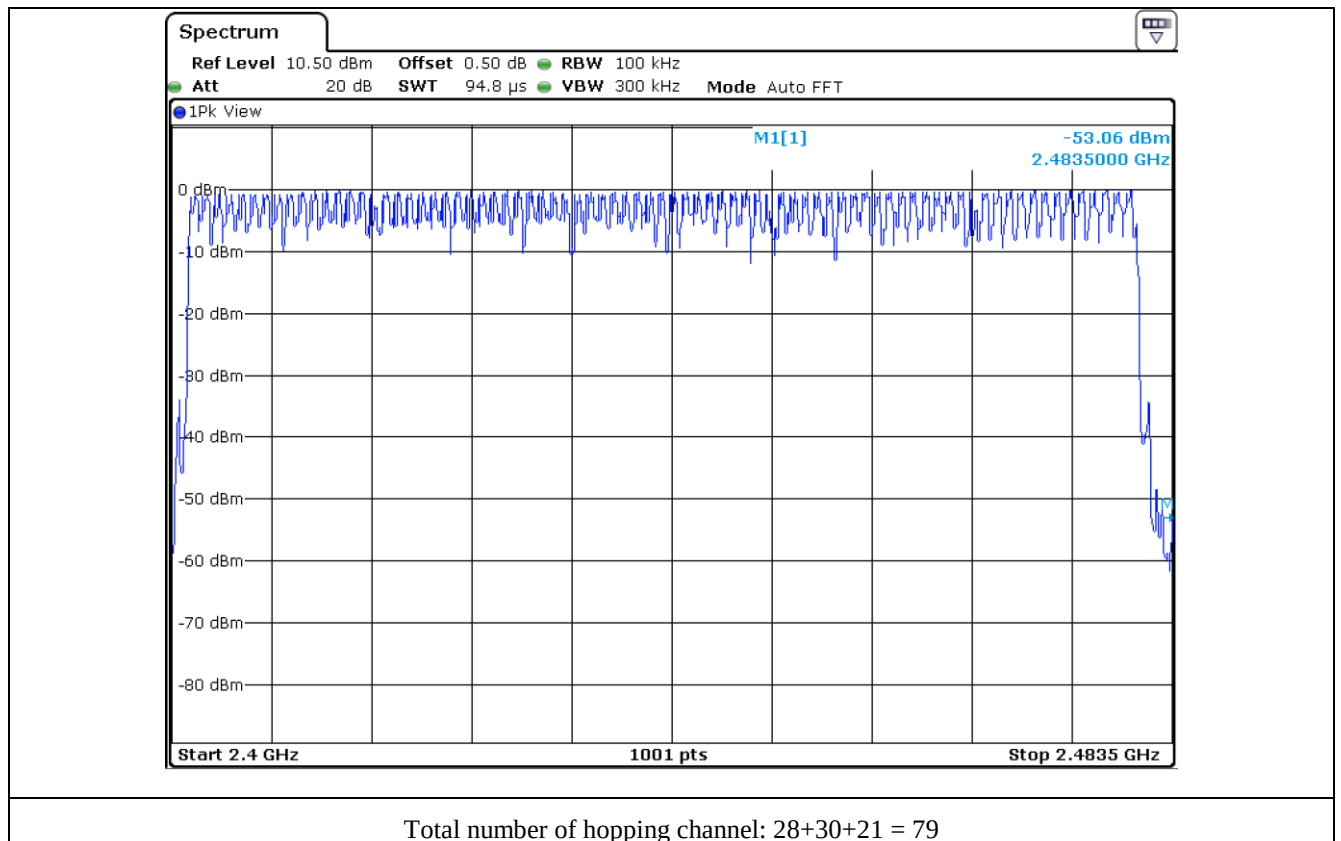
-. Test Date : June 08, 2017

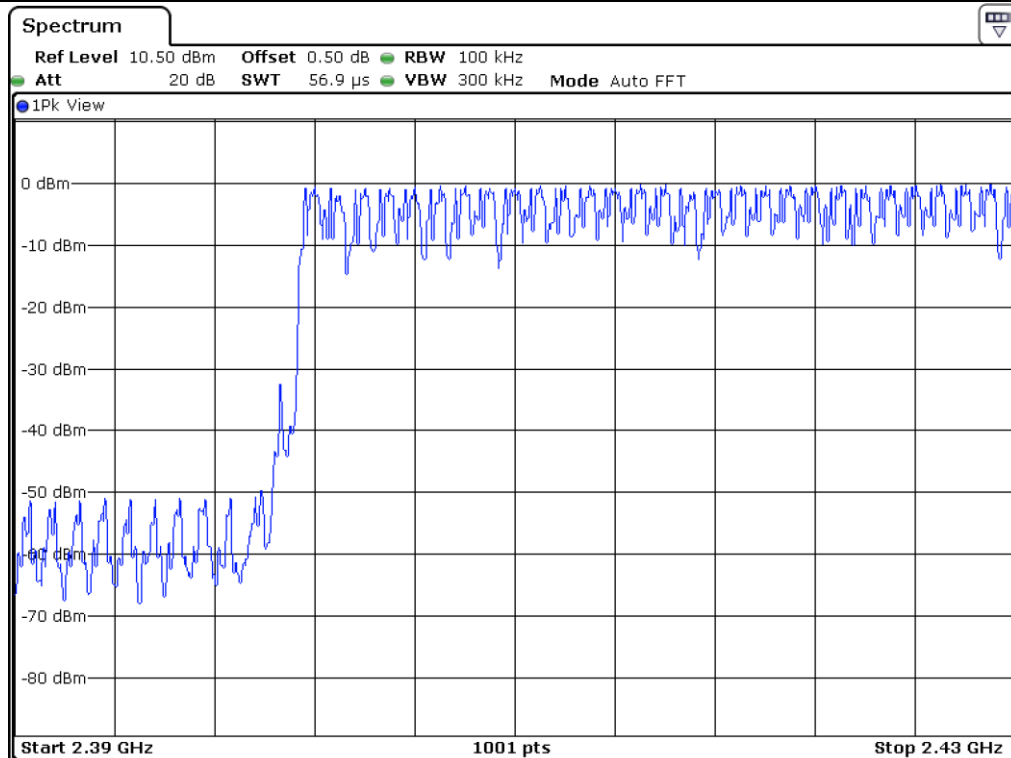
-. Test Result : Pass

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

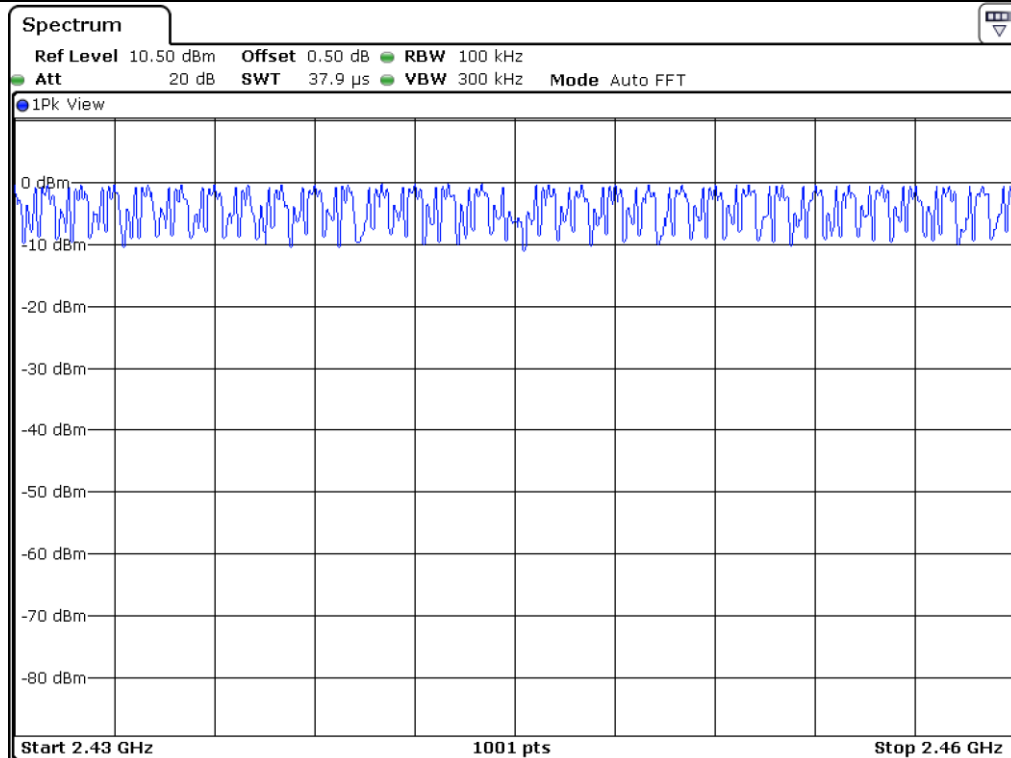


Tested by: Min-Gu Ji / Assistant Manager

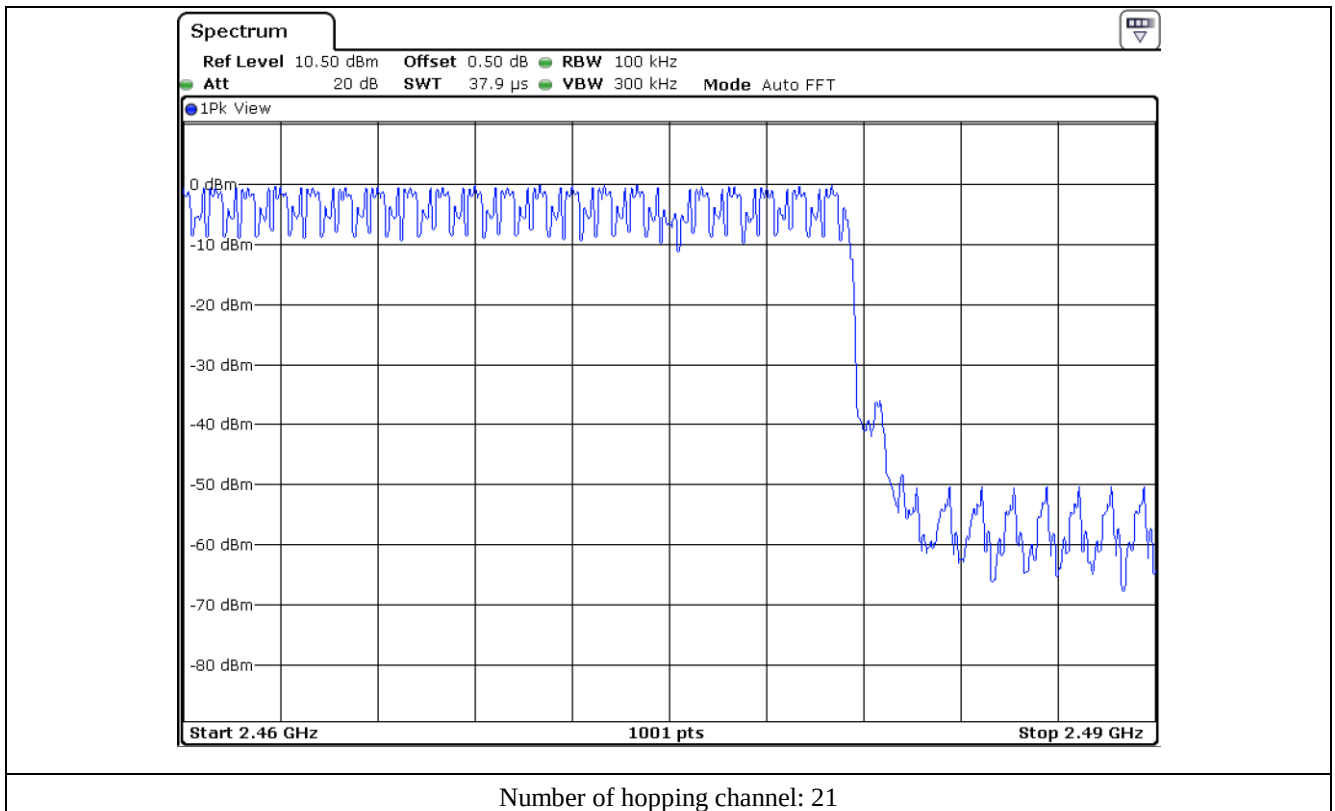




Number of hopping channel: 28



Number of hopping channel: 30



9.6 Test data for 3 Mbps

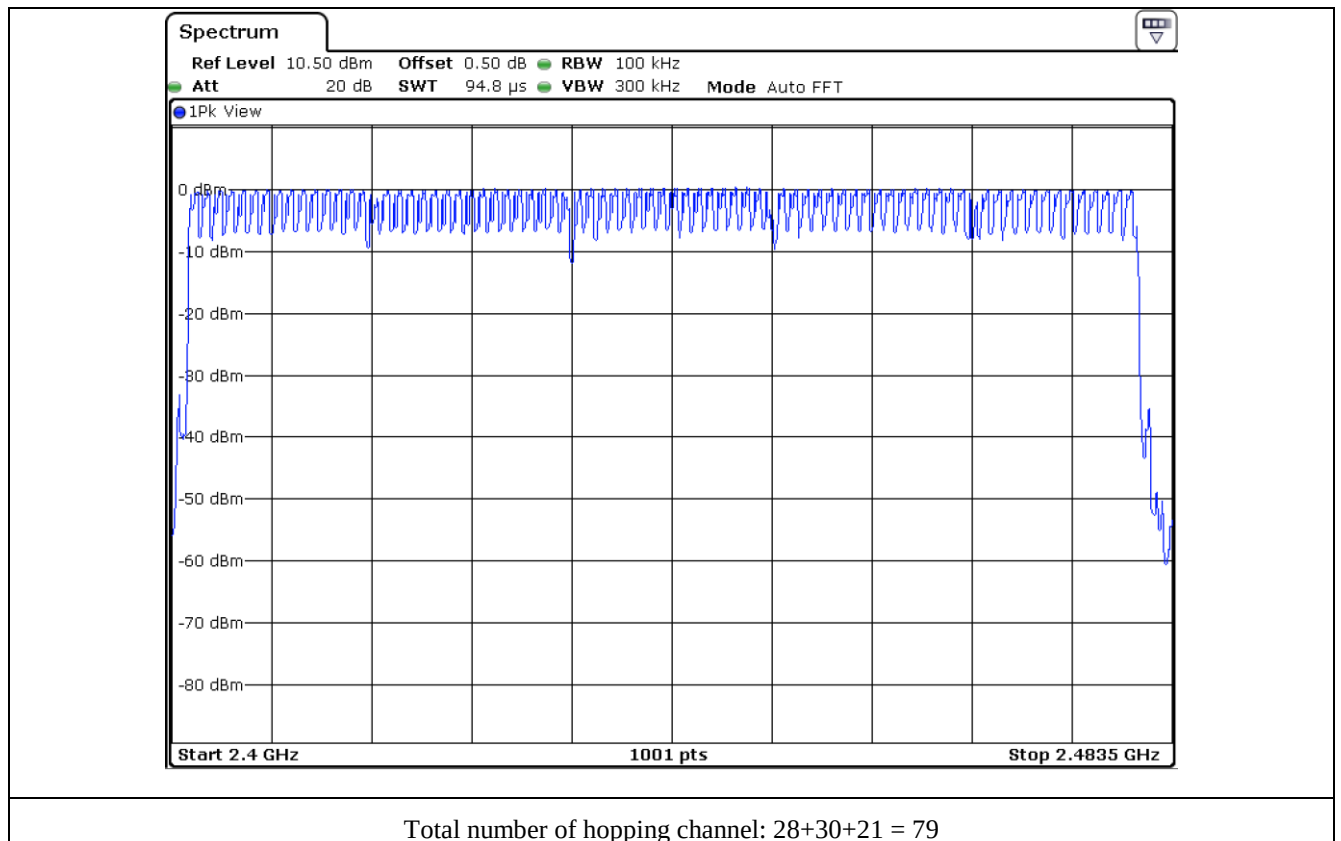
-. Test Date : June 08, 2017

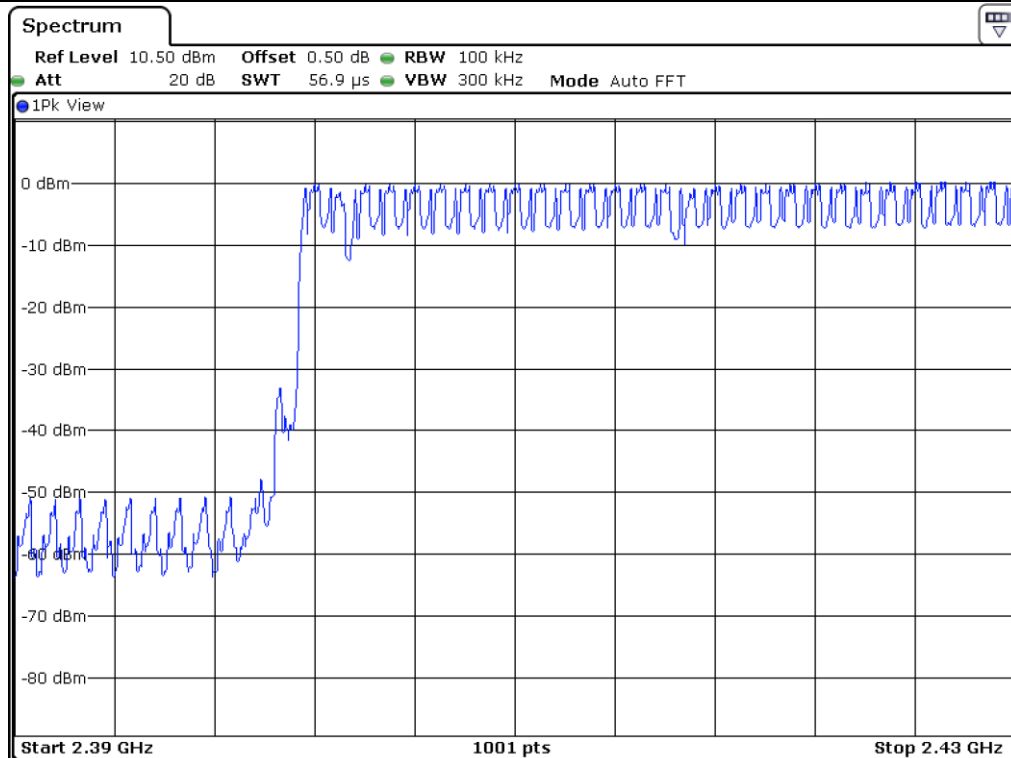
-. Test Result : Pass

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

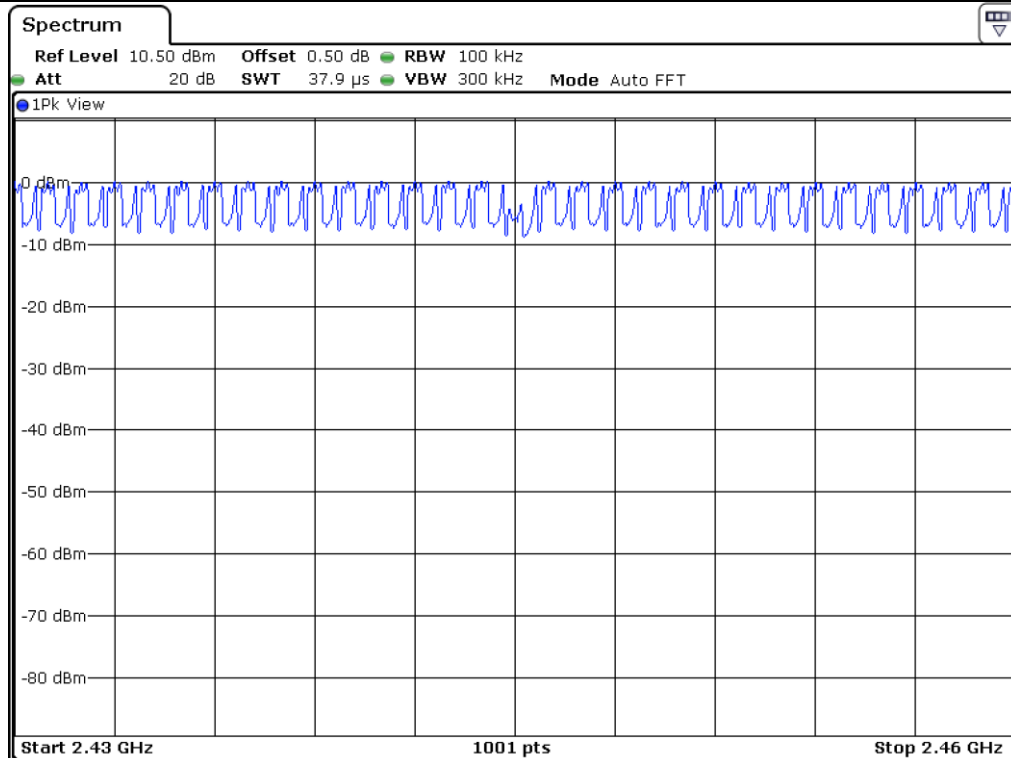


Tested by: Min-Gu Ji / Assistant Manager

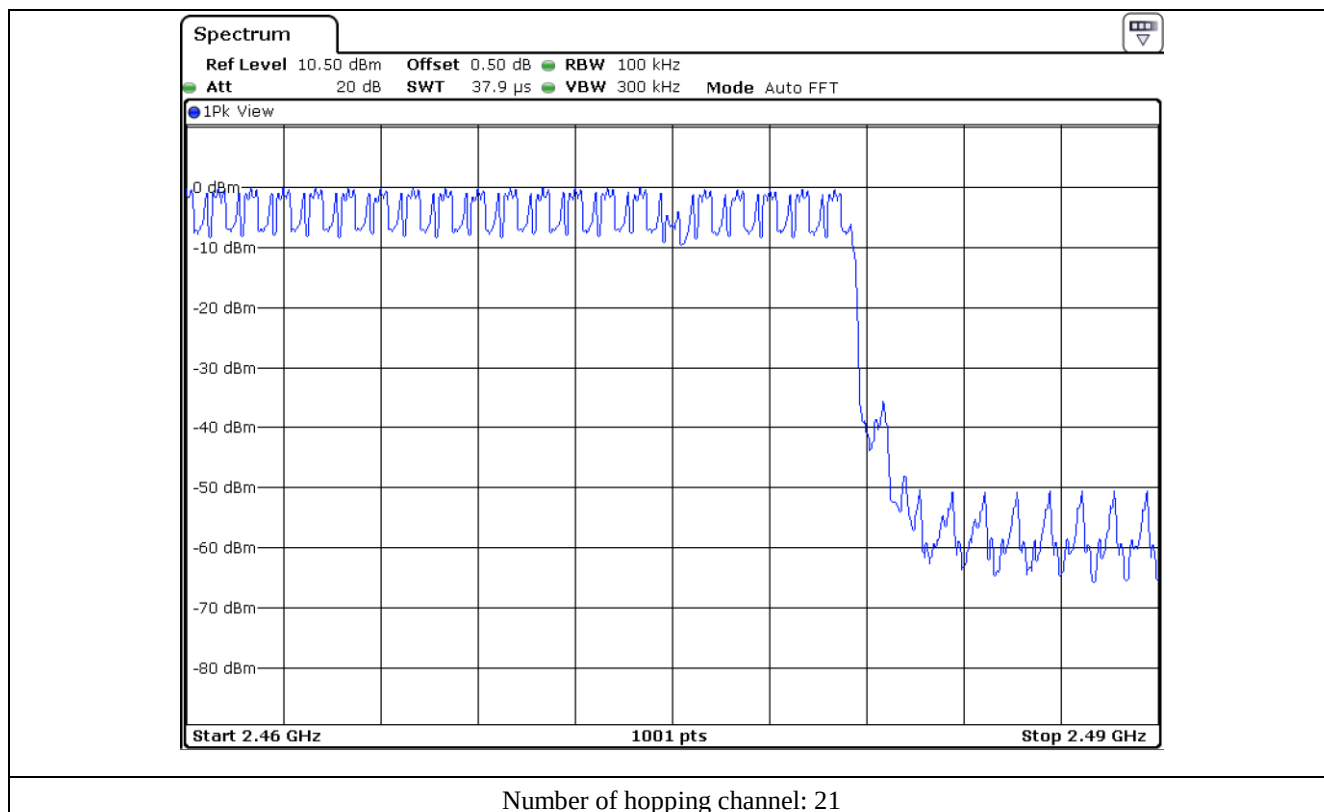




Number of hopping channel: 28



Number of hopping channel: 30



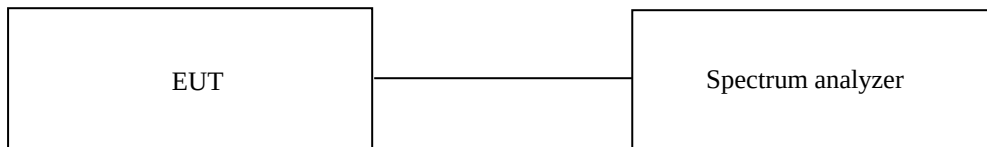
10. TIME OF OCCUPANCY

10.1 Operating environment

Temperature : 23 °C
Relative humidity : 44 % 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.
■ - FSV40	Rohde & Schwarz	Signal Analyzer	101009	Apr. 05, 2017 (1Y)

All test equipment used is calibrated on a regular basis.

