



FCC RF Test Report

The product was received on Apr. 24, 2019 and testing was completed on Jun. 21, 2019. We, Sporton International (Kunshan) Inc., would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

This report contains data that were produced under subcontract by Laboratory SPORTON INTERNATIONAL INC.

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



Reviewed by: Jason Jia / Supervisor

Approved by: James Huang / Manager



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No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300
People's Republic of China



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REVISION HISTORY



SUMMARY OF TEST RESULT

Report Section	FCC Rule	Description	Limit	Result	Remark
3.1	15.247(a)(1)	Number of Channels	$\geq 15\text{Chs}$	Pass	-
3.2	15.247(a)(1)	Hopping Channel Separation	$\geq 2/3 \text{ of } 20\text{dB BW}$	Pass	-
3.3	15.247(a)(1)	Dwell Time of Each Channel	$\leq 0.4\text{sec in } 31.6\text{sec period}$	Pass	-
3.4	15.247(a)(1)	20dB Bandwidth	NA	Pass	-
3.4	-	99% Bandwidth	-	Pass	-
3.5	15.247(b)(1)	Peak Output Power	$\leq 125 \text{ mW}$	Pass	-
3.6	15.247(d)	Conducted Band Edges	$\leq 20\text{dBc}$	Pass	-
3.7	15.247(d)	Conducted Spurious Emission	$\leq 20\text{dBc}$	Pass	-
3.8	15.247(d)	Radiated Band Edges and Radiated Spurious Emission	15.209(a) & 15.247(d)	Pass	Under limit 16.35 dB at 52.31 MHz
3.9	15.207	AC Conducted Emission	15.207(a)	Pass	Under limit 7.53 dB at 0.77775 MHz
3.10	15.203 & 15.247(b)	Antenna Requirement	N/A	Pass	-



1 General Description

1.1 Applicant

LEOMO, Inc.

7-22-17 Nishi Gotanda TOC Bldg. 7F Shinagawa-ku, Tokyo, 1410031, Japan

1.2 Manufacturer

LEOMO, Inc.

2000 Central Avenue, Suite 150, Boulder CO 80301, USA

1.3 Product Feature of Equipment Under Test

Product Feature	
Equipment	Smartphone
Brand Name	LEOMO
Model Name	LEM-TS1
FCC ID	2AD9M-003A
EUT supports Radios application	GSM/WCDMA/LTE WLAN 2.4GHz 802.11b/g/n HT20/HT40 WLAN 5GHz 802.11a/n HT20/HT40 Bluetooth BR/EDR/LE/ANT+ NFC and GNSS
IMEI Code	Conducted : N/A Radiation: 355681100008919 Conduction: 355681100008836
HW Version	DVT
SW Version	000T_1_020
EUT Stage	Identical Prototype

Remark: The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.



1.4 Product Specification of Equipment Under Test

Standards-related Product Specification	
Tx/Rx Frequency Range	2402 MHz ~ 2480 MHz
Number of Channels	79
Carrier Frequency of Each Channel	2402+n*1 MHz; n=0~78
Maximum Output Power to Antenna	BT EDR chip of CYW2070 : Bluetooth BR(1Mbps) : 8.69 dBm (0.0074 W) Bluetooth EDR (2Mbps) : 7.98 dBm (0.0063 W) Bluetooth EDR (3Mbps) : 8.25 dBm (0.0067 W) BT EDR chip of WCN3660B : Bluetooth BR(1Mbps) : 13.85 dBm (0.0243 W) Bluetooth EDR (2Mbps) : 13.90 dBm (0.0245 W) Bluetooth EDR (3Mbps) : 14.17 dBm (0.0261 W)
99% Occupied Bandwidth	BT EDR chip of CYW2070 : Bluetooth BR(1Mbps) : 0.903MHz Bluetooth EDR (2Mbps) : 1.213MHz Bluetooth EDR (3Mbps) : 1.190MHz BT EDR chip of WCN3660B : Bluetooth BR(1Mbps) : 0.906MHz Bluetooth EDR (2Mbps) : 1.166MHz Bluetooth EDR (3Mbps) : 1.149MHz
Antenna Type / Gain	BT EDR chip of CYW2070: PIFA Antenna type with gain -1.25 dBi BT EDR chip of WCN3660B: Loop Antenna Type with gain -1.57 dBi
Type of Modulation	Bluetooth BR (1Mbps) : GFSK Bluetooth EDR (2Mbps) : $\pi/4$ -DQPSK Bluetooth EDR (3Mbps) : 8-DPSK

1.5 Modification of EUT

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



1.6 Testing Location

Sportun International (Kunshan) Inc. is accredited to ISO/IEC 17025:2017 by American Association for Laboratory Accreditation with Certificate Number 5145.02.