10.4 Test data for 1 Mbps

-. Test Date : June 08, 2017

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	0.390	10.13	31.6	124.84	400	PASS
DH3	1.650	5.060	31.6	263.83	400	
DH5	2.890	3.38	31.6	308.68	400	

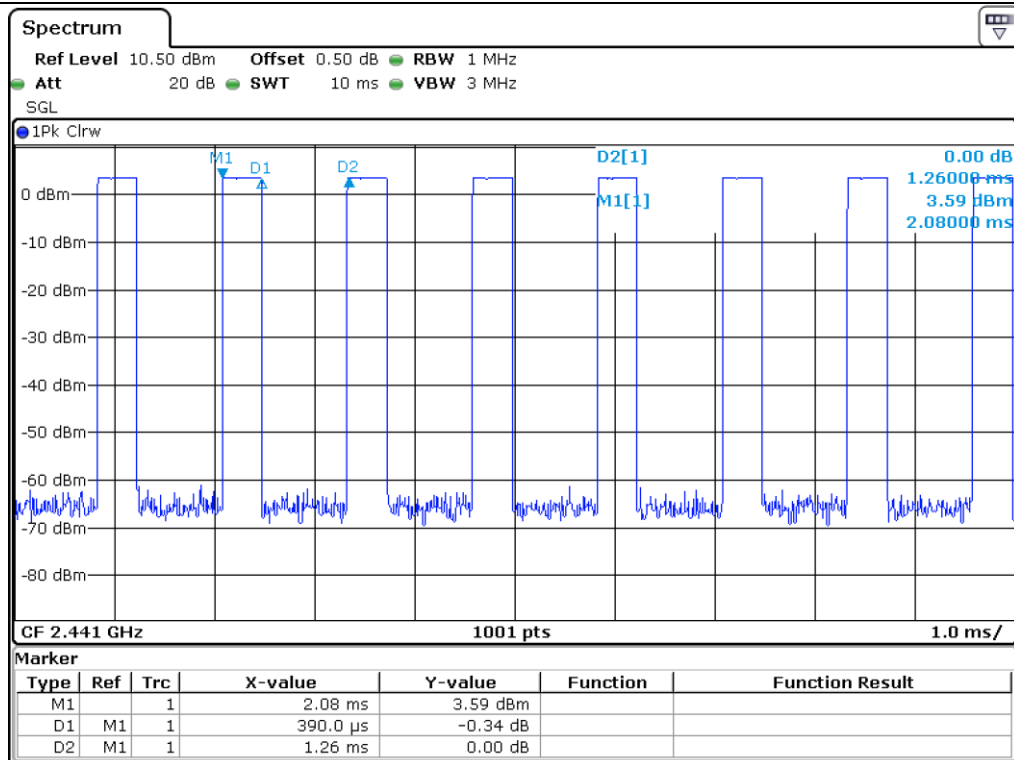
Total dwell time is calculated as following.

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

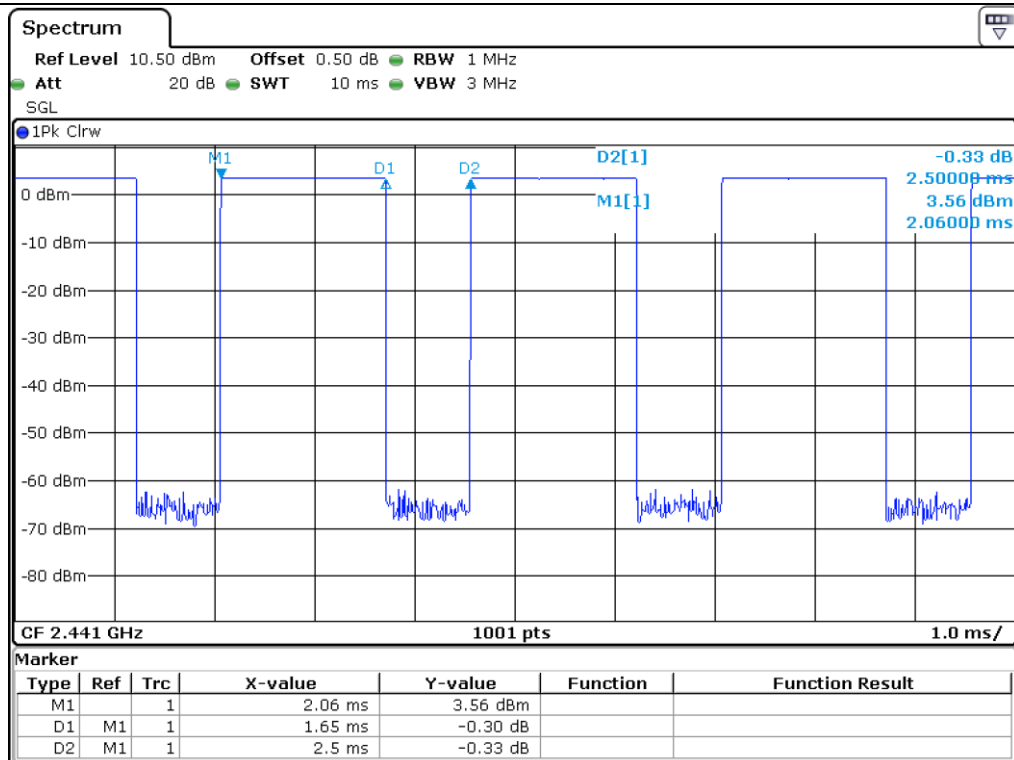
Remark: See next page for an overview sweep performed with peak detector.



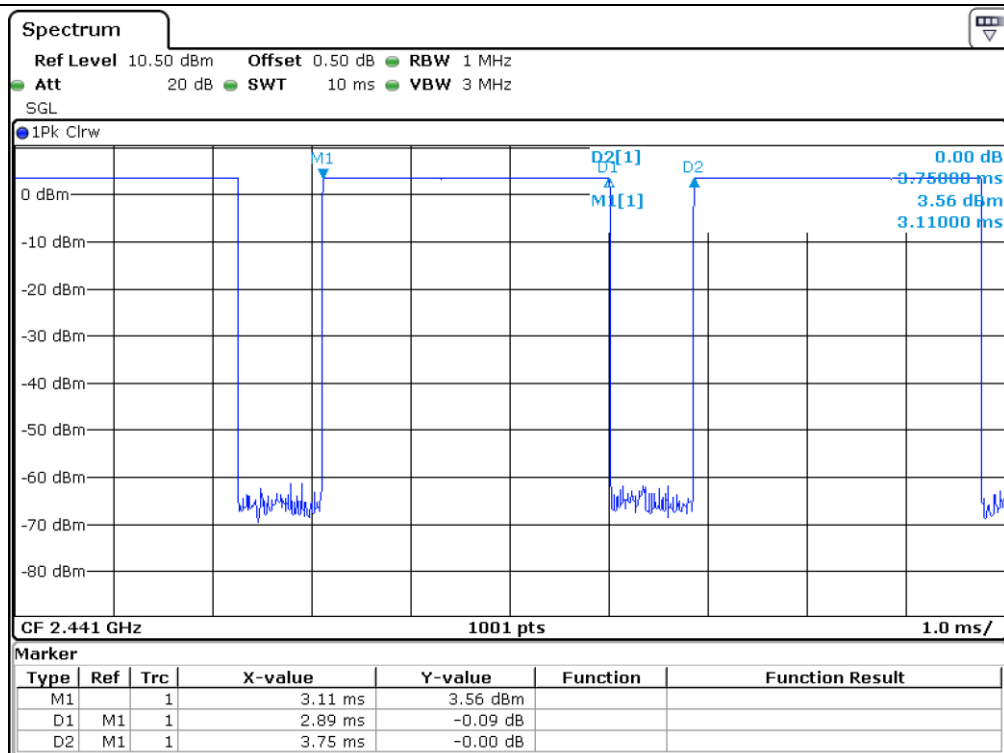
Tested by: Min-Gu Ji / Assistant Manager



DH1



DH3



DH5

10.5 Test data for 2 Mbps

-. Test Date : June 08, 2017

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	0.410	10.13	31.6	131.24	400	PASS
2-DH3	1.660	5.060	31.6	265.43	400	
2-DH5	2.900	3.38	31.6	309.74	400	

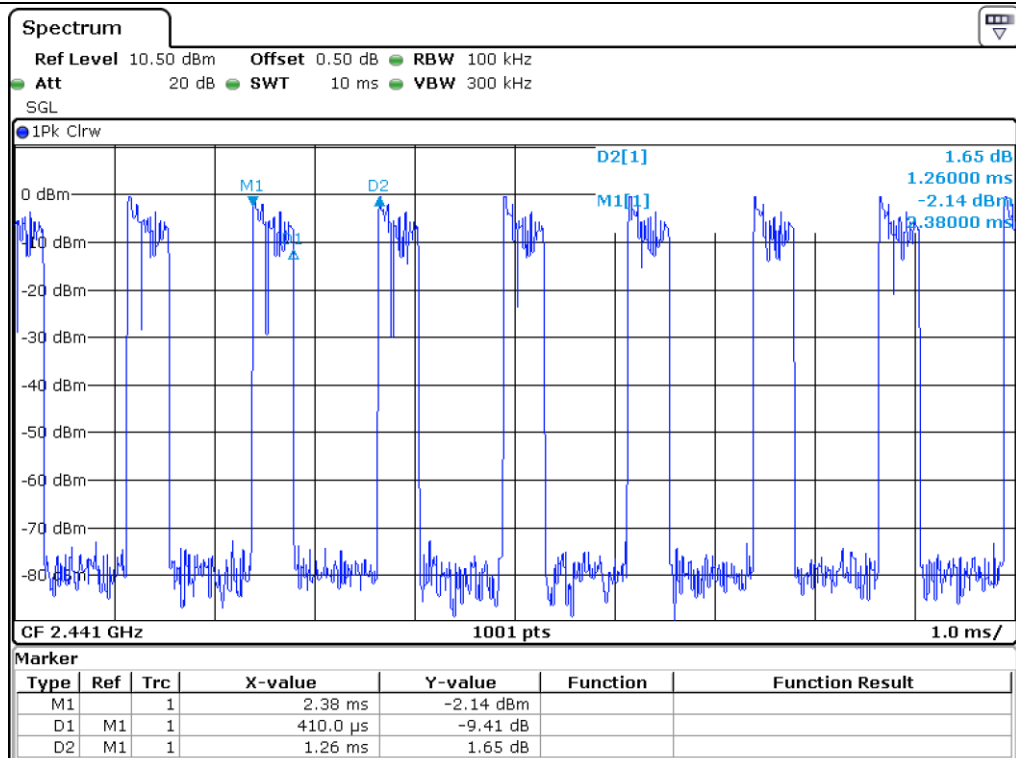
Total dwell time is calculated as following.

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

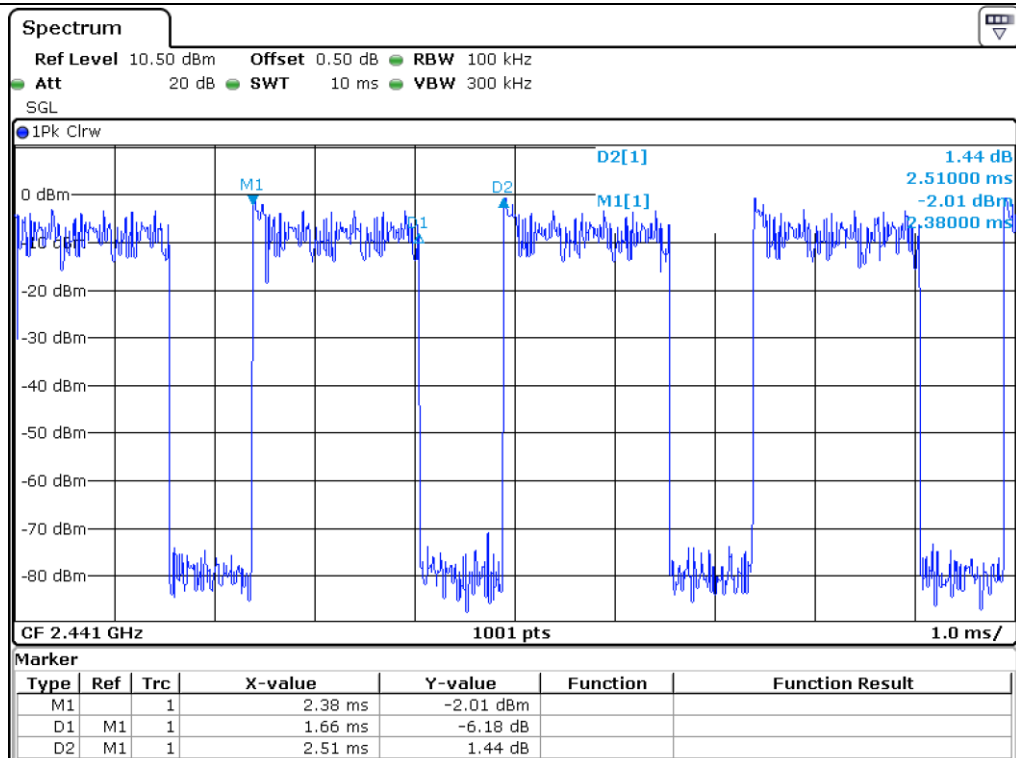
Remark: See next page for an overview sweep performed with peak detector.



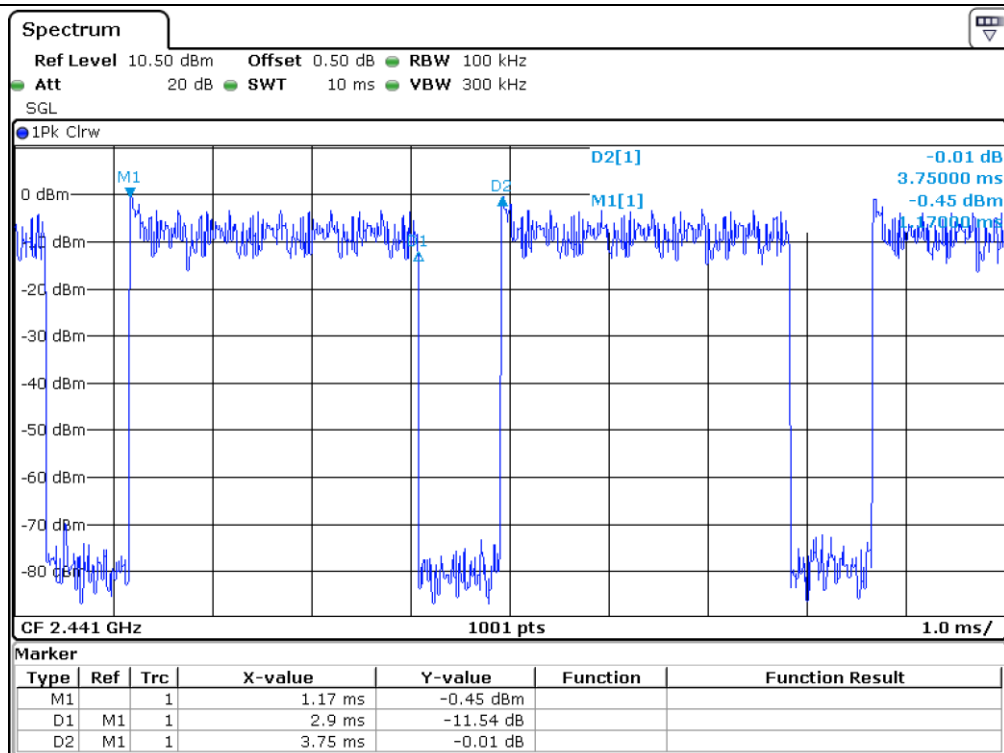
Tested by: Min-Gu Ji / Assistant Manager



2-DH1



2-DH3



2-DH5

10.6 Test data for 3 Mbps

-. Test Date : June 08, 2017

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	0.400	10.13	31.6	128.04	400	PASS
3-DH3	1.650	5.060	31.6	263.83	400	
3-DH5	2.910	3.38	31.6	310.81	400	

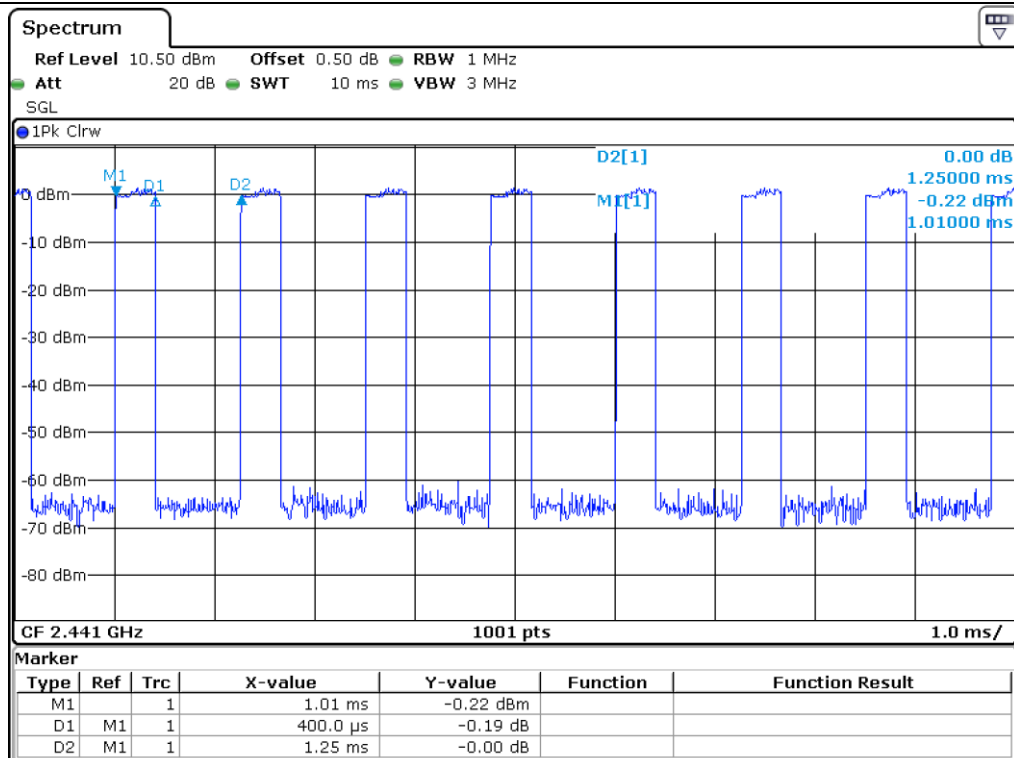
Total dwell time is calculated as following.

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

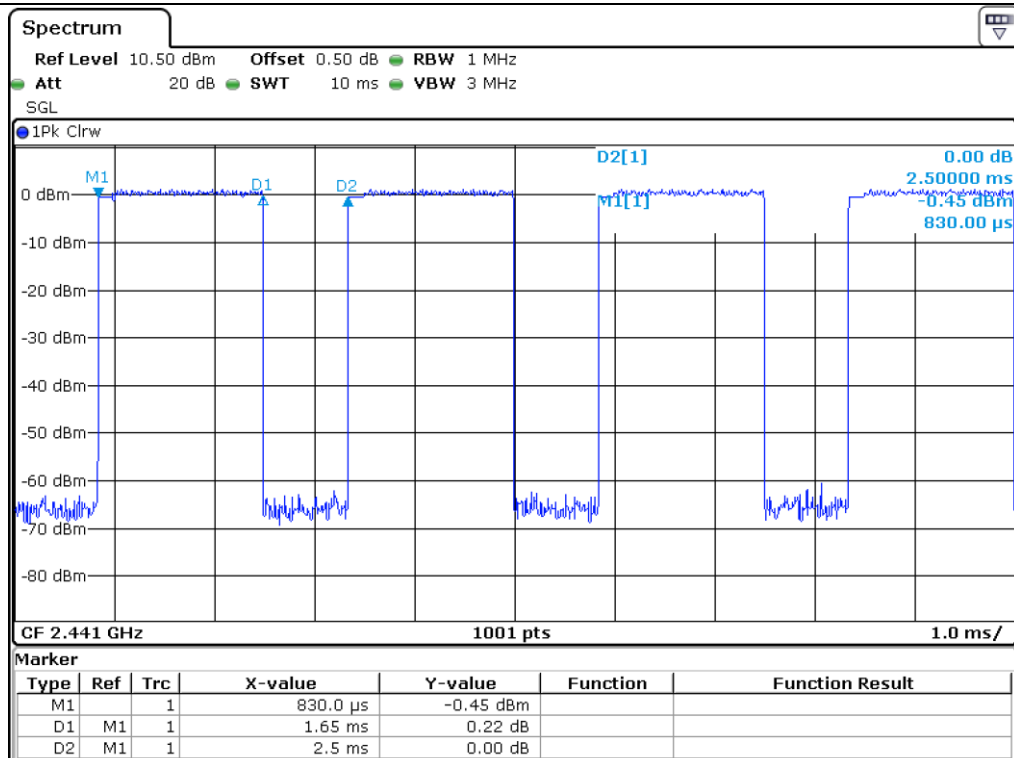
Remark: See next page for an overview sweep performed with peak detector.



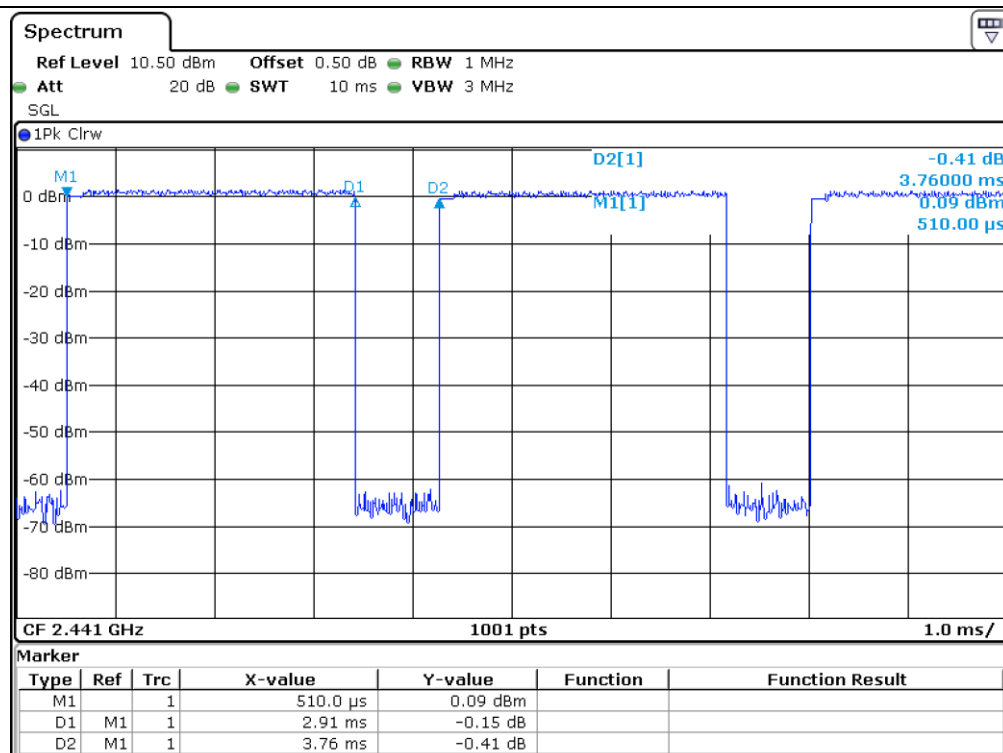
Tested by: Min-Gu Ji / Assistant Manager



3-DH1



3-DH3



3-DH5

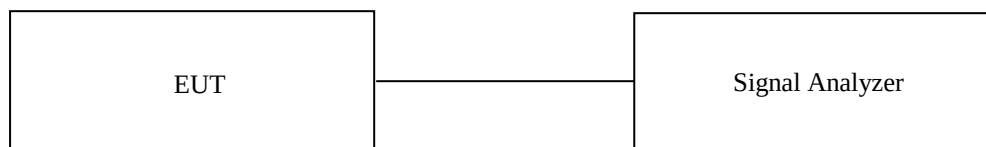
11. MAXIMUM PEAK OUTPUT POWER

11.1 Operating environment

Temperature : 23 °C
Relative humidity : 44 % 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.
■ - FSV40	Rohde & Schwarz	Signal Analyzer	101009	Apr. 05, 2017 (1Y)

All test equipment used is calibrated on a regular basis.

11.4 Test data for 1 Mbps

-. Test Date : June 08, 2017

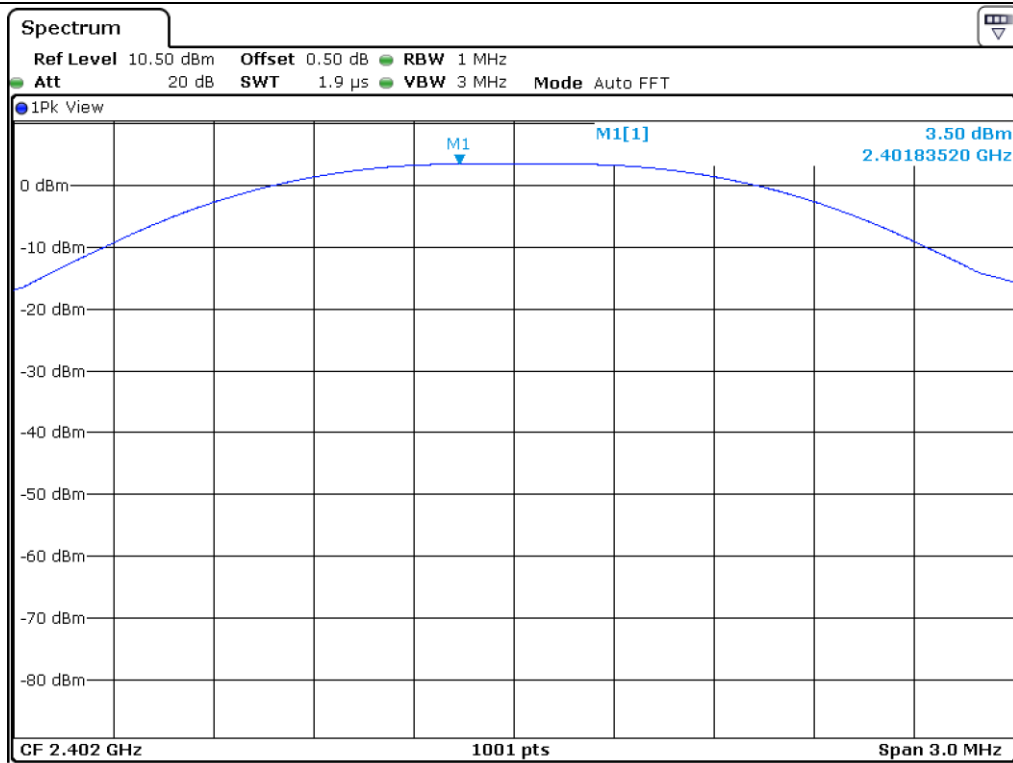
-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402	3.50	21.00	17.50
MIDDLE	2 441	3.79	21.00	17.21
HIGH	2 480	3.53	21.00	17.47

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



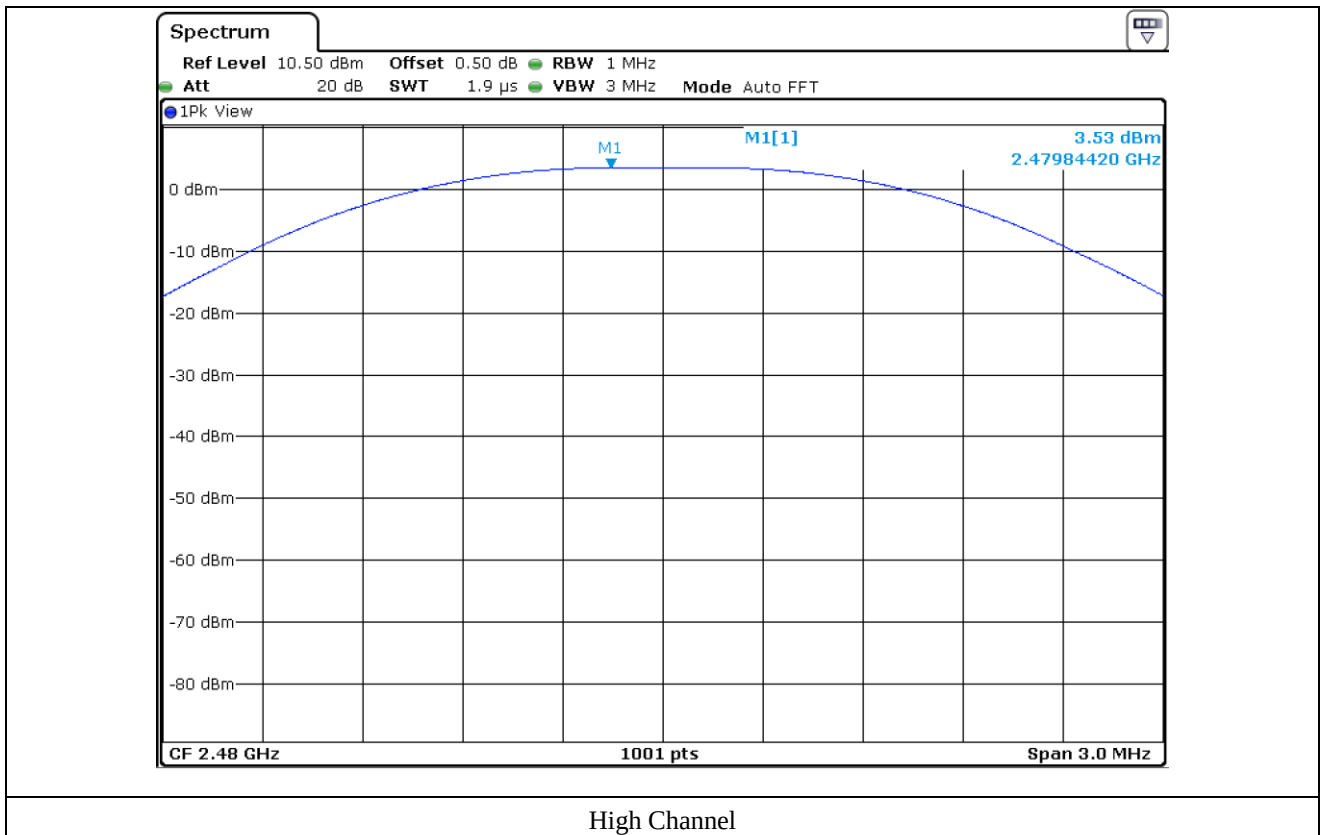
Tested by: Min-Gu Ji / Assistant Manager



Low Channel



Middle Channel



11.5 Test data for 2 Mbps

-. Test Date : June 08, 2017

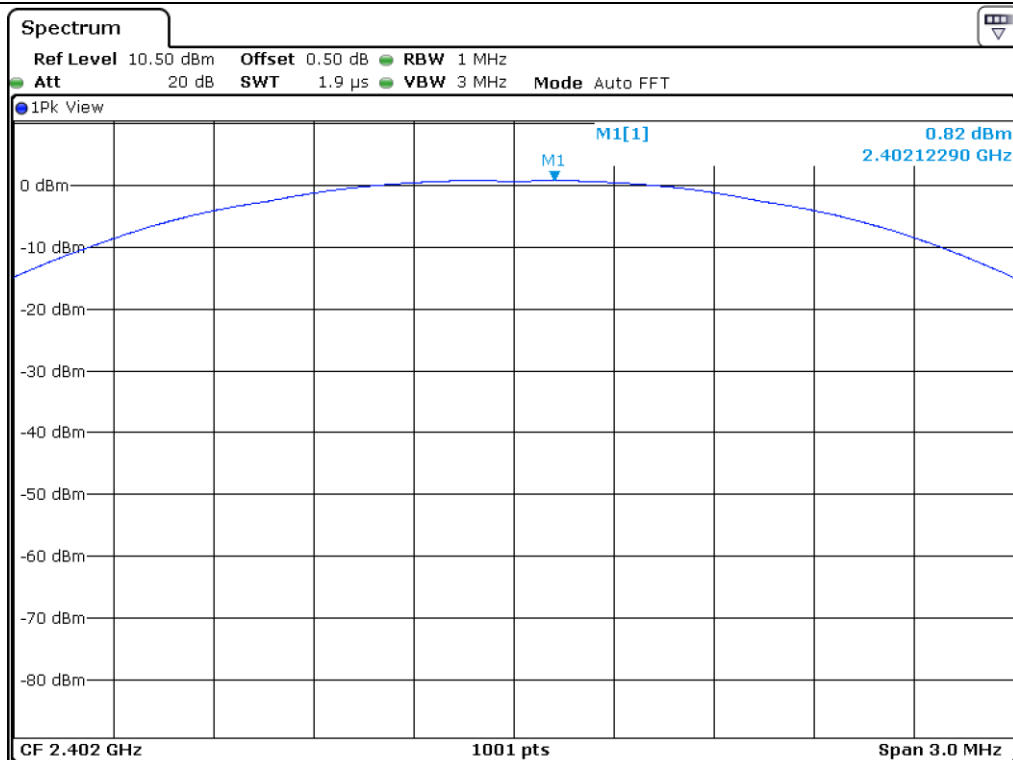
-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402	0.82	21.00	20.18
MIDDLE	2 441	1.27	21.00	19.73
HIGH	2 480	1.22	21.00	19.78

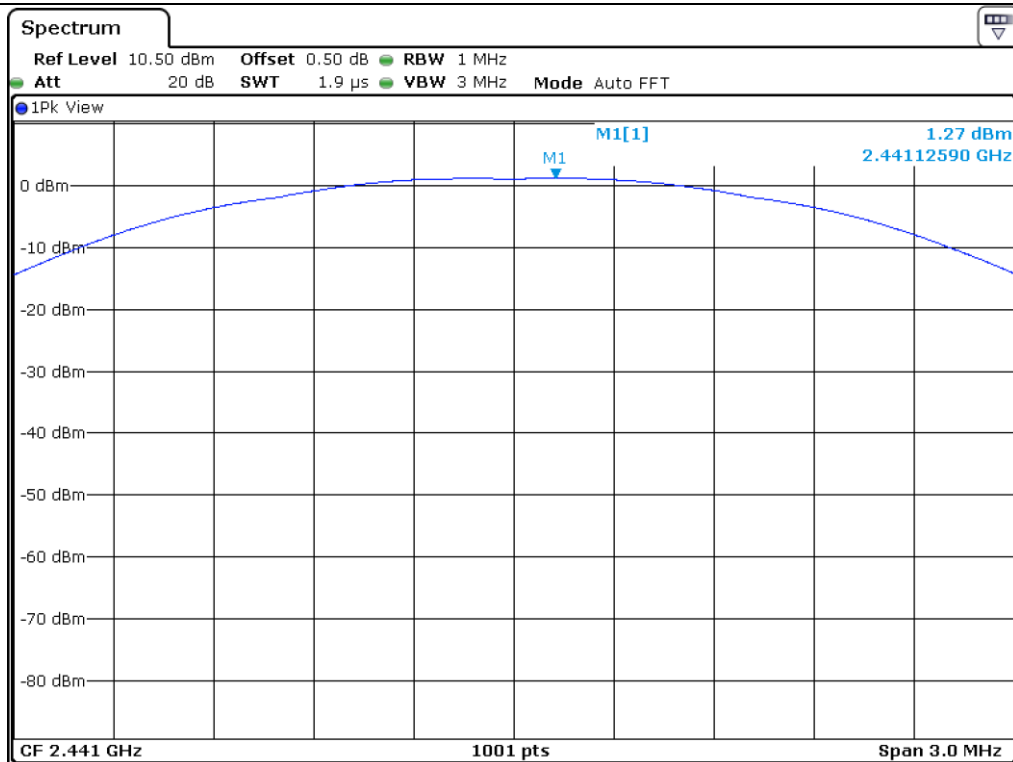
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



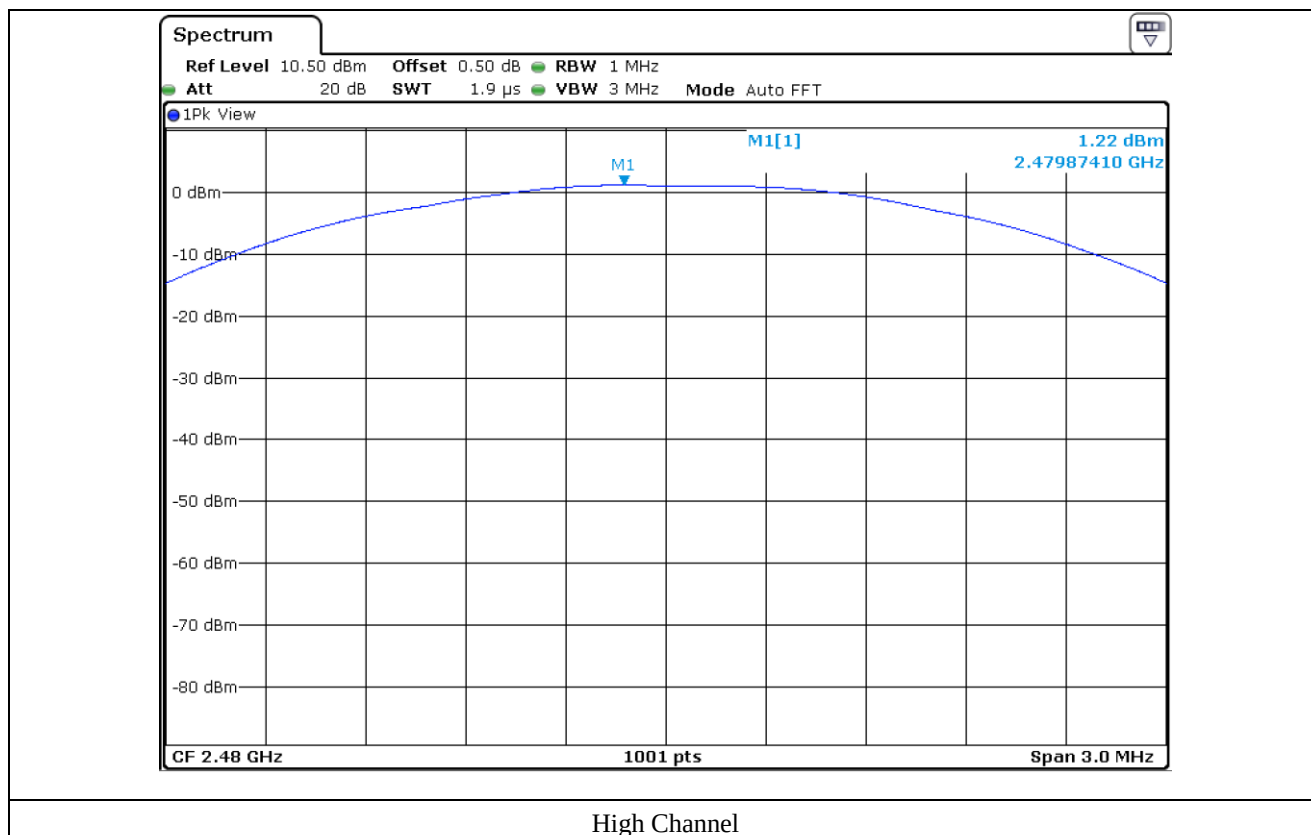
Tested by: Min-Gu Ji / Assistant Manager



Low Channel



Middle Channel



11.6 Test data for 3 Mbps

-. Test Date : June 08, 2017

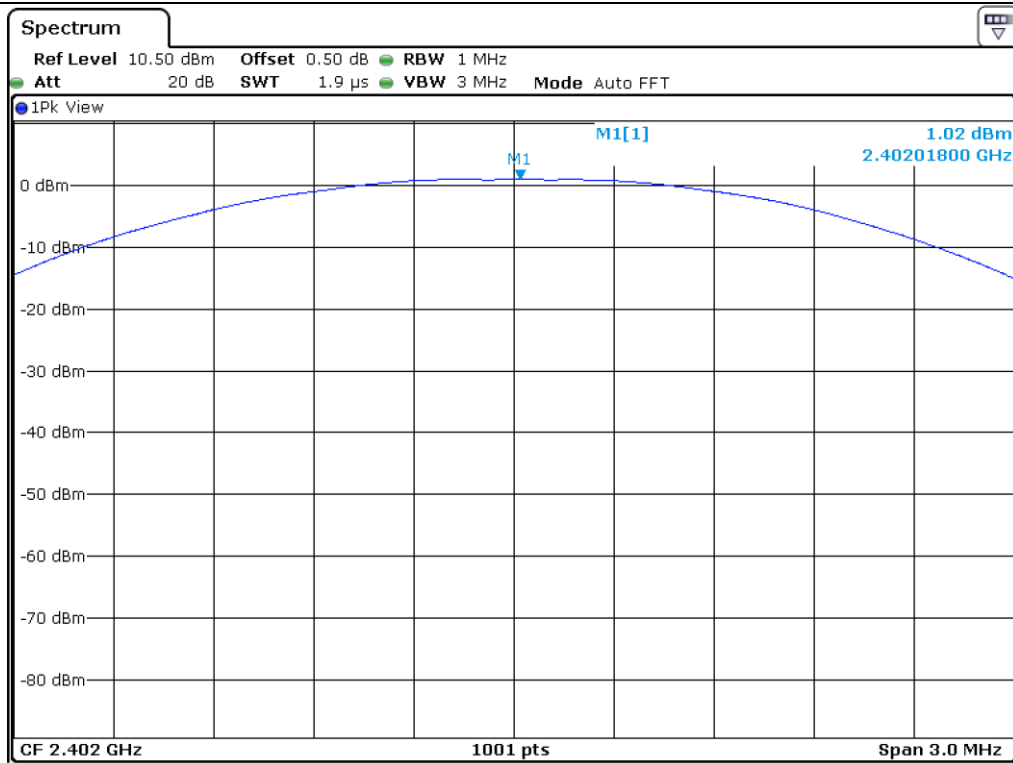
-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VLAUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402	1.02	21.00	19.98
MIDDLE	2 441	1.32	21.00	19.68
HIGH	2 480	0.87	21.00	20.13

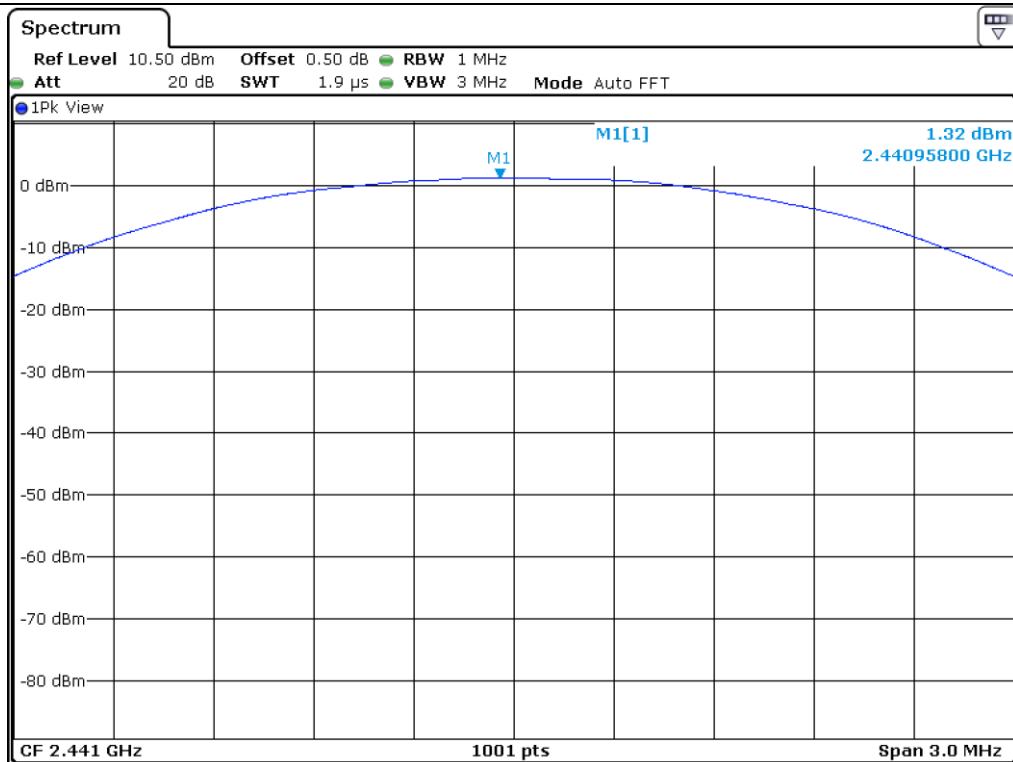
Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)