Test Firm	Sportun International (Kunshan) Inc.		
Test Site Location	No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300 People's Republic of China TEL : +86-512-57900158 FAX : +86-512-57900958		
Test Site No.	Sportun Site No.	FCC Designation No.	FCC Test Firm Registration No.
	03CH05-KS	CN1257	314309

SPORTON INTERNATIONAL INC. is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code : 1190) and under the FCC-recognized accredited testing laboratories by Mutual Recognition Agreement (MRA) in FCC Test.

Test Site	SPORTON INTERNATIONAL INC.		
Test Site Location	No.52, Huaya 1st Rd., Guishan Dist. Taoyuan City Taiwan Tel: 886-3-327-3456 FAX: +886-3-327-0978		
Test Site No.	Sportun Site No.	FCC designation No.	FCC Test Firm Registration No.
	CO05-HY, TH05-HY	TW1190	553509

Test data subcontracted: All test item of this report except Radiated Spurious Emission.



1.7 Applicable Standards

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

- ♦ 47 CFR Part 15 Subpart C §15.247
- ♦ FCC KDB 558074 D01 15.247 Meas Guidance v05r01
- ♦ ANSI C63.10-2013

Remark:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.



2 Test Configuration of Equipment Under Test

2.1 Carrier Frequency Channel

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
2400-2483.5 MHz	0	2402	27	2429	54	2456
	1	2403	28	2430	55	2457
	2	2404	29	2431	56	2458
	3	2405	30	2432	57	2459
	4	2406	31	2433	58	2460
	5	2407	32	2434	59	2461
	6	2408	33	2435	60	2462
	7	2409	34	2436	61	2463
	8	2410	35	2437	62	2464
	9	2411	36	2438	63	2465
	10	2412	37	2439	64	2466
	11	2413	38	2440	65	2467
	12	2414	39	2441	66	2468
	13	2415	40	2442	67	2469
	14	2416	41	2443	68	2470
	15	2417	42	2444	69	2471
	16	2418	43	2445	70	2472
	17	2419	44	2446	71	2473
	18	2420	45	2447	72	2474
	19	2421	46	2448	73	2475
	20	2422	47	2449	74	2476
	21	2423	48	2450	75	2477
	22	2424	49	2451	76	2478
	23	2425	50	2452	77	2479
	24	2426	51	2453	78	2480
	25	2427	52	2454	-	-
	26	2428	53	2455	-	-



2.2 Test Mode

- a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: conduction emission (150 kHz to 30 MHz), radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, pre-scanned in three orthogonal panels, X, Y, Z. The worst cases(Z, X Plane) were recorded in this report, and the worst mode of radiated spurious emissions is Bluetooth 1Mbps mode for BT EDR chip of CYW2070, and Bluetooth 3Mbps mode for BT EDR chip of WCN3660B, and recorded in this report.
- b. AC power line Conducted Emission was tested under maximum output power.