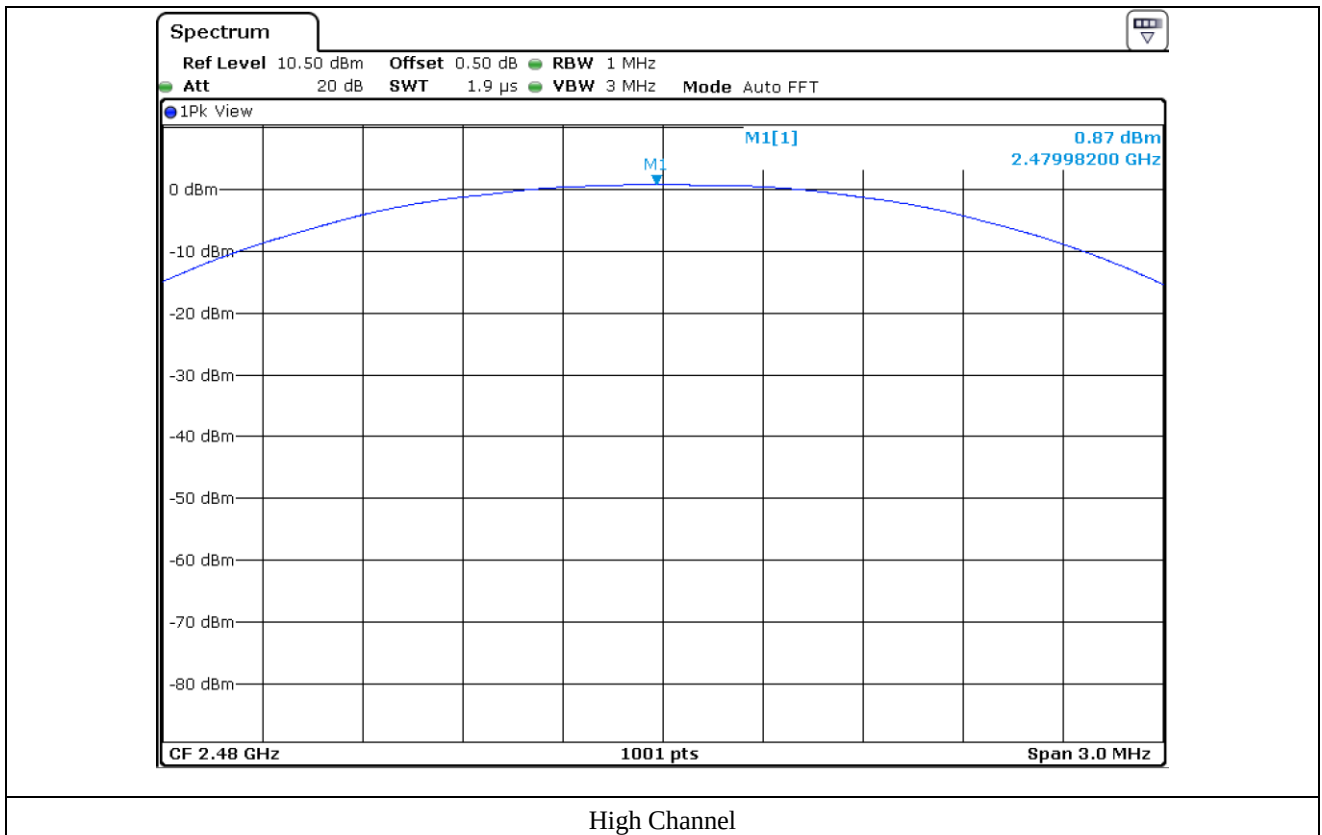
Tested by: Min-Gu Ji / Assistant Manager



Low Channel



Middle Channel



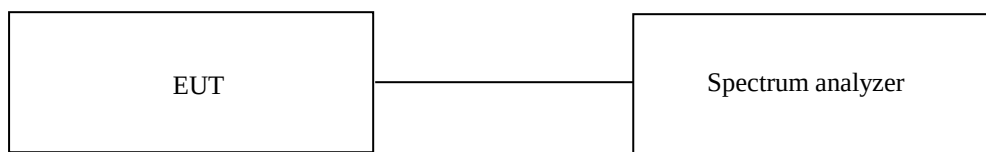
12. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

12.1 Operating environment

Temperature : 23 °C
Relative humidity : 50 % 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.

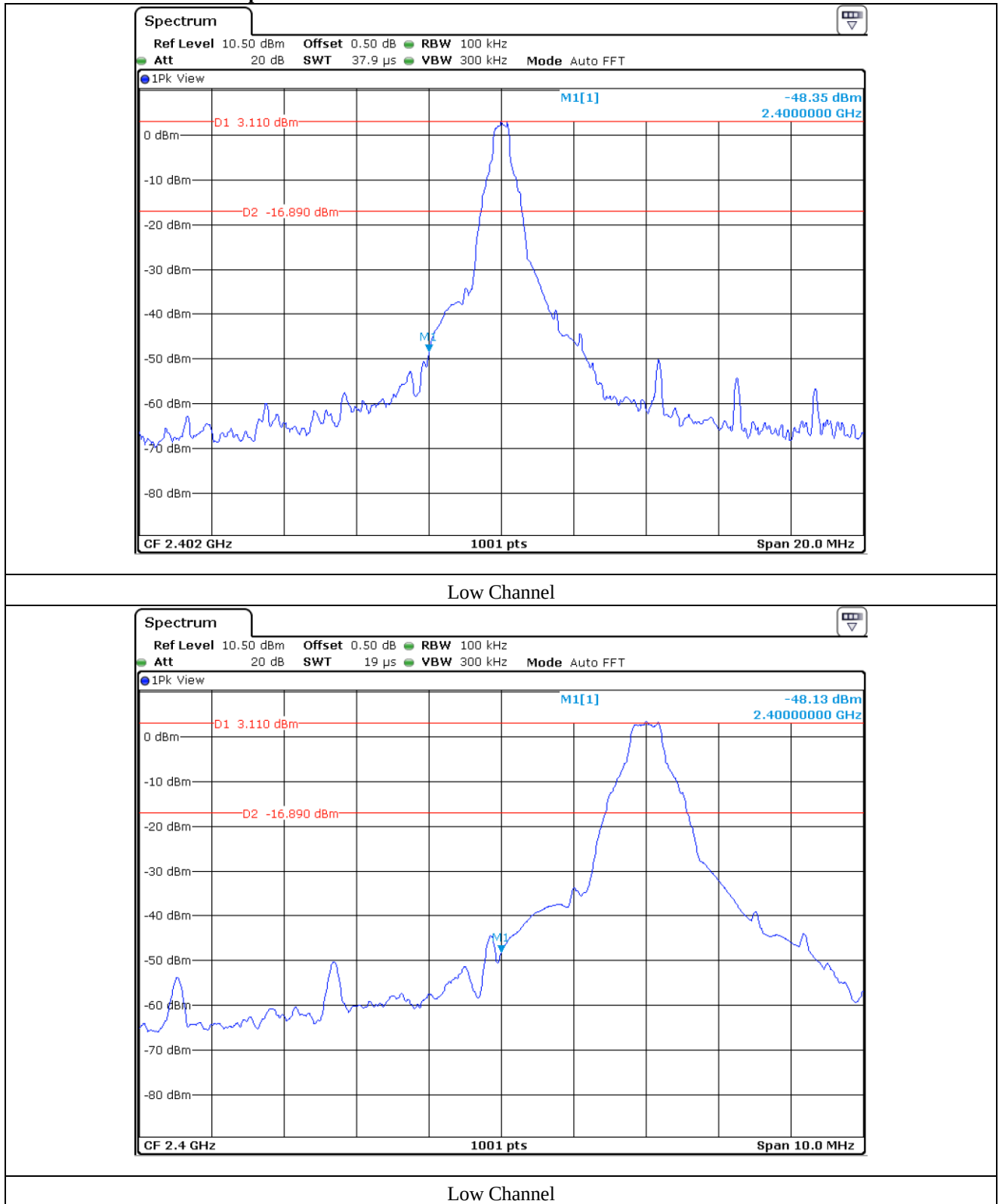
12.4 Test equipment used

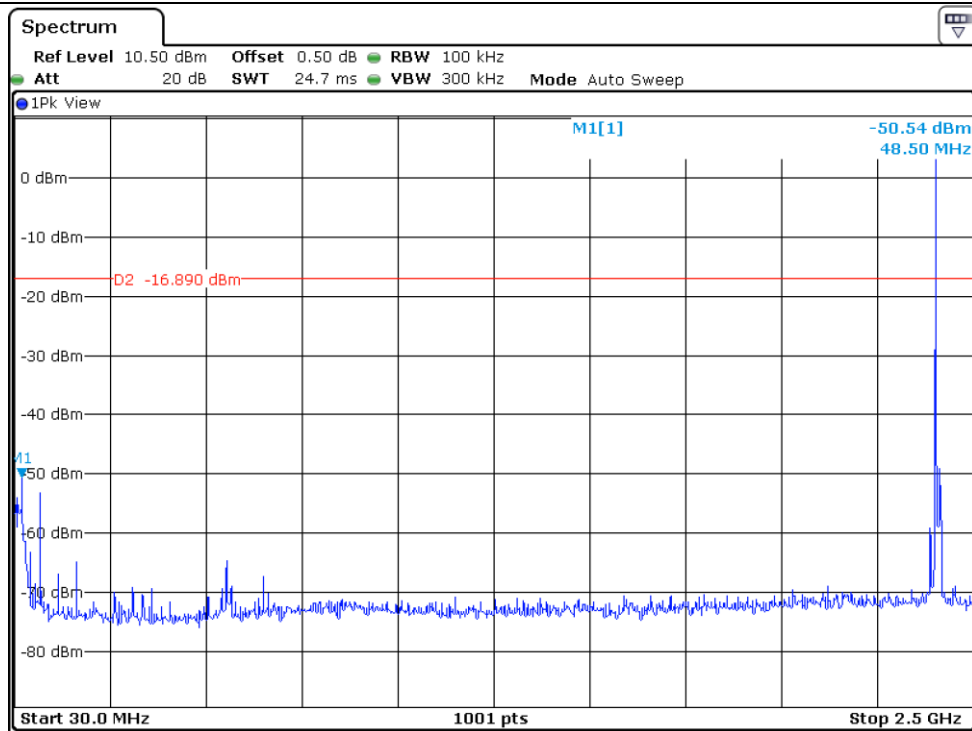
	Model Number	Manufacturer	Description	Serial Number	Last Cal. (Interval)
□ -	ESCI	Rohde & Schwarz	EMI Test Receiver	101012	Nov. 01, 2016 (1Y)
■ -	ESU	Rohde & Schwarz	EMI Test Receiver	100261	Apr. 05, 2017 (1Y)
□ -	8564E	HP	Spectrum Analyzer	3650A00756	Sep. 29, 2016 (1Y)
□ -	FSP	Rohde & Schwarz	Spectrum Analyzer	100017	Sep. 28, 2016 (1Y)
■ -	310N	Sonoma Instrument	AMPLIFIER	312544	Apr. 04, 2017 (1Y)
■ -	FSV30	Rohde & Schwarz	Signal Analyzer	101372	Nov. 10, 2016 (1Y)
■ -	SCU-18	Rohde & Schwarz	Pre-Amplifier	102209	May. 30, 2017 (1Y)
■ -	MA240	HD GmbH	Antenna Master	N/A	N/A
□ -	HD100	HD GmbH	Position Controller	N/A	N/A
■ -	DS420S	HD GmbH	Turn Table	N/A	N/A
□ -	FMZB 1513	Schwarzbeck	LOOP ANTENNA	1513-235	Jun. 10, 2016 (2Y)
■ -	VULB9163	Schwarzbeck	TRILOG Broadband Antenna	9163-255	May 20, 2016 (2Y)
■ -	BBHA9120D	Schwarzbeck	Horn Antenna	BBHA9120D295	Aug. 31, 2015 (2Y)
■ -	BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170178	Aug. 31, 2015 (2Y)
■ -	83051A	Agilent	Microwave System Preamplifier	3950M00201	Apr. 06, 2017 (1Y)

All test equipment used is calibrated on a regular basis.

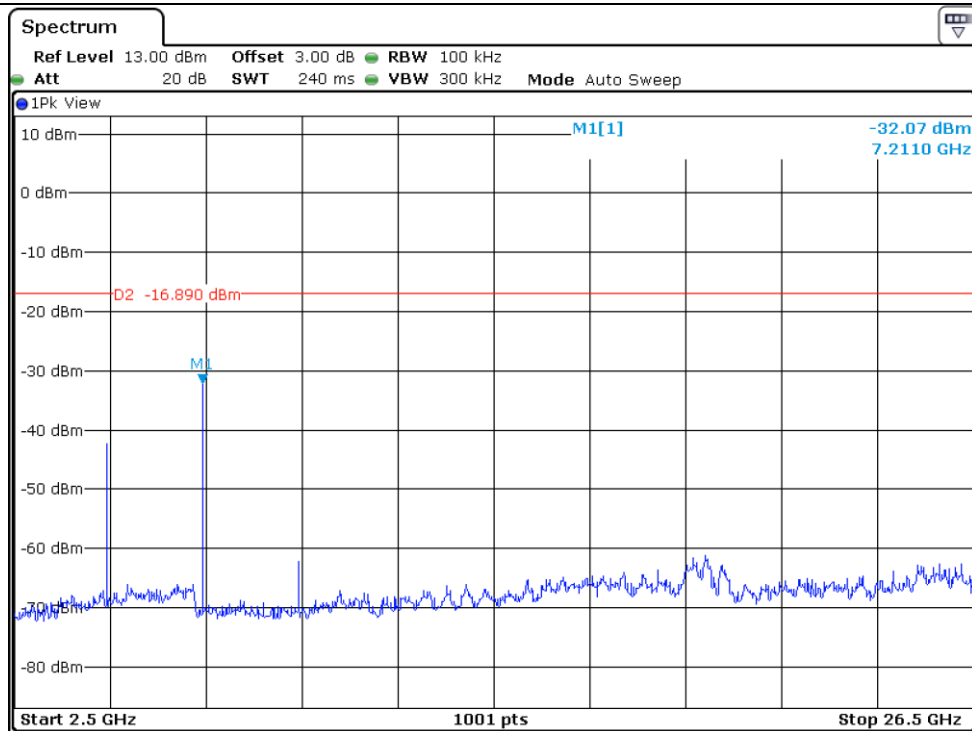
12.5 Test data for conducted emission

12.5.1 Test data for 1 Mbps

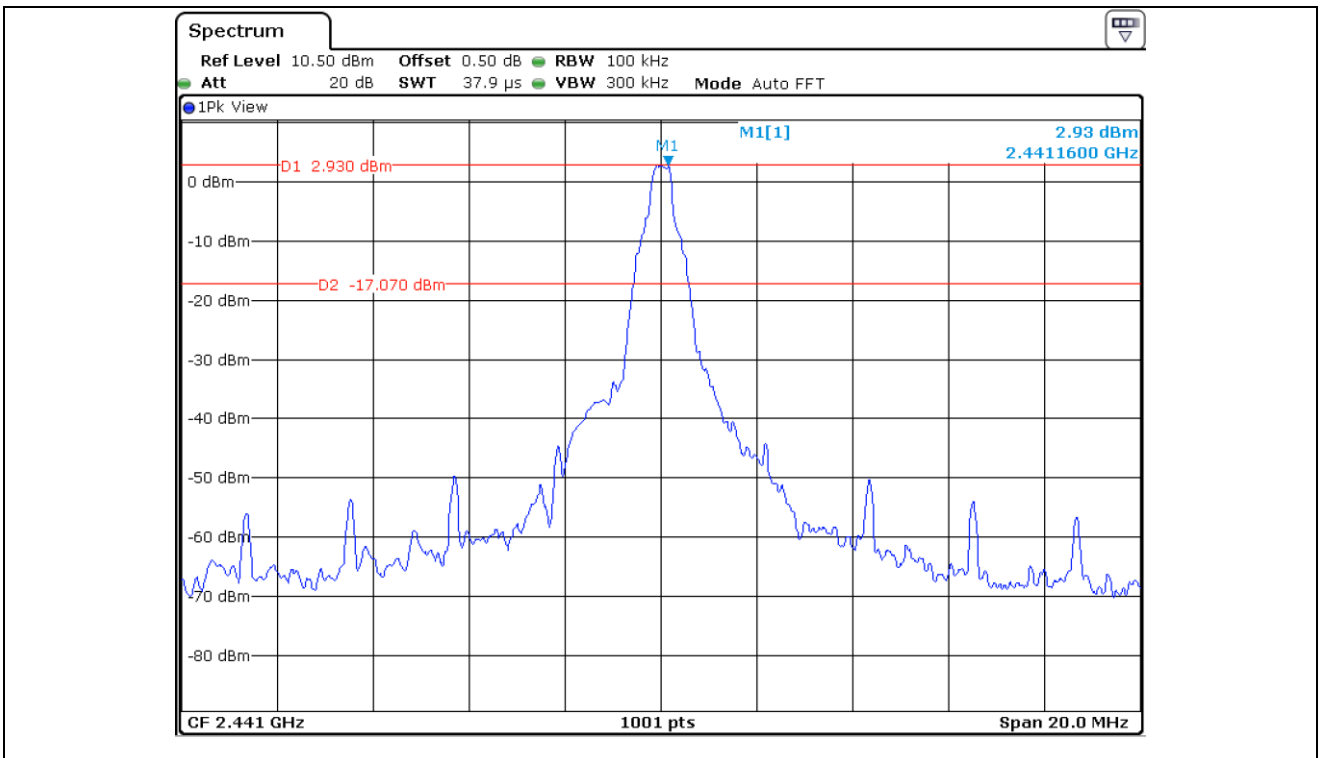




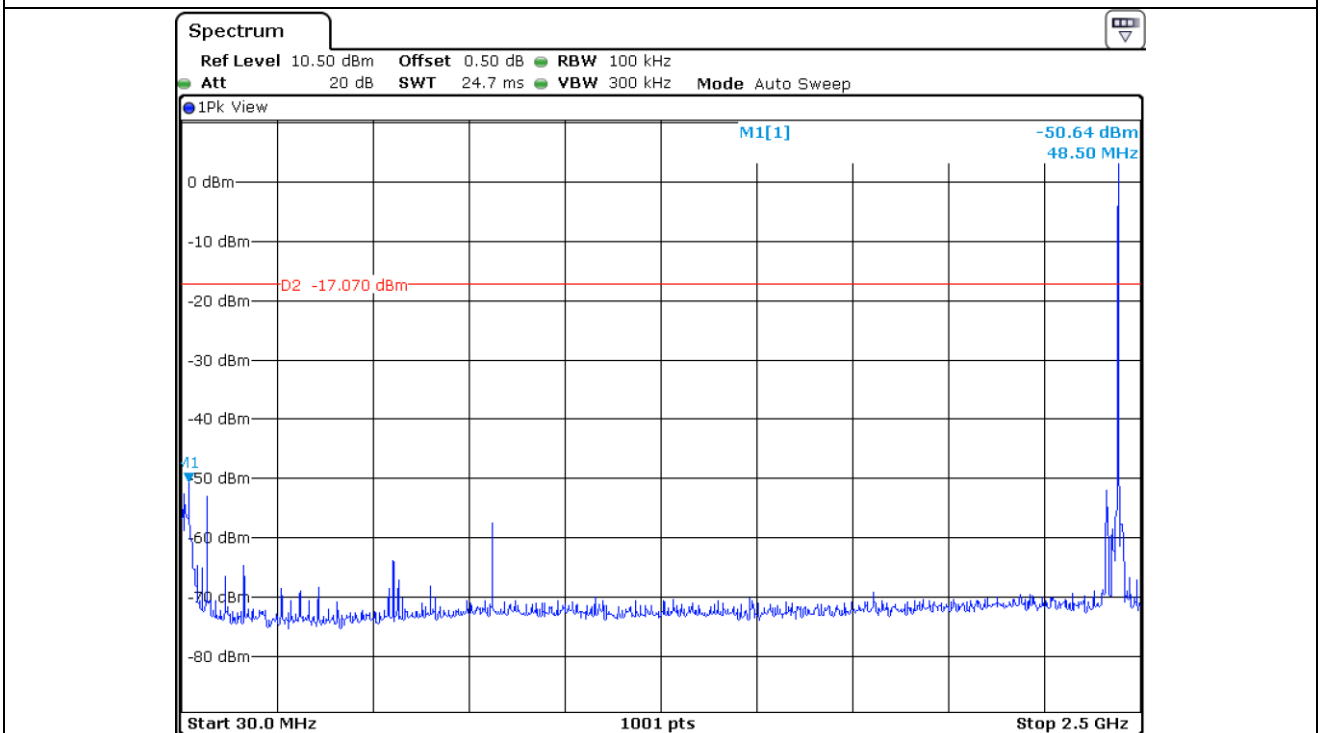
Low Channel



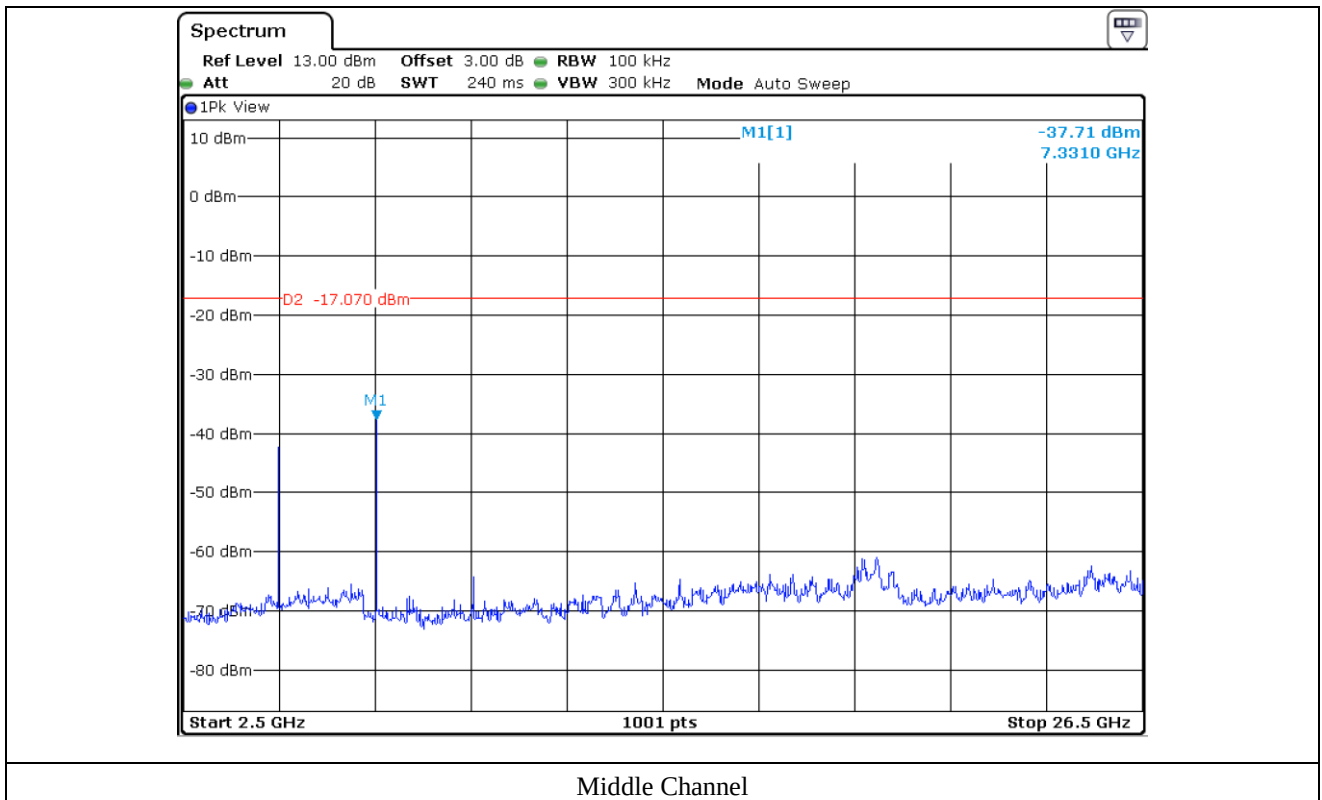
Low Channel

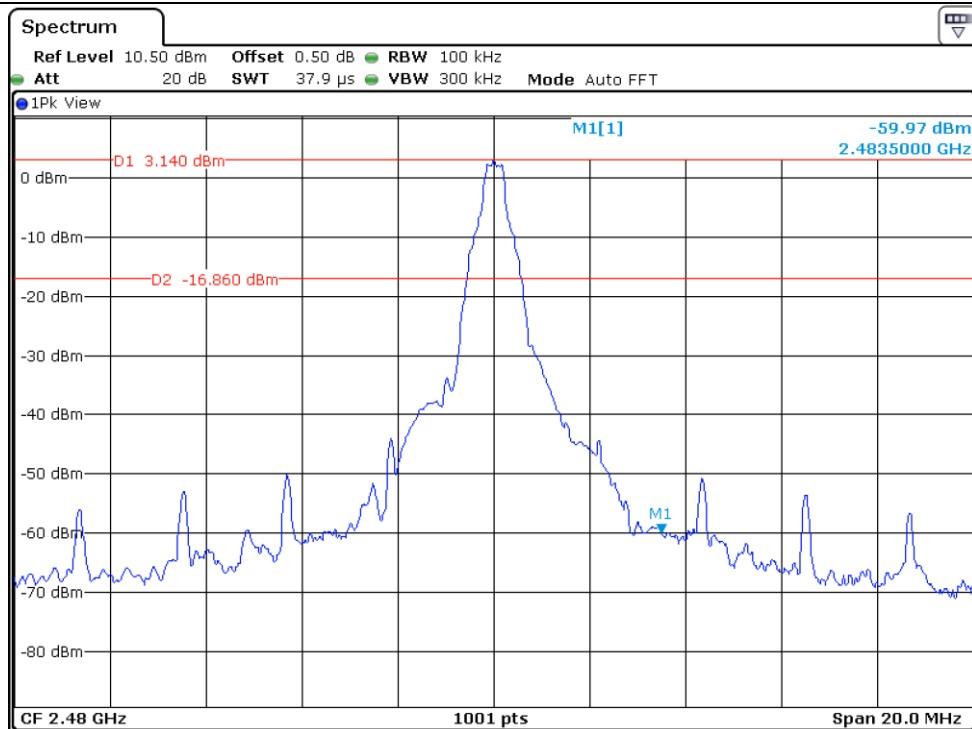


Middle Channel

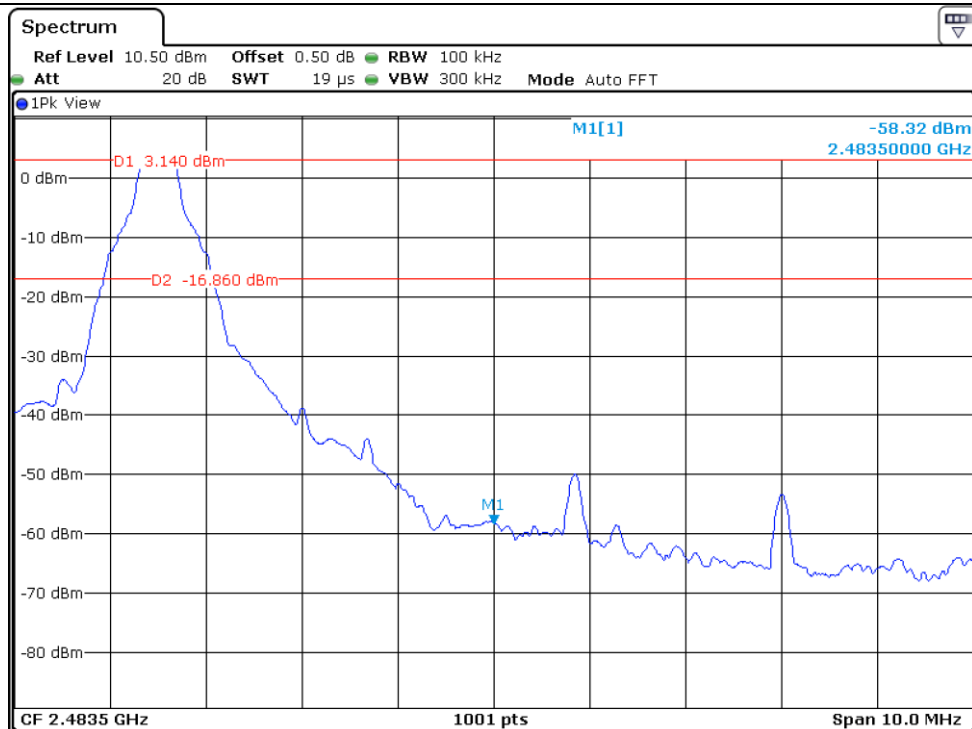


Middle Channel

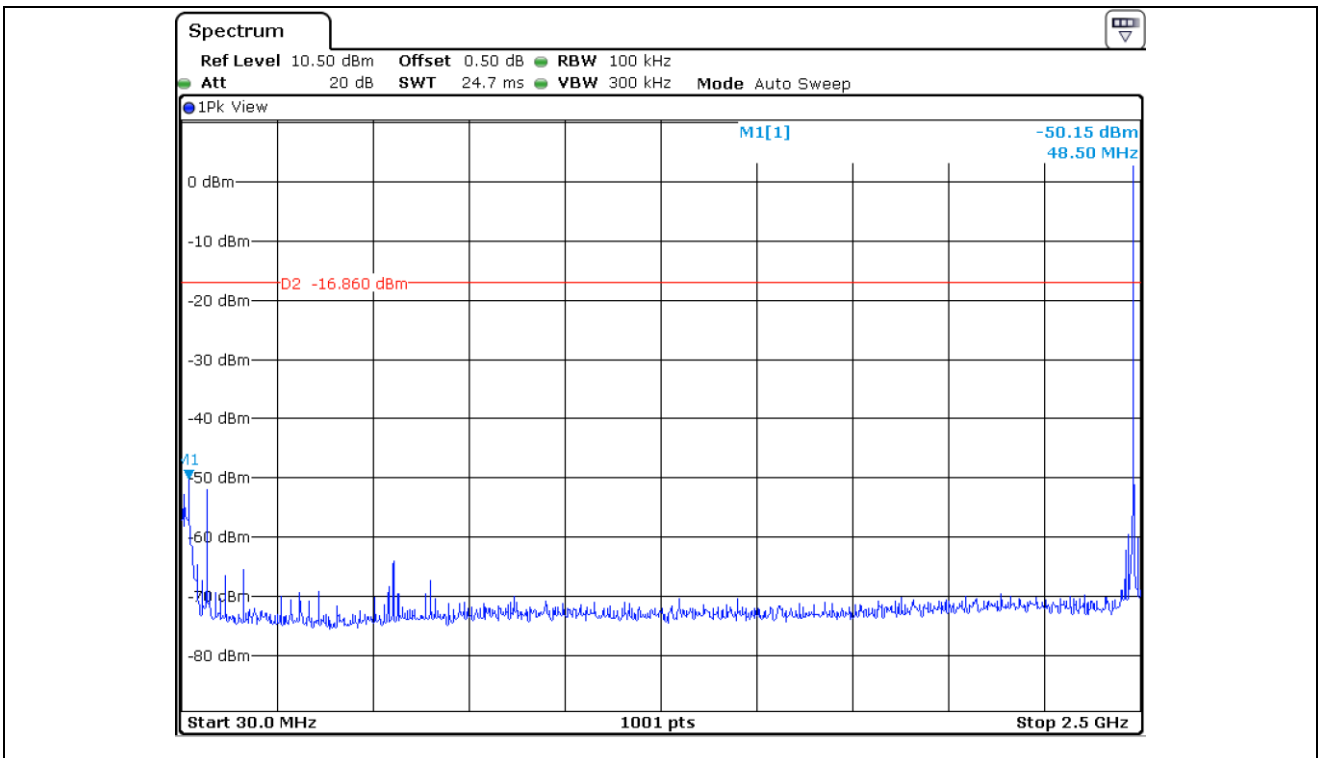




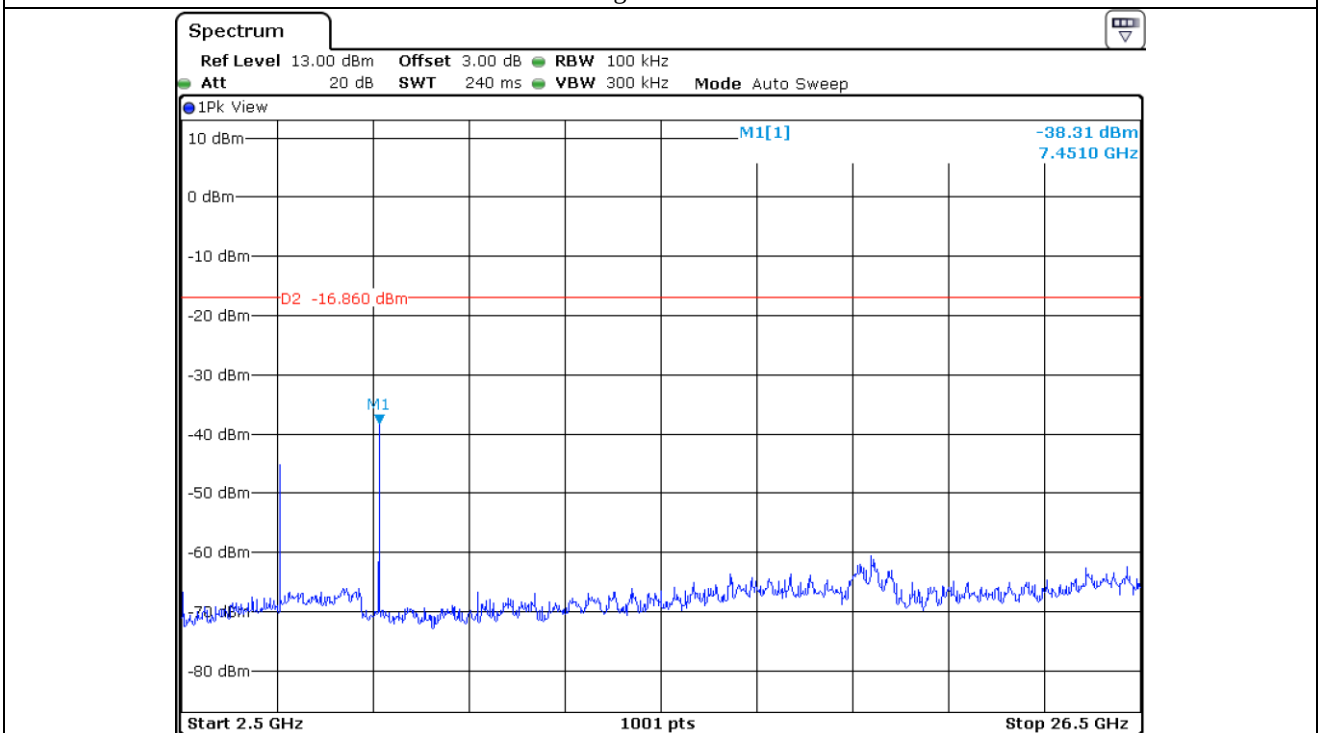
High Channel



High Channel

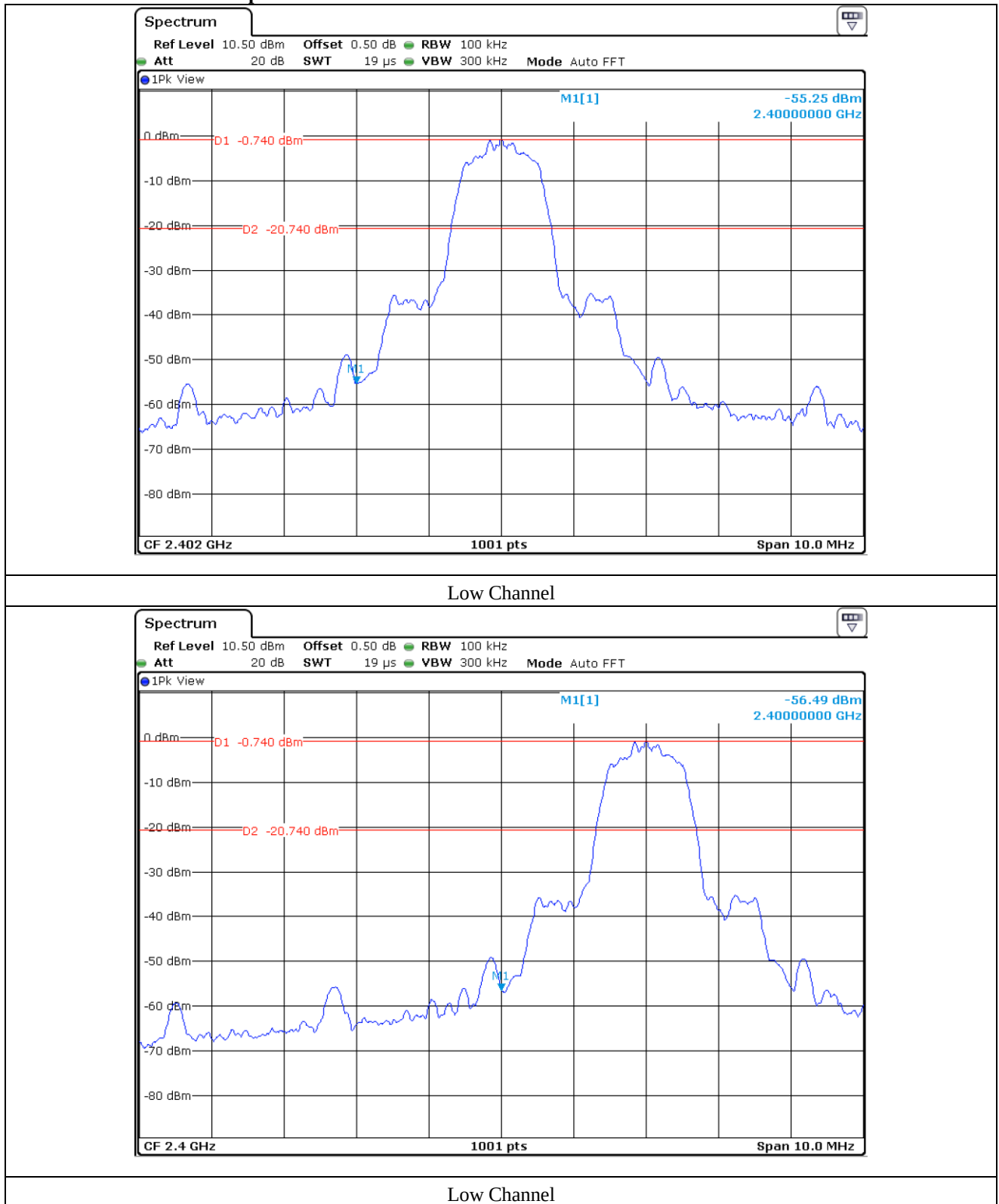


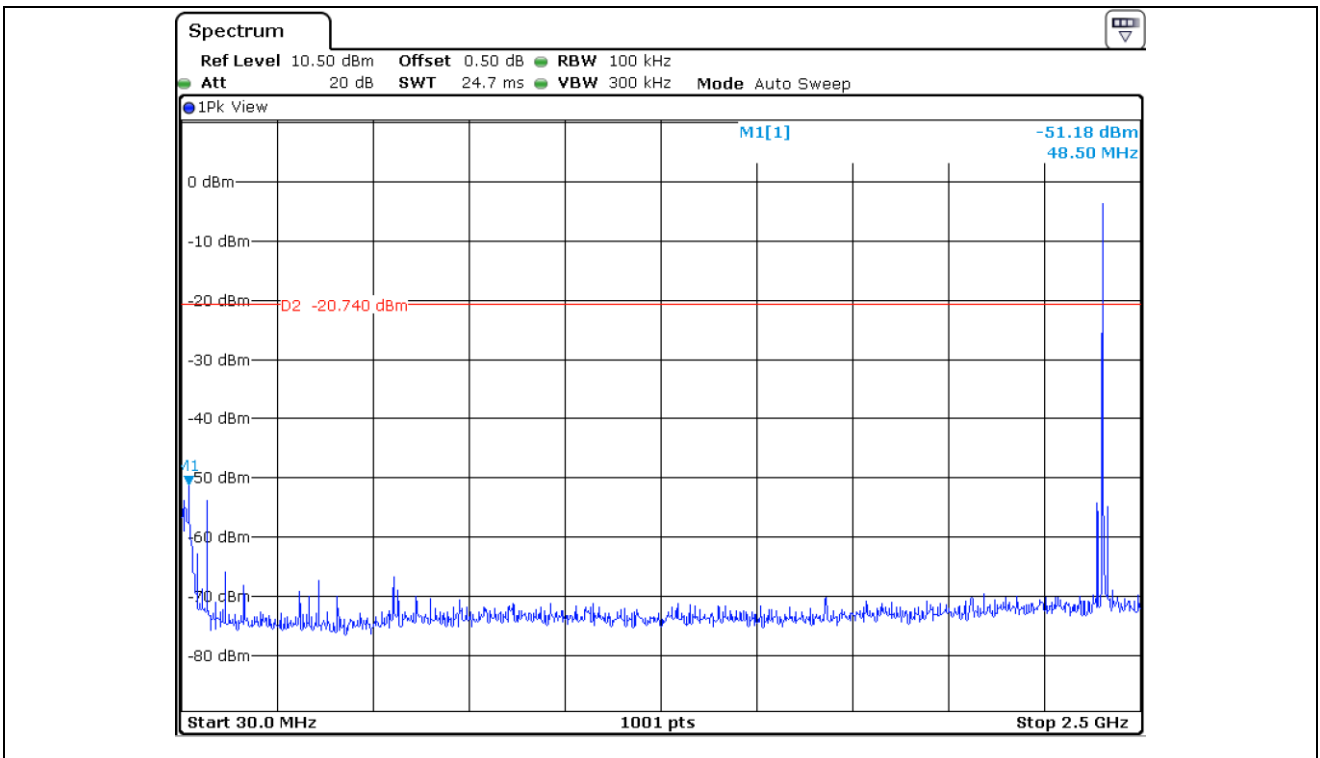
High Channel



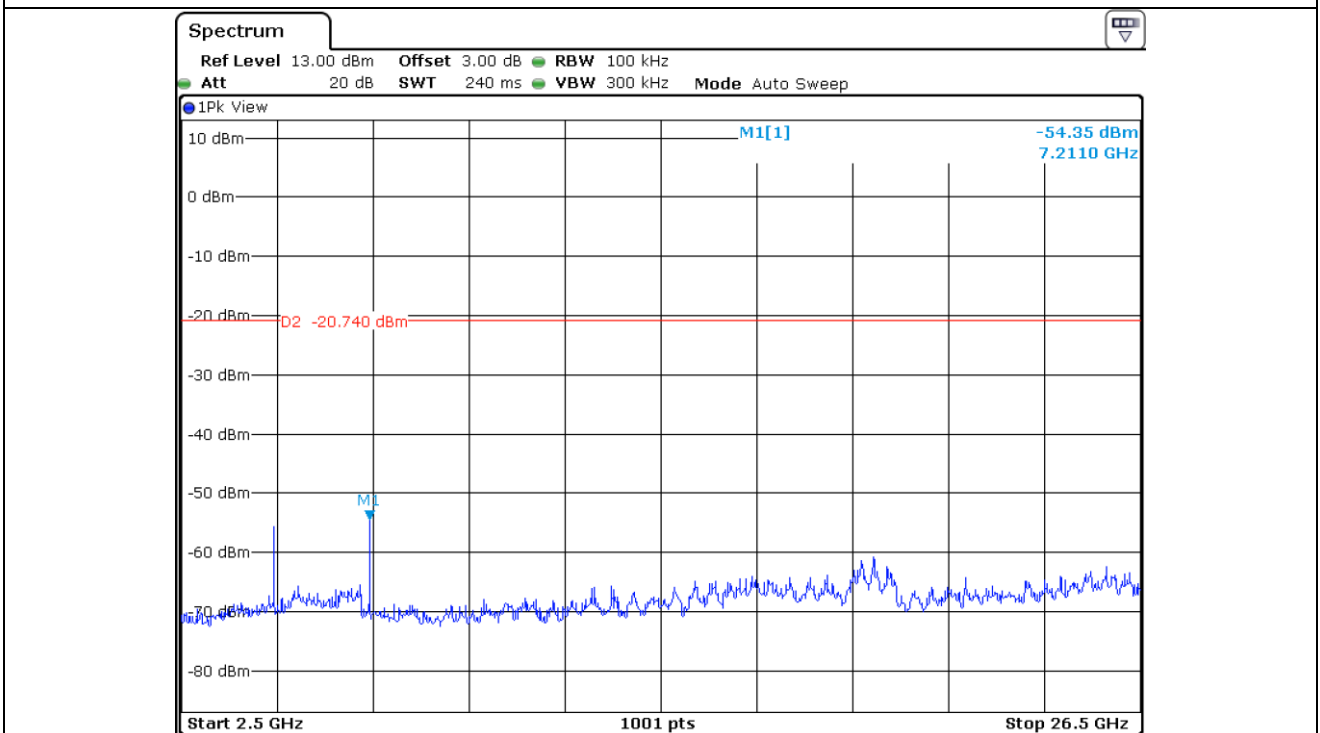
High Channel

12.5.2 Test data for 2 Mbps

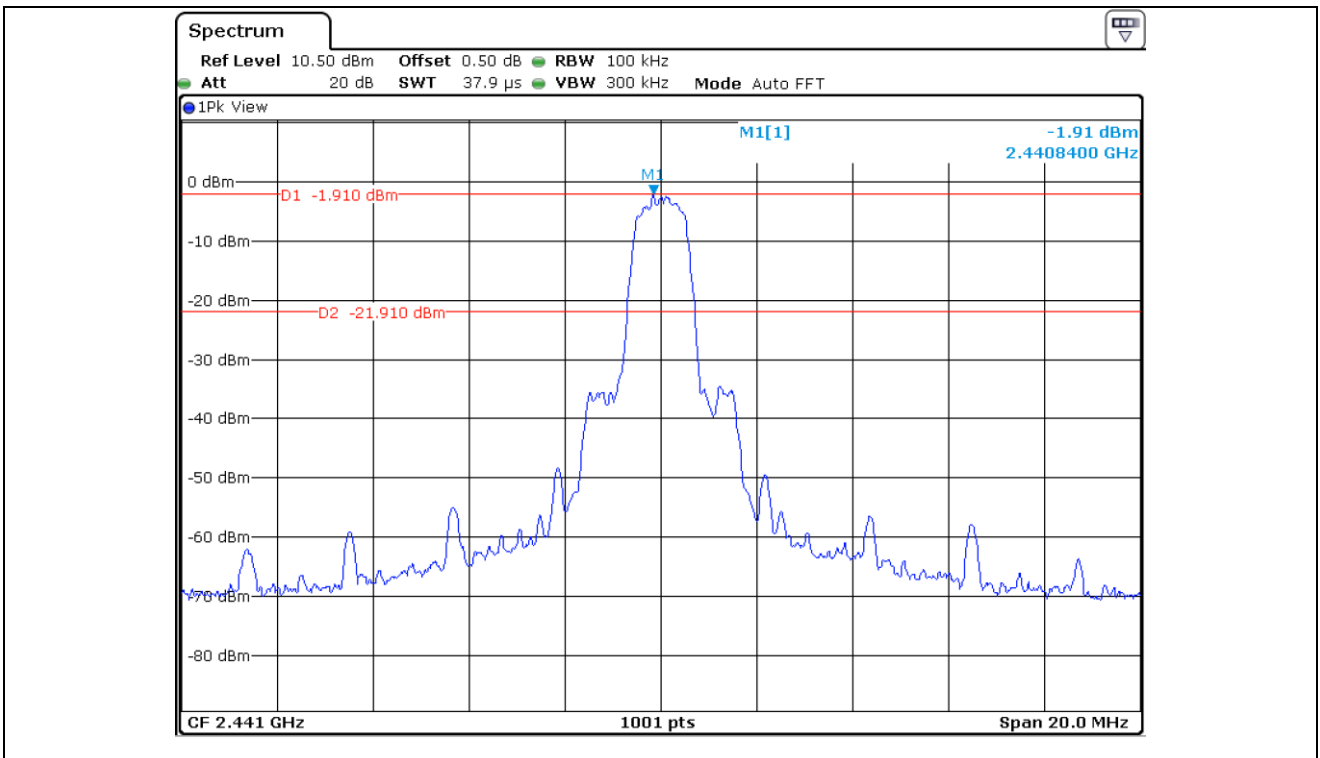




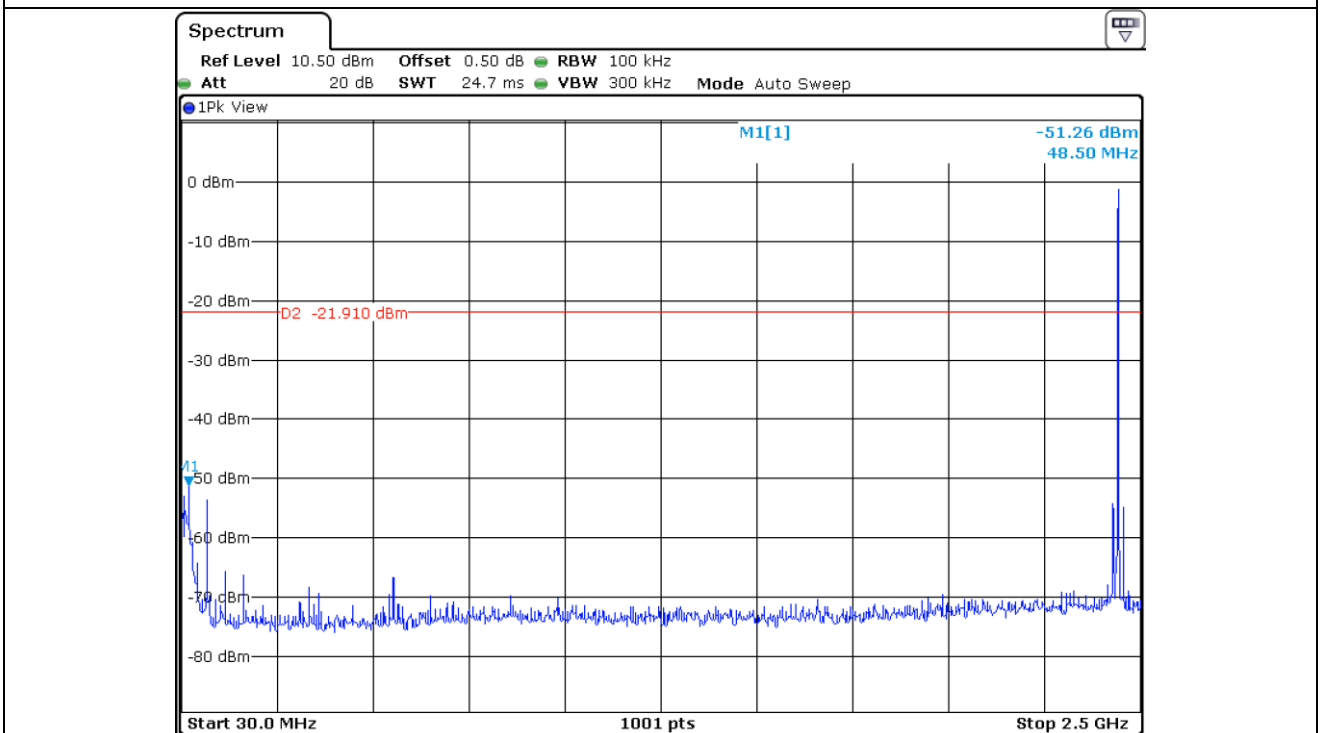
Low Channel



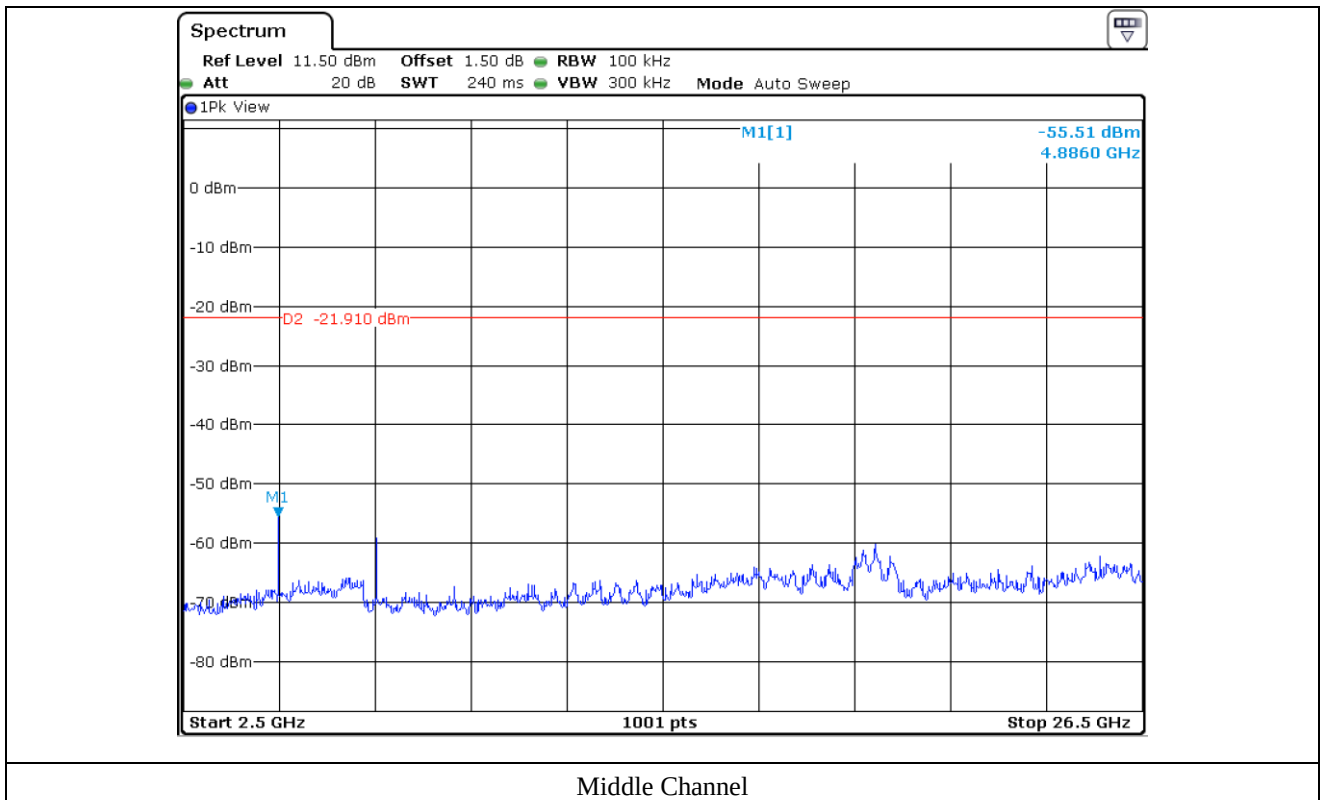
Low Channel

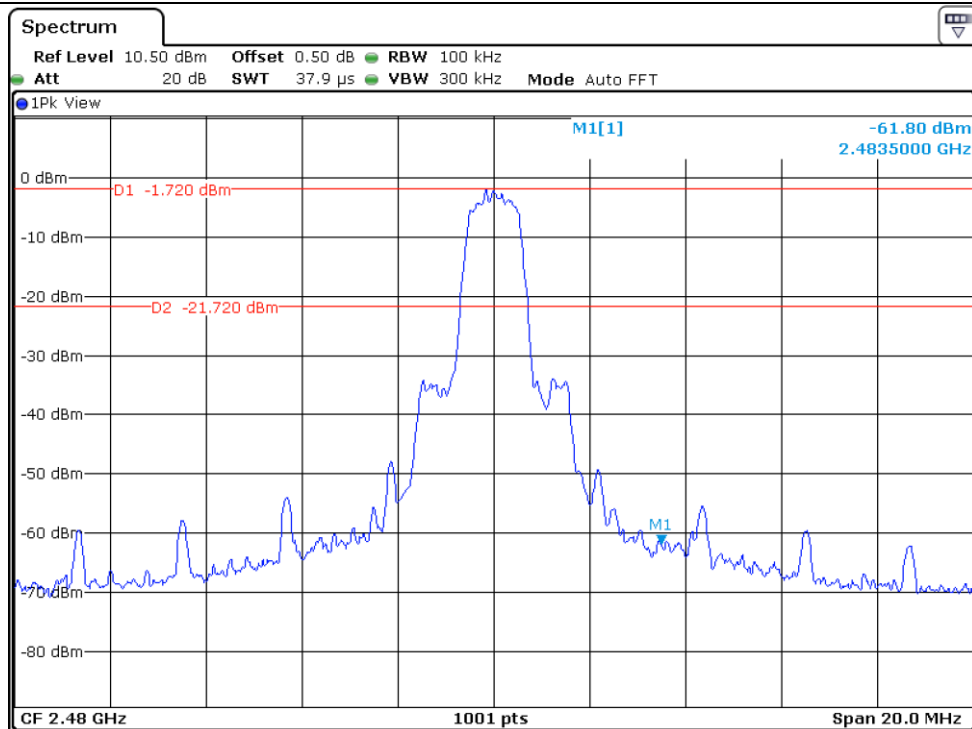


Middle Channel

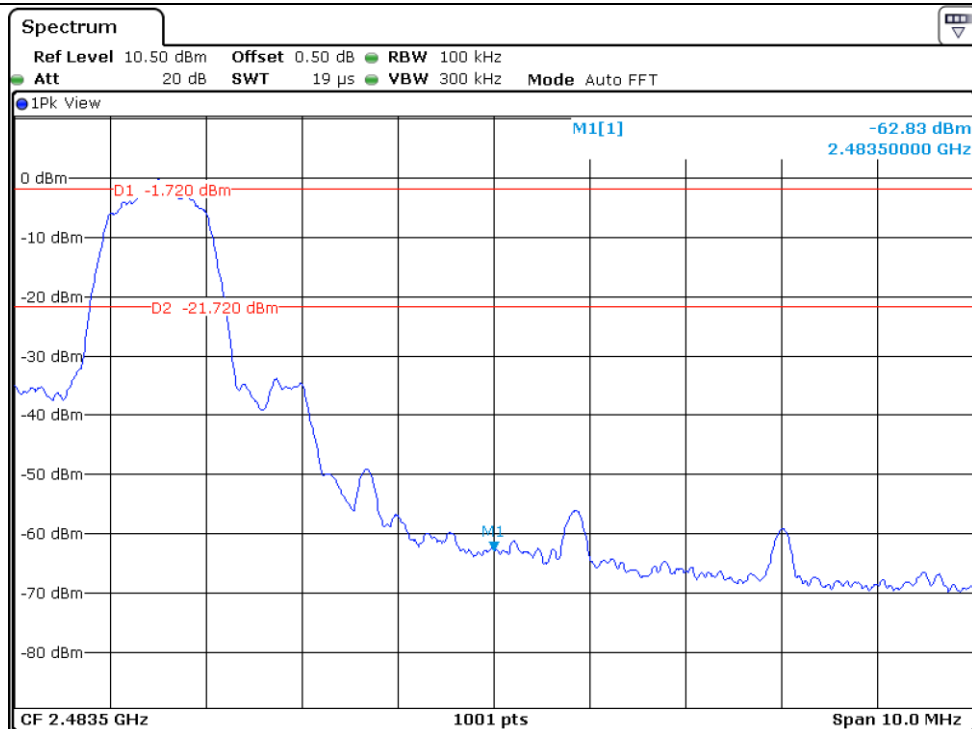


Middle Channel

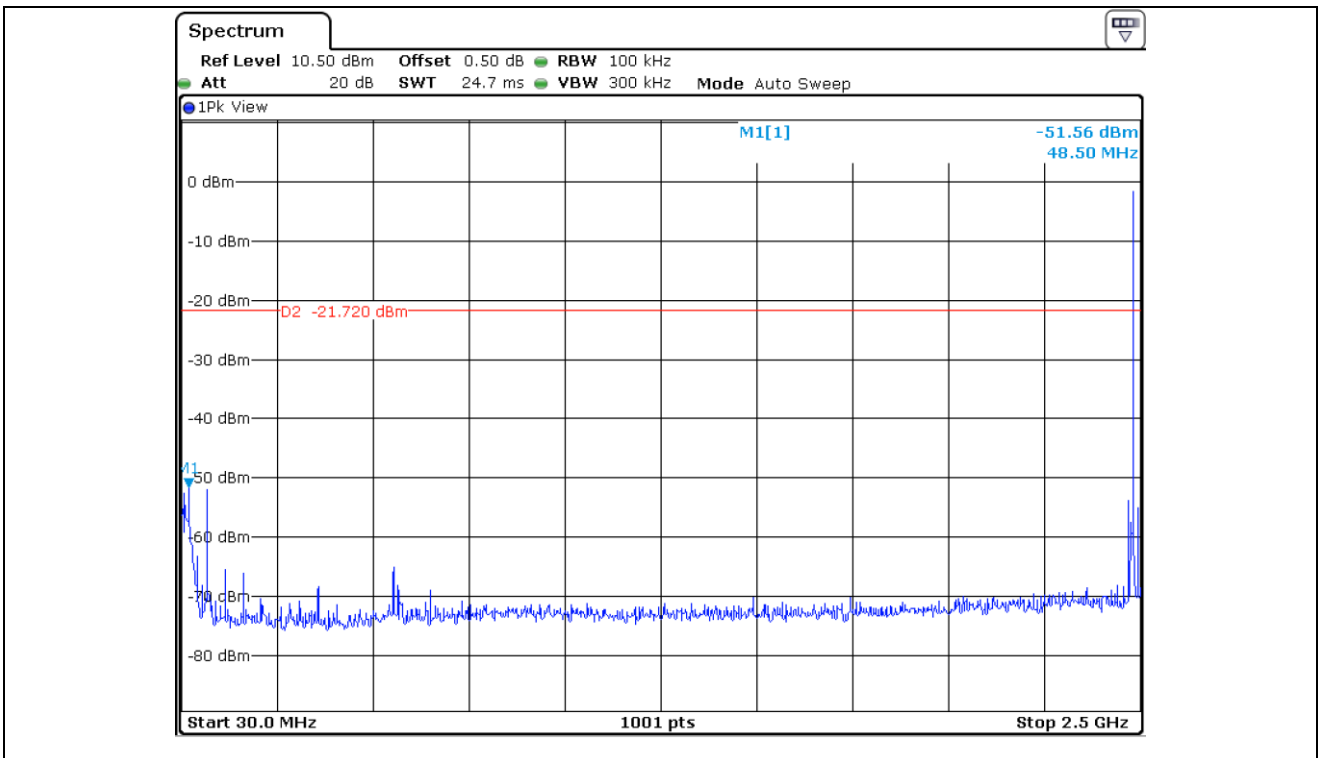




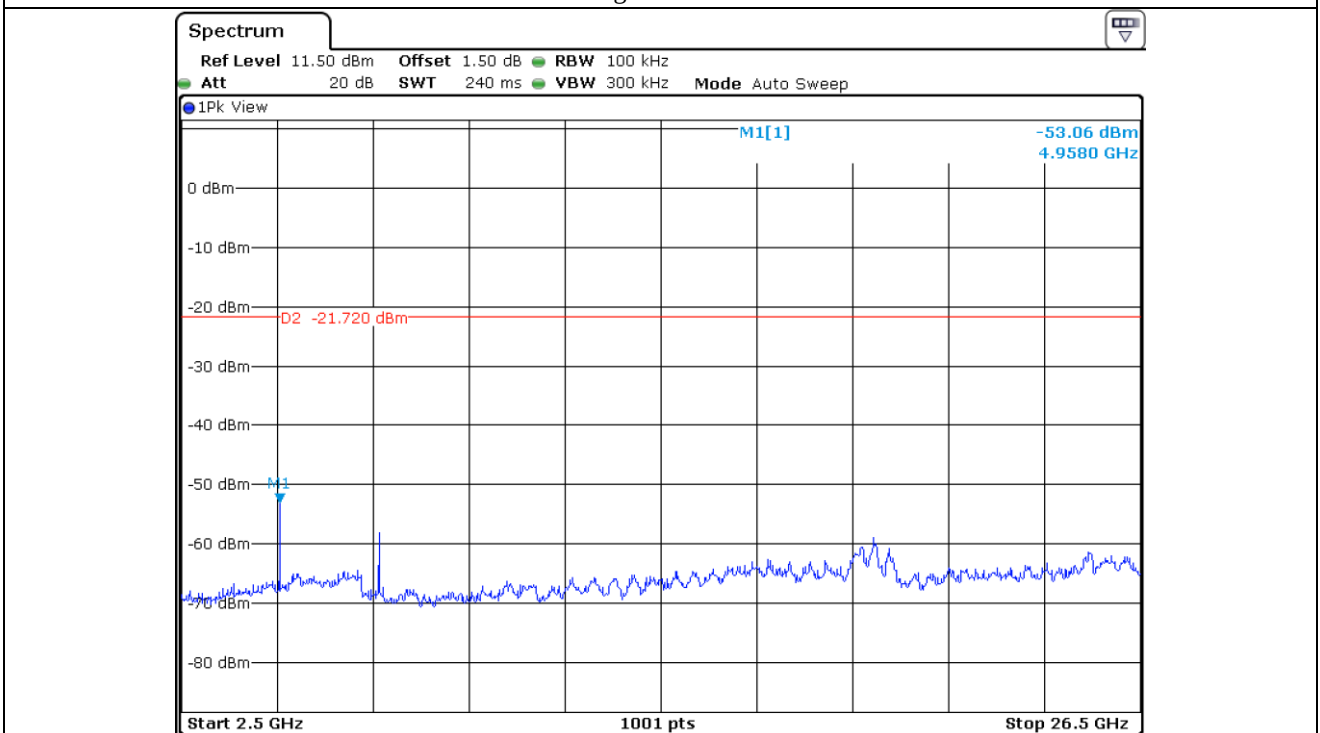
High Channel



High Channel

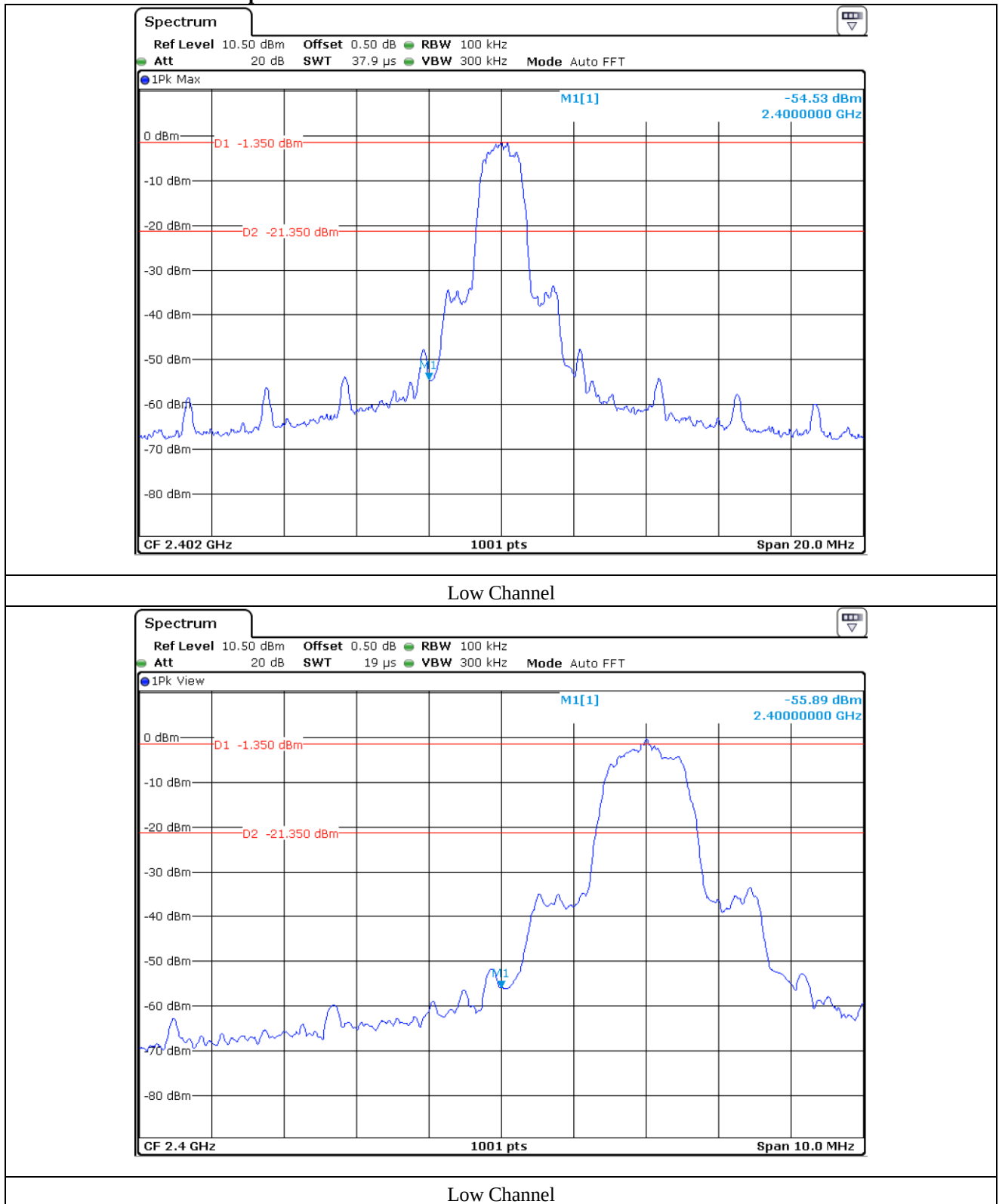


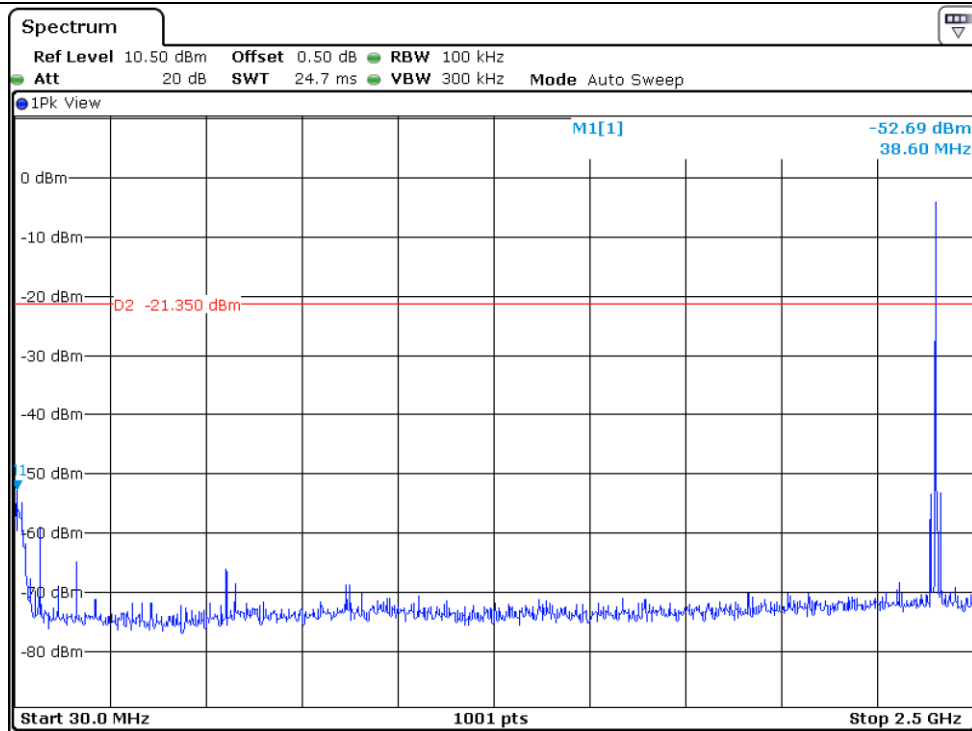
High Channel



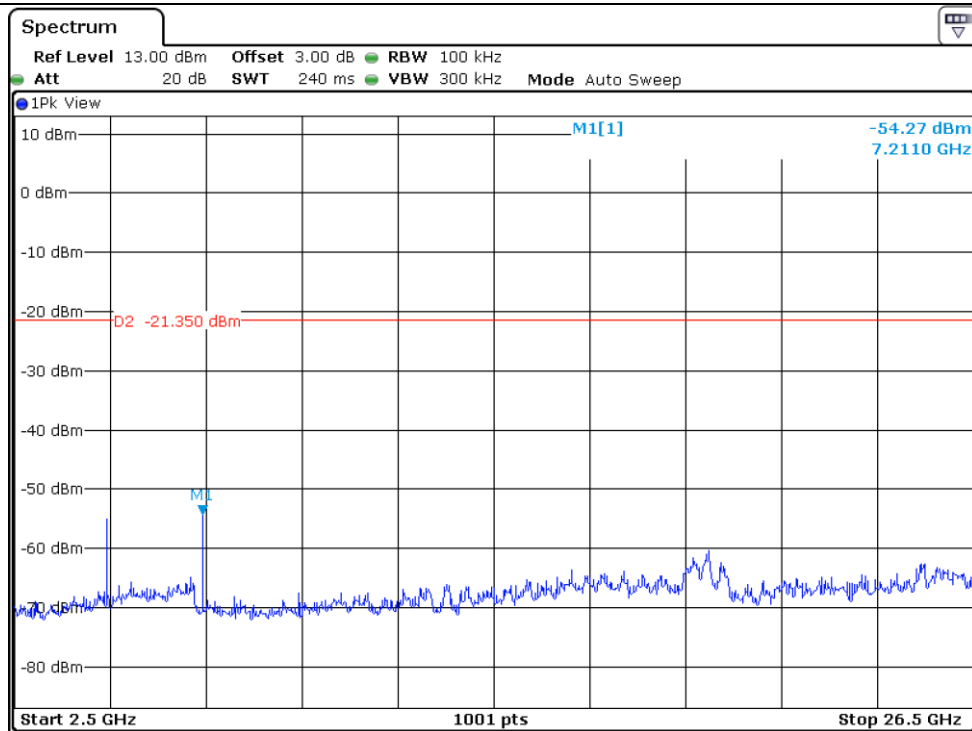
High Channel

12.5.3 Test data for 3 Mbps

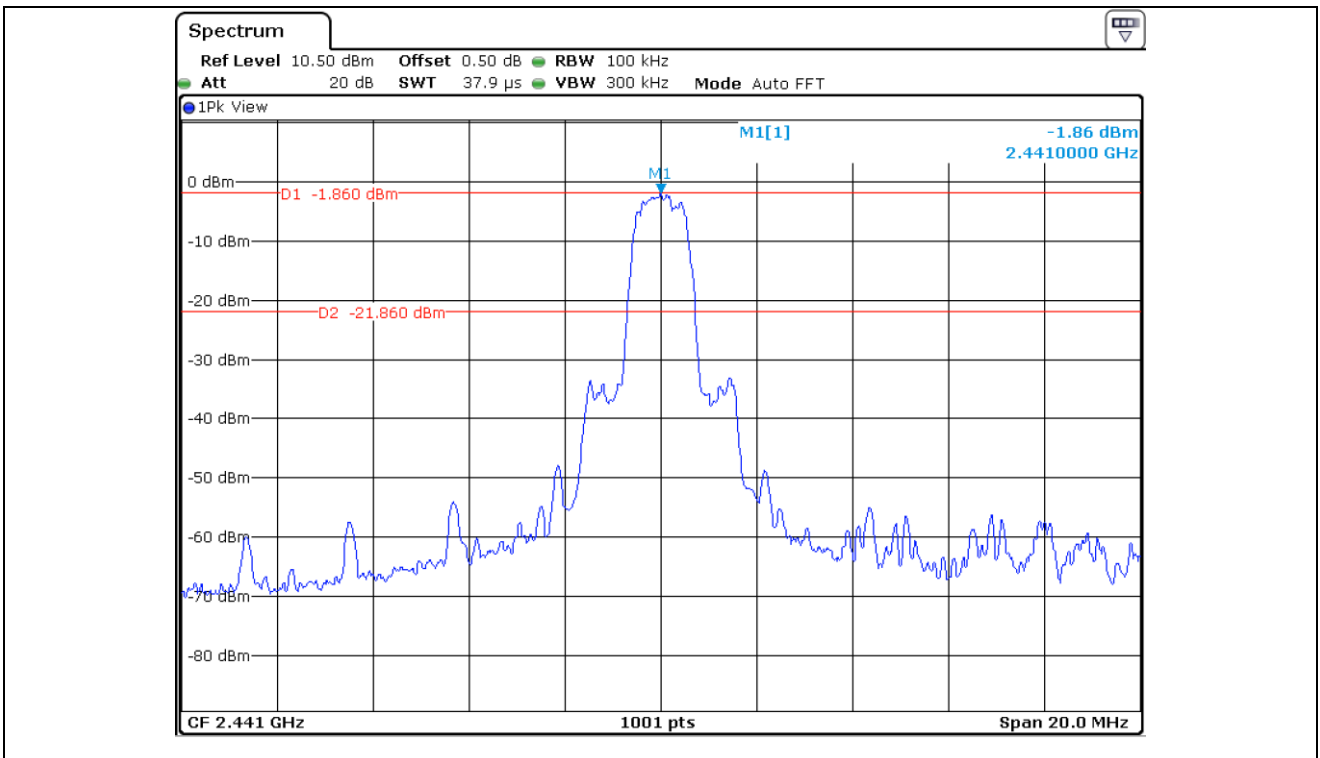




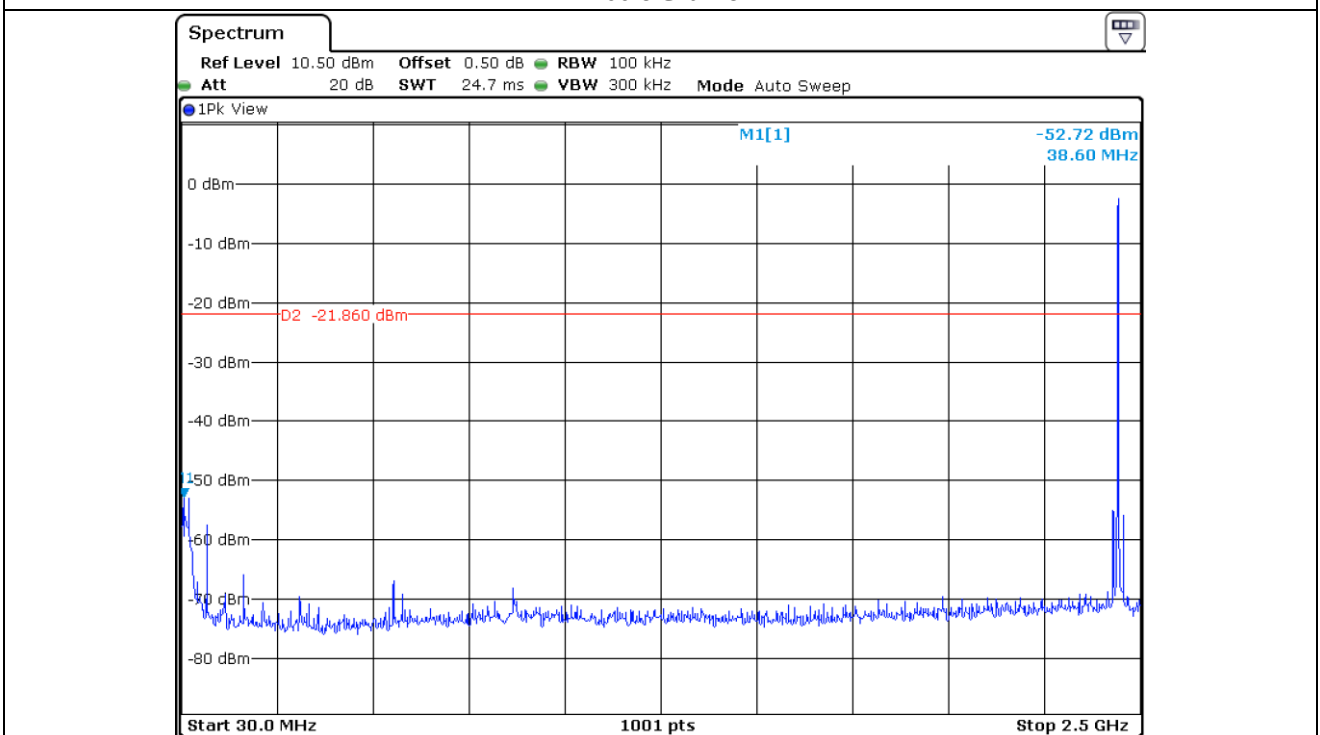
Low Channel



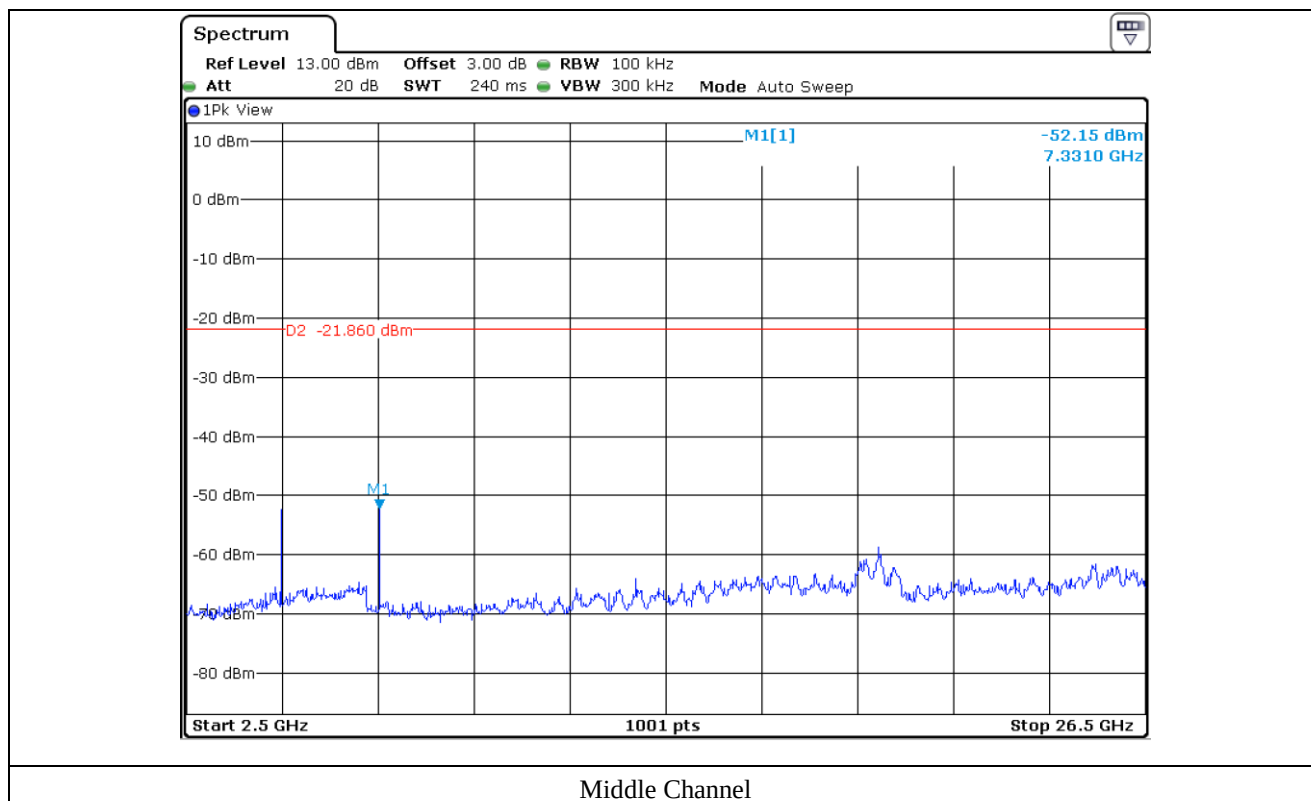
Low Channel

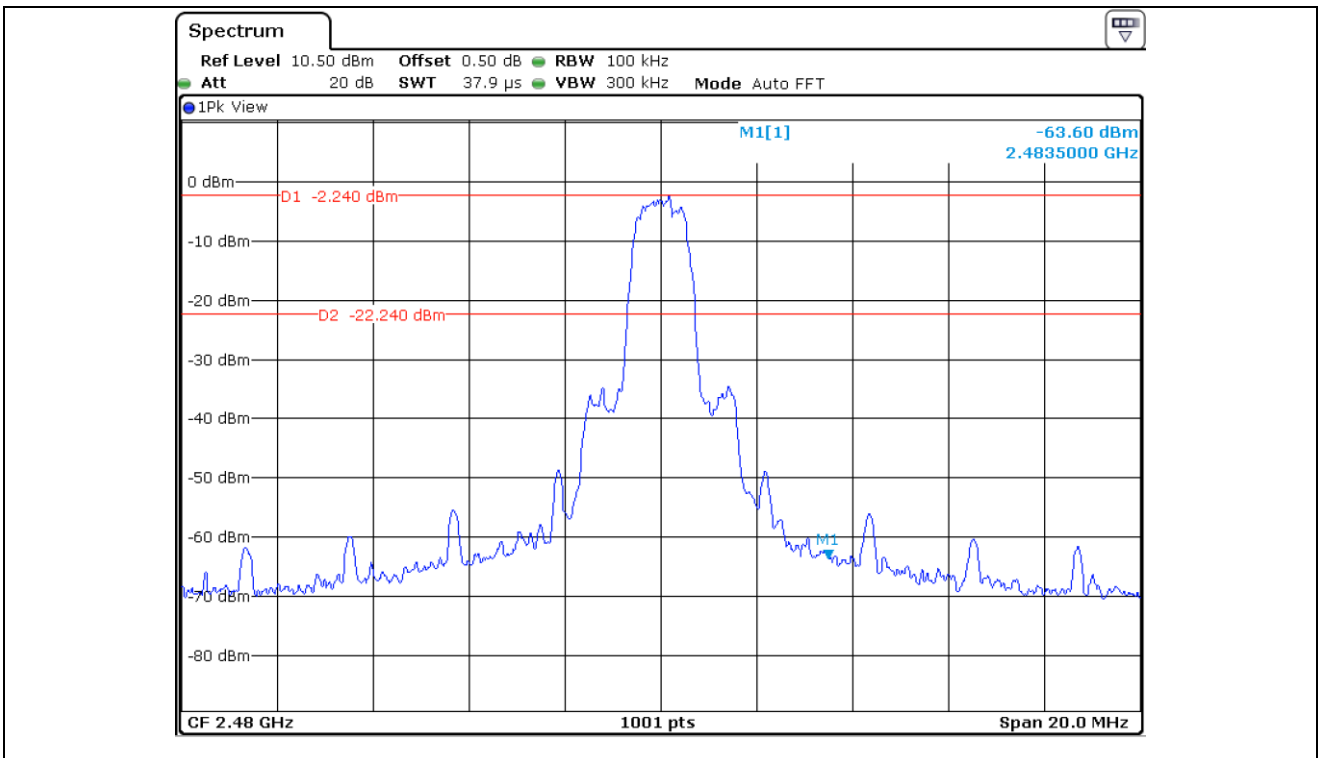


Middle Channel

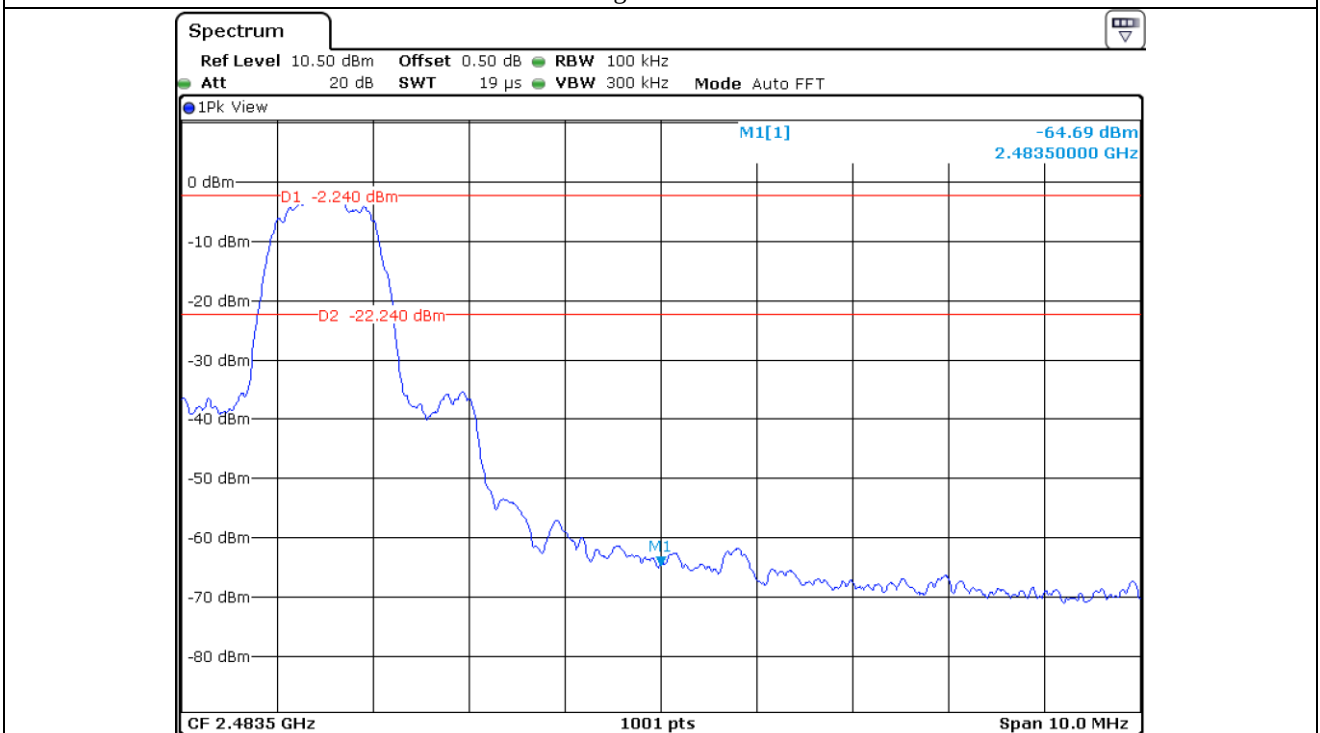


Middle Channel

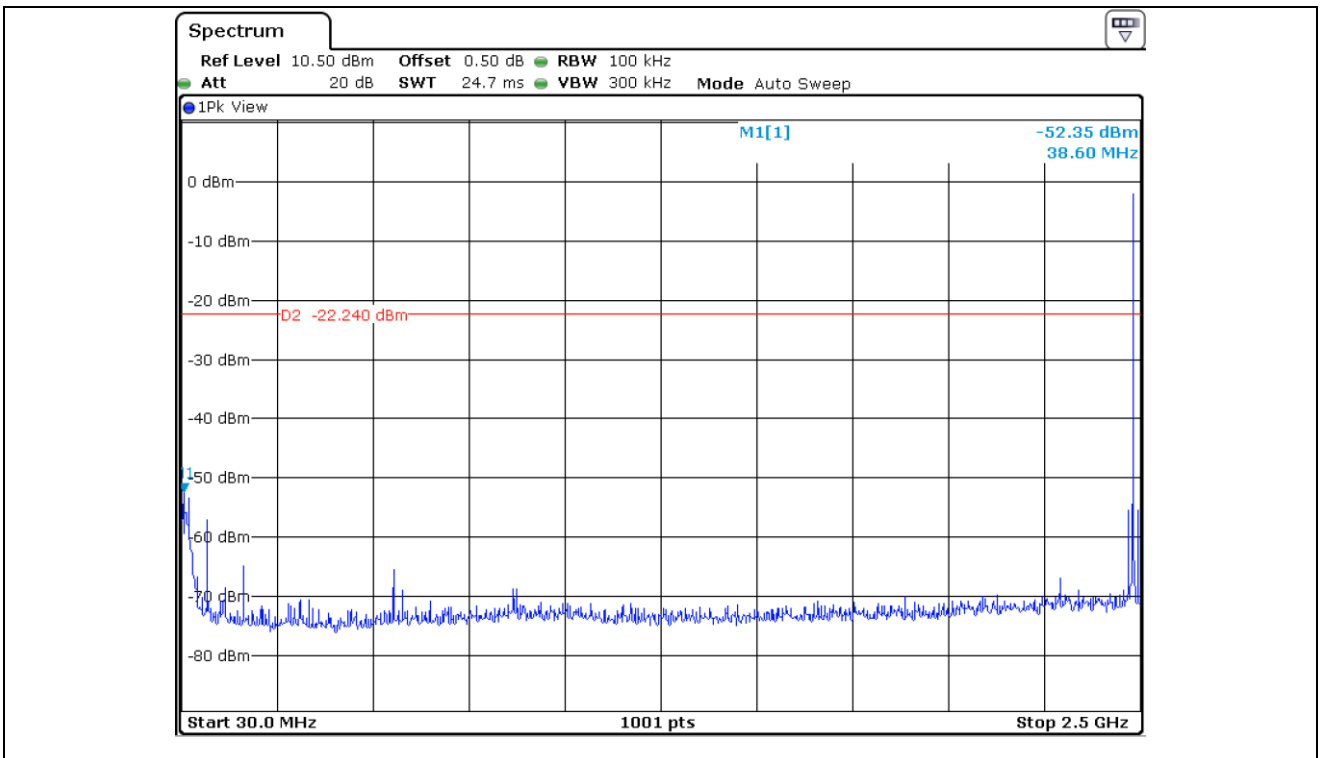




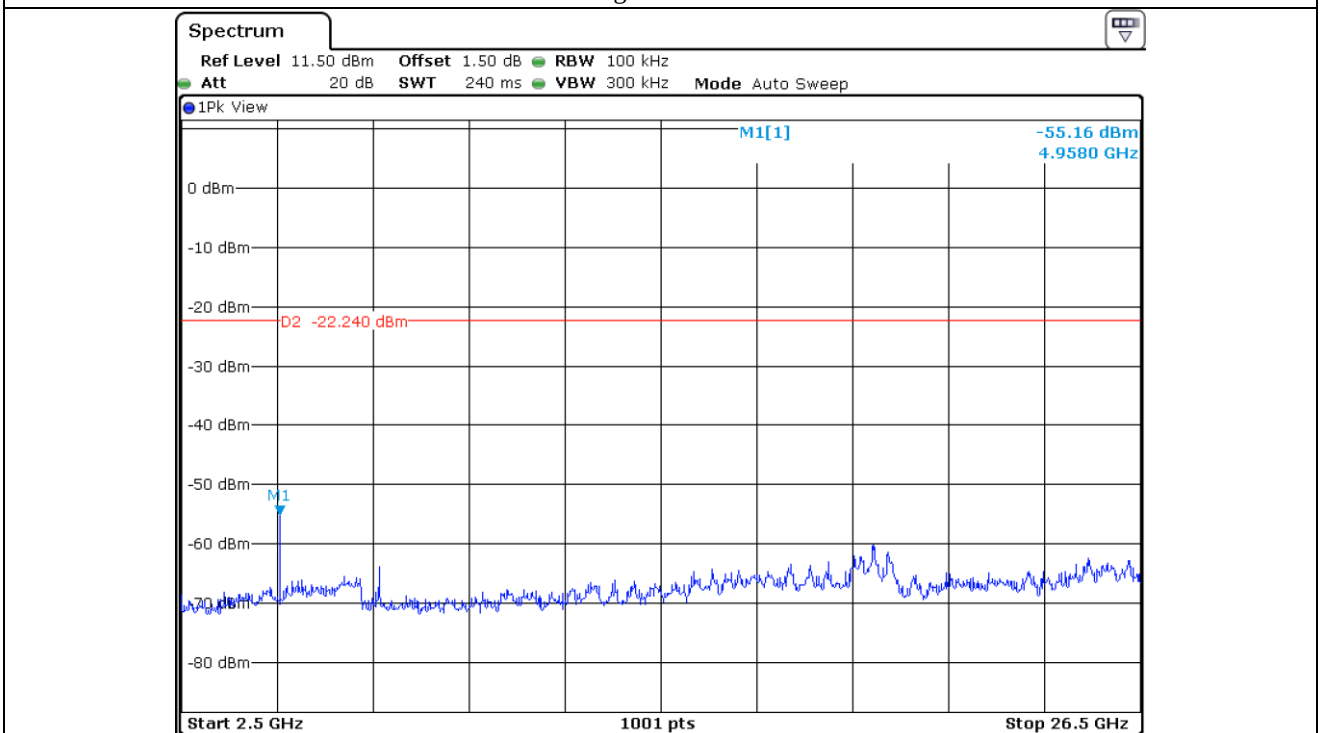
High Channel



High 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 : June 12, 2017
- . 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	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
2 389.17	39.21	Peak	H	27.30	11.40	40.00	37.91	74.00	36.09
	32.20	Average	H				30.90	54.00	23.10
2 389.97	44.83	Peak	V				43.53	74.00	30.47
	23.74	Average	V				22.44	54.00	31.56
Test Data for High Channel									
2 484.88	39.53	Peak	H	27.30	11.40	40.00	38.23	74.00	35.77
	23.36	Average	H				22.06	54.00	31.94
2 484.14	36.69	Peak	V				35.39	74.00	38.61
	23.91	Average	V				22.61	54.00	31.39

Tabulated test data for Restricted Band

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



Tested by: Min-Gu Ji / Assistant Manager

12.6.1.2 Test data for 2 Mbps

- . Test Date : June 12, 2017
- . 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	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
2 386.51	41.64	Peak	H	27.30	11.40	40.00	40.34	74.00	33.66
	23.60	Average	H				22.30	54.00	31.70
2 386.04	40.86	Peak	V				39.56	74.00	34.44
	23.43	Average	V				22.13	54.00	31.87
Test Data for High Channel									
2 483.50	40.16	Peak	H	27.30	11.40	40.00	38.86	74.00	35.14
	25.89	Average	H				24.59	54.00	29.41
	38.69	Peak	V				37.39	74.00	36.61