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

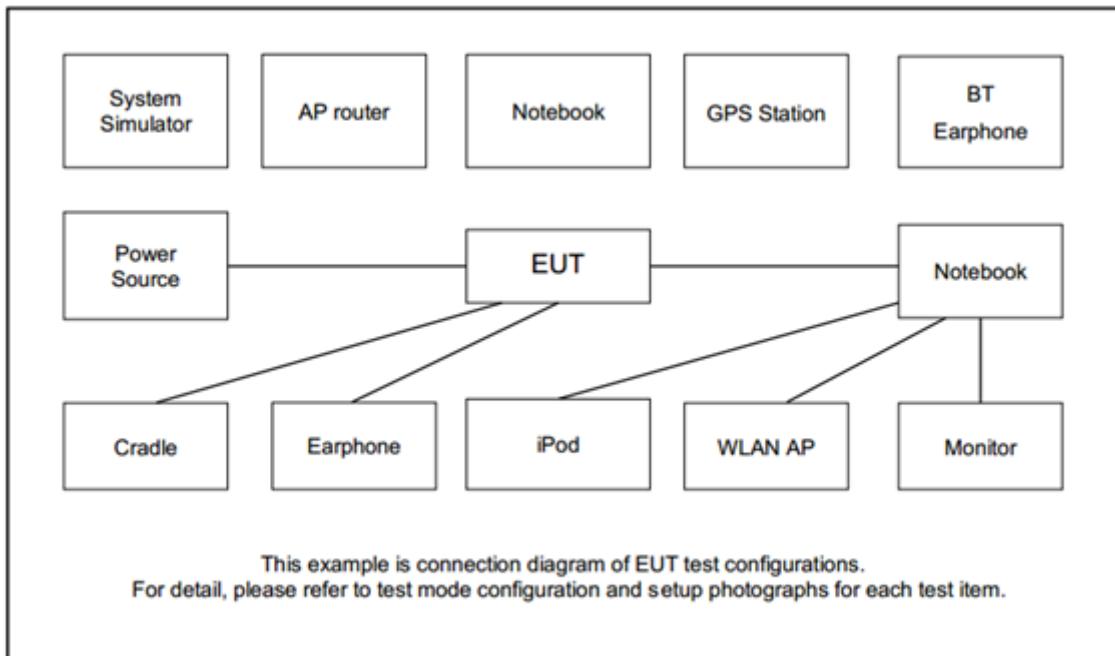
Summary table of Test Cases				
Test Item	Data Rate / Modulation			
	Bluetooth BR 1Mbps GFSK	Bluetooth EDR 2Mbps $\pi/4$ -DQPSK	Bluetooth EDR 3Mbps 8-DPSK	
Conducted Test Cases	Mode 1: CH00_2402 MHz Mode 2: CH39_2441 MHz Mode 3: CH78_2480 MHz	Mode 4: CH00_2402 MHz Mode 5: CH39_2441 MHz Mode 6: CH78_2480 MHz	Mode 7: CH00_2402 MHz Mode 8: CH39_2441 MHz Mode 9: CH78_2480 MHz	
Radiated Test Cases	Bluetooth BR 1Mbps GFSK			
	Mode 1: CH00_2402 MHz Mode 2: CH39_2441 MHz Mode 3: CH78_2480 MHz			
AC Conducted Emission	Mode 1 : LTE Band 17 Idle + Bluetooth Link + WLAN (2.4G)Link + ANT+Link + Power Bank + USB Cable + Adapter			

Remark:

1. For radiated test cases, the worst mode data rate 1Mbps for BT EDR chip of CYW2070 and 1Mbps for BT EDR chip of WCN3660B were reported only, because this data rate has the highest RF output power at preliminary tests, and no other significantly frequencies found in conducted spurious emission.



2.3 Connection Diagram of Test System



2.4 Support Unit used in test configuration and system

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	BT Base Station	R&S	CBT	N/A	N/A	Unshielded,1.8m
2.	Base Station	Anritsu	MT8820C	N/A	N/A	Unshielded,1.8m
3.	GPS Station	Pendulum	GSG-54	N/A	N/A	Unshielded,1.8m
4.	Bluetooth Earphone	SonyEricsson	MW600	PY700A2029	N/A	N/A
5.	WLAN AP	ASUS	RT-AC1750	MSQ-RTAC66U B1	N/A	Unshielded,1.8m
6.	iPod	Apple	A1285	DoC	Shielded, 1.0m	N/A
7.	NOTE BOOK	Dell	Latitude E6320	FCC DoC	N/A	AC I/P : Unshielded, 1.2m DC O/P : Shielded, 1.8m
8.	Adapter	Nokia	AS-10WU	N/A	N/A	N/A
9.	USB Cable	Nokia	N/A	N/A	Shielded, 1m	N/A
10.	ANT Plus	FIH	N/A	N/A	N/A	N/A
11.	Power Bank	LEOMO	LEM-PM1	N/A	N/A	N/A



2.5 EUT Operation Test Setup

For Bluetooth function, the engineering test program was provided and enabled to make EUT connect with Bluetooth base station to continuous transmit/receive.