	23.34	Average	V				22.04	54.00	31.96

Tabulated test data for Restricted Band

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



Tested by: Min-Gu Ji / Assistant Manager

12.6.1.3 Test data for 3 Mbps

- . Test Date : June 12, 2017
- . 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	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
2 389.48	40.80	Peak	H	27.30	11.40	40.00	39.50	74.00	34.50
	28.52	Average	H				27.22	54.00	26.78
2 389.73	46.20	Peak	V				44.90	74.00	29.10
	24.01	Average	V				22.71	54.00	31.29
Test Data for High Channel									
2 492.64	42.09	Peak	H	27.30	11.40	40.00	40.79	74.00	33.21
	30.15	Average	H				28.85	54.00	25.15
2 483.77	40.63	Peak	V				39.33	74.00	34.67
	22.95	Average	V				21.65	54.00	32.35

Tabulated test data for Restricted Band

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



Tested by: Min-Gu Ji / Assistant Manager

12.6.2 Spurious & Harmonic Radiated Emission above 1 GHz

12.6.2.1 Test data for 1 Mbps

- . Test Date : June 12, 2017
- . 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	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
4 804.00	35.81	Peak	H	30.80	16.10	40.60	42.11	74.00	31.89
	23.15	Average	H				29.45	54.00	24.55
	35.72	Peak	V				42.02	74.00	31.98
	24.15	Average	V				30.45	54.00	23.55
Test Data for Middle Channel									
4 882.00	35.43	Peak	H	30.90	16.10	40.60	41.83	74.00	32.17
	22.15	Average	H				28.55	54.00	25.45
	35.36	Peak	V				41.76	74.00	32.24
	23.15	Average	V				29.55	54.00	24.45
Test Data for High Channel									
4 960.00	35.21	Peak	H	31.00	16.10	40.60	41.71	74.00	32.29
	24.16	Average	H				30.66	54.00	23.34
	34.15	Peak	V				40.65	74.00	33.35
	23.16	Average	V				29.66	54.00	24.34

Tabulated test data for Restricted Band

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



Tested by: Min-Gu Ji / Assistant Manager

12.6.2.2 Test data for 2 Mbps

- Test Date : June 12, 2017
- 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	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
4 804.00	36.89	Peak	H	30.80	16.10	40.60	43.19	74.00	30.81
	24.53	Average	H				30.83	54.00	23.17
	37.48	Peak	V				43.78	74.00	30.22
	27.43	Average	V				33.73	54.00	20.27
Test Data for Middle Channel									
4 882.00	36.15	Peak	H	30.90	16.10	40.60	42.55	74.00	31.45
	22.15	Average	H				28.55	54.00	25.45
	36.15	Peak	V				42.55	74.00	31.45
	24.33	Average	V				30.73	54.00	23.27
Test Data for High Channel									
4 960.00	34.47	Peak	H	31.00	16.10	40.60	40.97	74.00	33.03
	22.00	Average	H				28.50	54.00	25.50
	34.23	Peak	V				40.73	74.00	33.27
	21.05	Average	V				27.55	54.00	26.45

Tabulated test data for Restricted Band

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



Tested by: Min-Gu Ji / Assistant Manager

12.6.2.3 Test data for 3 Mbps

- Test Date : June 12, 2017
- 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	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel									
4 804.00	34.49	Peak	H	30.80	16.10	40.60	40.79	74.00	33.21
	21.90	Average	H				28.20	54.00	25.80
	34.50	Peak	V				40.80	74.00	33.20
	22.12	Average	V				28.42	54.00	25.58
Test Data for Middle Channel									
4 882.00	33.16	Peak	H	30.90	16.10	40.60	39.56	74.00	34.44
	23.11	Average	H				29.51	54.00	24.49
	32.05	Peak	V				38.45	74.00	35.55
	22.15	Average	V				28.55	54.00	25.45
Test Data for High Channel									
4 960.00	34.13	Peak	H	31.00	16.10	40.60	40.63	74.00	33.37
	23.15	Average	H				29.65	54.00	24.35
	32.15	Peak	V				38.65	74.00	35.35
	16.24	Average	V				22.74	54.00	31.26

Tabulated test data for Restricted Band

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



Tested by: Min-Gu Ji / Assistant Manager

12.6.3 Spurious Radiated Emission

12.6.3.1 Software used

Software name	Software version	Manufacturer
Radiated Emission Measurement Software	2.00.0197	Techno Science Japan Co.,Ltd

12.6.3.2 Test Data for 30 MHz ~ 1 000 MHz

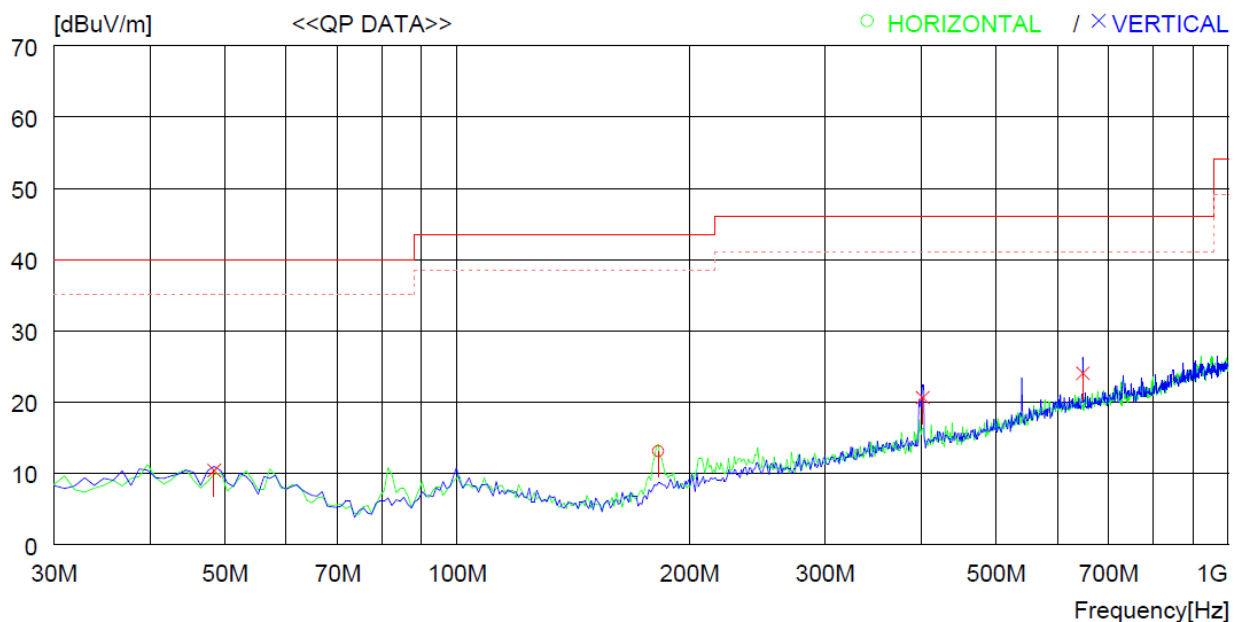
Humidity Level : 53 % R.H. Temperature: 24 °C

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

Result : PASSED

EUT : CAI Monitoring System Date: June 13, 2017

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



No.	FREQ [MHz]	READING QP [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal -----										
1	182.290	33.0	10.0	3.2	33.1	13.1	43.5	30.4	200	0
----- Vertical -----										
2	48.430	27.6	14.2	1.7	33.1	10.4	40.0	29.6	100	122
3	401.510	33.4	15.8	4.6	33.2	20.6	46.0	25.4	100	358
4	647.887	32.2	19.5	5.8	33.5	24.0	46.0	22.0	100	0

Tested by: Min-Gu Ji / Assistant Manager

12.6.3.2 Test Data for Below 30 MHz

- . Test Date : June 13, 2017
- . 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 Condition : Highest Output Power Transmitting Mode
- . Result : PASSED

Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss	Amp Gain	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
Any emissions were not observed from the EUT.								

12.6.3.3 Test Data for above 1 GHz

- . Test Date : June 13, 2017
- . Resolution bandwidth : 1 MHz for Peak and Average Mode
- . Frequency range : 1 GHz ~ 26.5 GHz
- . Measurement distance : 3 m
- . Operating Condition : Highest Output Power Transmitting Mode
- . Result : PASSED

Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss	Amp Gain	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
Any emissions were not observed from the EUT.								



Tested by: Min-Gu Ji / Assistant Manager

13. CONDUCTED EMISSION TEST

13.1 Operating environment

Temperature : 23 °C
Relative humidity : 42 % R.H.

13.2 Test set-up

The EUT was placed on a wooden table, 0.8 m height above the floor. Power was fed to the EUT through a 50 Ω / 50 μ H + 5 Ω Artificial Mains Network (AMN). The ground plane was electrically bonded to the reference ground system and all power lines were filtered from ambient.