For AC power line conducted emissions, the EUT was set to connect with the WLAN AP under large package sizes transmission.

2.6 Measurement Results Explanation Example

For all conducted test items:

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

Example:

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

Offset = RF cable loss + attenuator factor.

Following shows an offset computation example with cable loss 15.2 dB and attenuator factor 10.0 dB

$$\text{Offset(dB)} = \text{RF cable loss(dB)} + \text{attenuator factor. .}$$

$$= 15.2 \text{ (dB)} + 10.0 \text{ (dB)}$$

$$= 15.2 \text{ (dB)}$$



3 Test Result

3.1 Number of Channel Measurement

3.1.1 Limits of Number of Hopping Frequency

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

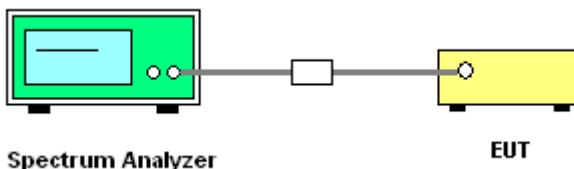
3.1.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.1.3 Test Procedure

1. The testing follows ANSI C63.10-2013 clause 7.8.3.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Enable the EUT hopping function.
5. Use the following spectrum analyzer settings: Span = the frequency band of operation; RBW = 300kHz; VBW \geq RBW; Sweep = auto; Detector function = peak; Trace = max hold.
6. The number of hopping frequency used is defined as the number of total channel.
7. Record the measurement data derived from spectrum analyzer.

3.1.4 Test Setup



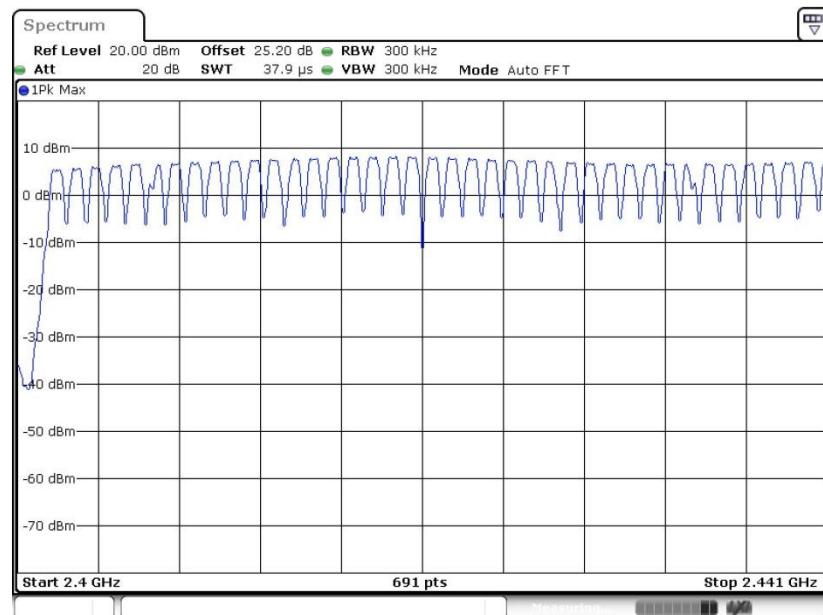
3.1.5 Test Result of Number of Hopping Frequency

Please refer to Appendix A.