13.3 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal. (Interval)
■ -	ESPI	Rohde & Schwarz	EMI Test Receiver	101278	Nov. 01, 2016 (1Y)
□ -	ESHS10	Rohde & Schwarz	EMI Test Receiver	834467/007	Apr. 03, 2017 (1Y)
□	NSLK8128	Schwarzbeck	AMN	8128-216	Apr. 05, 2017 (1Y)
■ -	NSLK8126	Schwarzbeck	AMN	8126-404	Apr. 03, 2017 (1Y)
□ -	3825/2	EMCO	AMN	9109-1869	Apr. 06, 2017 (1Y)
■ --	3825/2	EMCO	AMN	9109-1867	Apr. 07, 2017 (1Y)

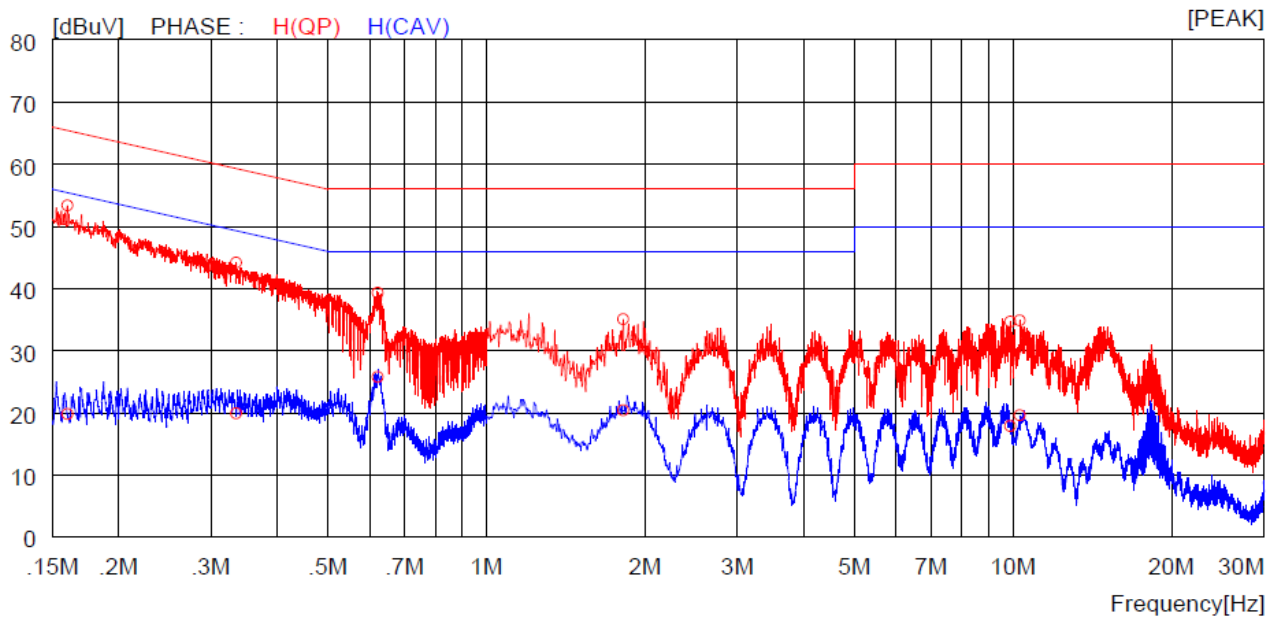
All test equipment used is calibrated on a regular basis.

13.4 Software used

Software name	Software version	Manufacturer
Noise Terminal Voltage Measurement Software	2.00.0180	Techno Science Japan Co.,Ltd

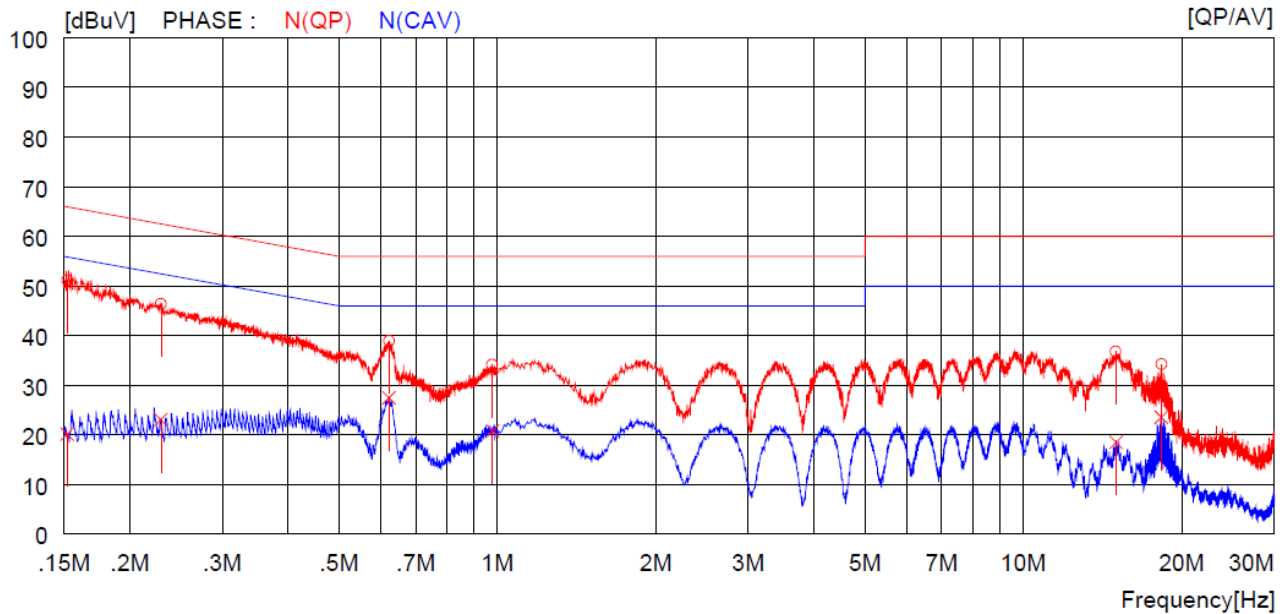
13.5 Test data for Charging Mode

- Test Date : June 13, 2017
- Resolution bandwidth : 9 kHz
- Frequency range : 0.15 MHz ~ 30 MHz
- Tested Line : HOT LINE



NO	FREQ	READING (PK)	C.F	RESULT	LIMIT		MARGIN		PHASE
	[MHz]	[dBuV]			QP	AV	QP	AV	
			[dB]	[dBuV]	[dBuV]	[dBuV]	[dB]	[dB]	
1	0.16000	53.2	0.1	53.3	65.5	55.5	12.2	2.2	H (QP)
2	0.33500	44.0	0.1	44.1	59.3	49.3	15.2	5.2	H (QP)
3	0.62300	39.2	0.1	39.3	56.0	46.0	16.7	6.7	H (QP)
4	1.82000	35.0	0.1	35.1	56.0	46.0	20.9	10.9	H (QP)
5	9.88500	34.2	0.4	34.6	60.0	50.0	25.4	15.4	H (QP)
6	10.32000	34.5	0.4	34.9	60.0	50.0	25.1	15.1	H (QP)
7	0.16000	19.8	0.0	19.8	65.5	55.5	45.7	35.7	H (CAV)
8	0.33500	19.8	0.1	19.9	59.3	49.3	39.4	29.4	H (CAV)
9	0.62300	25.7	0.1	25.8	56.0	46.0	30.2	20.2	H (CAV)
10	1.82000	20.3	0.1	20.4	56.0	46.0	35.6	25.6	H (CAV)
11	9.88500	17.5	0.4	17.9	60.0	50.0	42.1	32.1	H (CAV)
12	10.32000	19.2	0.4	19.6	60.0	50.0	40.4	30.4	H (CAV)

-. Tested Line : NEUTRAL LINE



NO	FREQ [MHz]	READING		C. FACTOR [dB]	RESULT		LIMIT		MARGIN		PHASE
		QP [dBuV]	AV [dBuV]		QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	
1	0.15200	51.1	----	0.1	51.2	----	65.9	----	14.7	----	N (QP)
2	0.22900	46.2	----	0.1	46.3	----	62.5	----	16.2	----	N (QP)
3	0.62200	38.8	----	0.1	38.9	----	56.0	----	17.1	----	N (QP)
4	0.97900	34.0	----	0.1	34.1	----	56.0	----	21.9	----	N (QP)
5	15.00000	36.1	----	0.6	36.7	----	60.0	----	23.3	----	N (QP)
6	18.31000	33.5	----	0.7	34.2	----	60.0	----	25.8	----	N (QP)
7	0.15200	----	20.0	0.1	----	20.1	----	55.9	----	35.8	N (CAV)
8	0.22900	----	22.9	0.1	----	23.0	----	52.5	----	29.5	N (CAV)
9	0.62200	----	27.4	0.1	----	27.5	----	46.0	----	18.5	N (CAV)
10	0.97900	----	20.7	0.1	----	20.8	----	46.0	----	25.2	N (CAV)
11	15.00000	----	17.9	0.6	----	18.5	----	50.0	----	31.5	N (CAV)
12	18.31000	----	22.8	0.7	----	23.5	----	50.0	----	26.5	N (CAV)

Remark: Margin (dB) = Limit – Level (Result)

The emission level in above table is included the transducer factor that means insertion loss (LISN), cable loss and attenuator.

Signature

Tested by: Min-Gu Ji / Assistant Manager