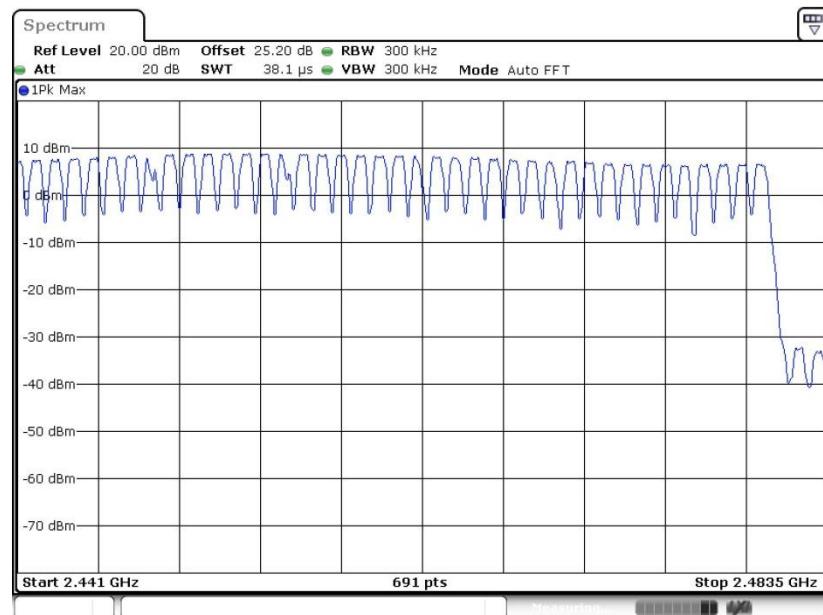


BT EDR chip of CYW2070 :

Number of Hopping Channel Plot on Channel 00 - 78



Date: 19.JUN.2019 10:20:31

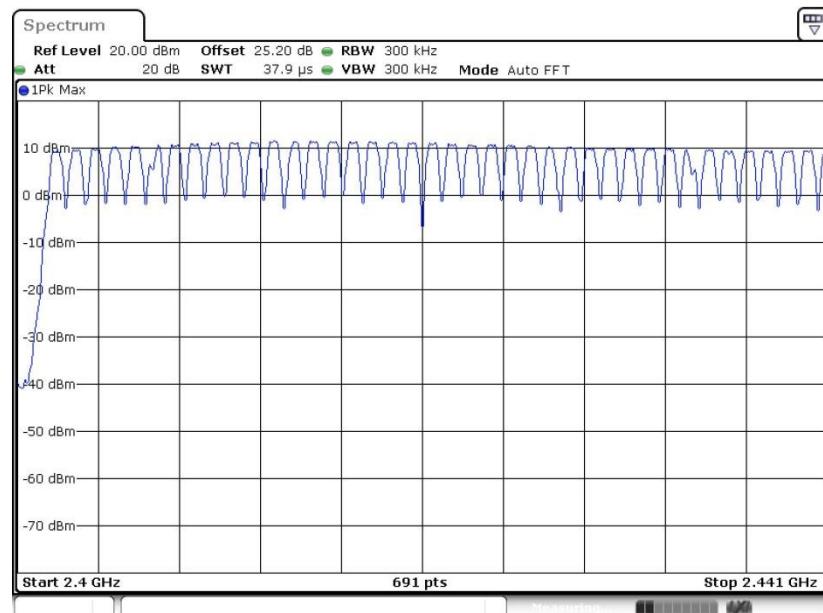


Date: 19.JUN.2019 10:21:34

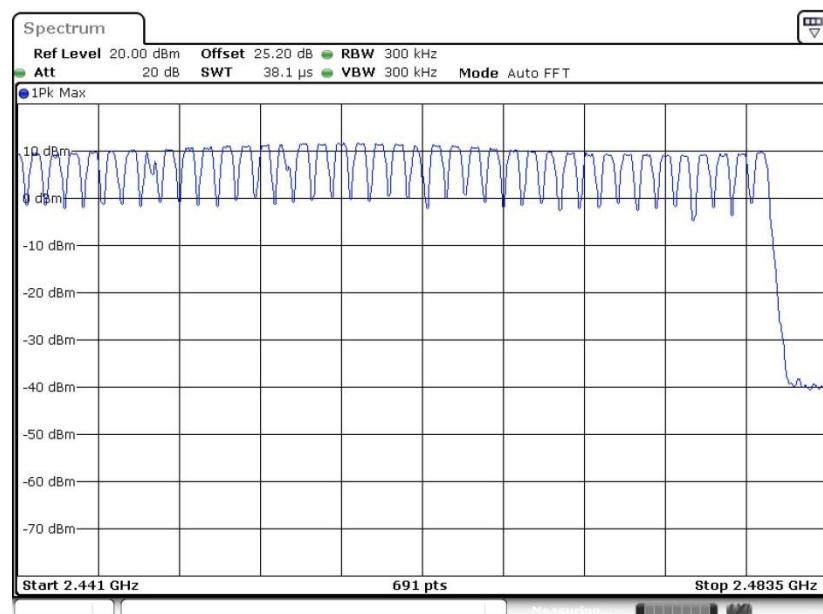


BT EDR chip of WCN3660B :

Number of Hopping Channel Plot on Channel 00 - 78



Date: 19.JUN.2019 12:10:34



Date: 19.JUN.2019 12:11:29



3.2 Hopping Channel Separation Measurement

3.2.1 Limit of Hopping Channel Separation

Frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater.

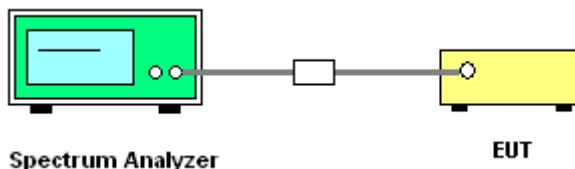
3.2.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.2.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 7.8.2.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Enable the EUT hopping function.
5. Use the following spectrum analyzer settings:
Span = wide enough to capture the peaks of two adjacent channels;
RBW = 300kHz; VBW \geq RBW; Sweep = auto; Detector function = peak; Trace = max hold.
6. Measure and record the results in the test report.

3.2.4 Test Setup



3.2.5 Test Result of Hopping Channel Separation

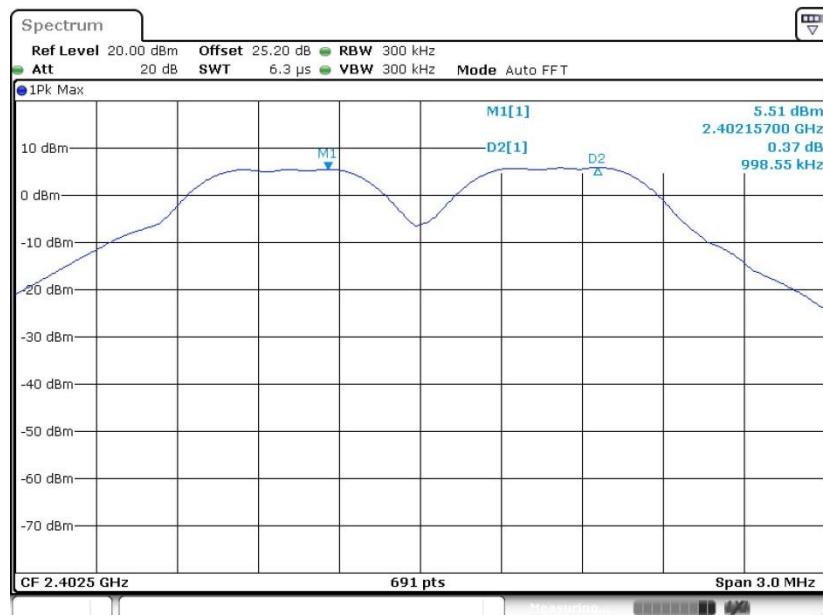
Please refer to Appendix A.



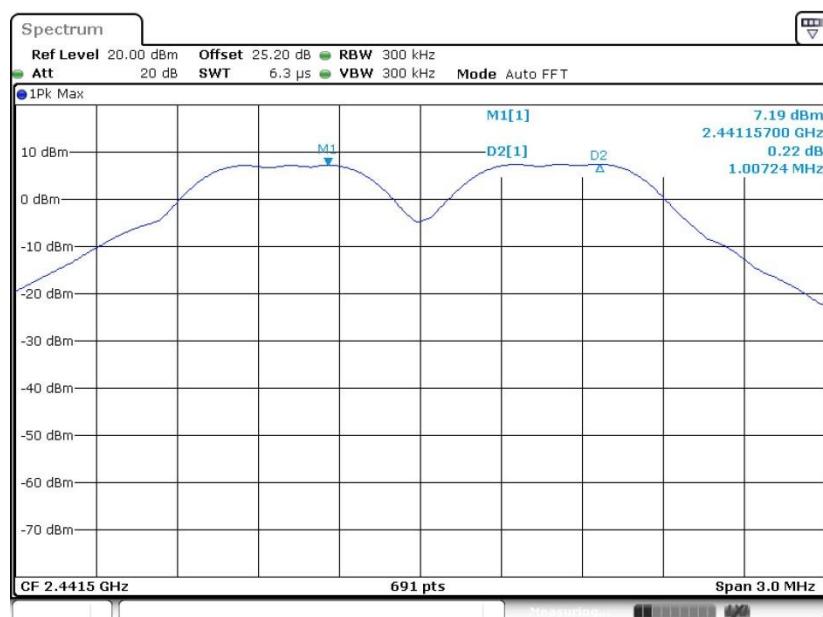
BT EDR chip of CYW2070 :

<1Mbps>

Channel Separation Plot on Channel 00 - 01

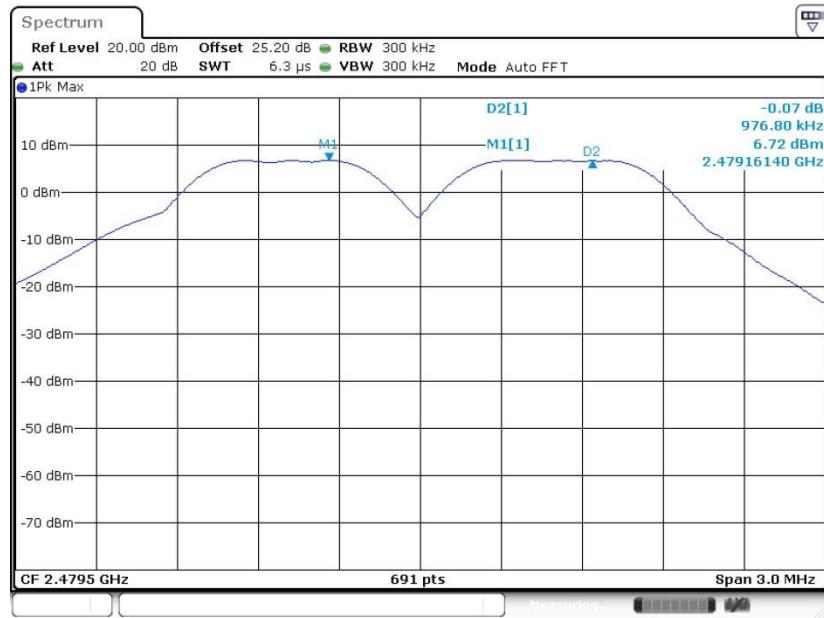


Channel Separation Plot on Channel 39 - 40





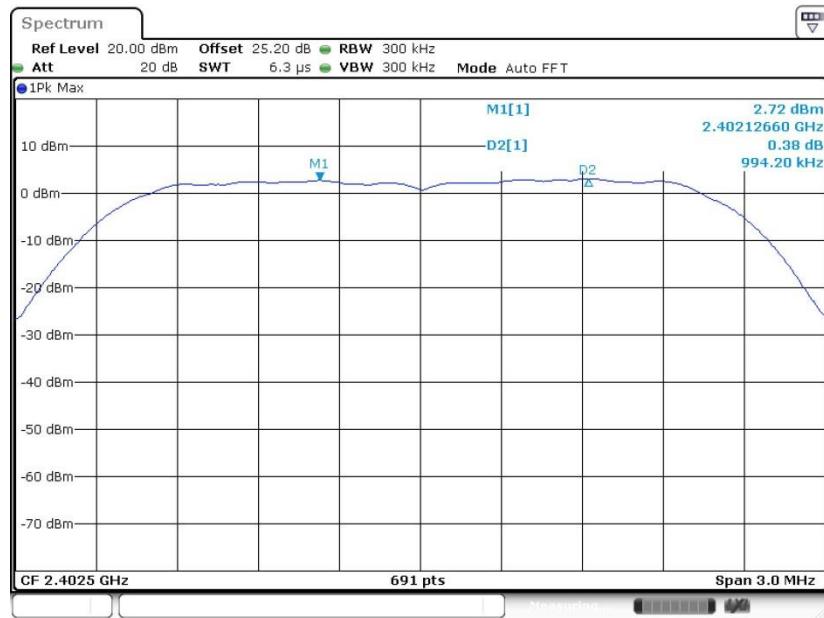
Channel Separation Plot on Channel 77 - 78



Date: 19.JUN.2019 11:18:44

<2Mbps>

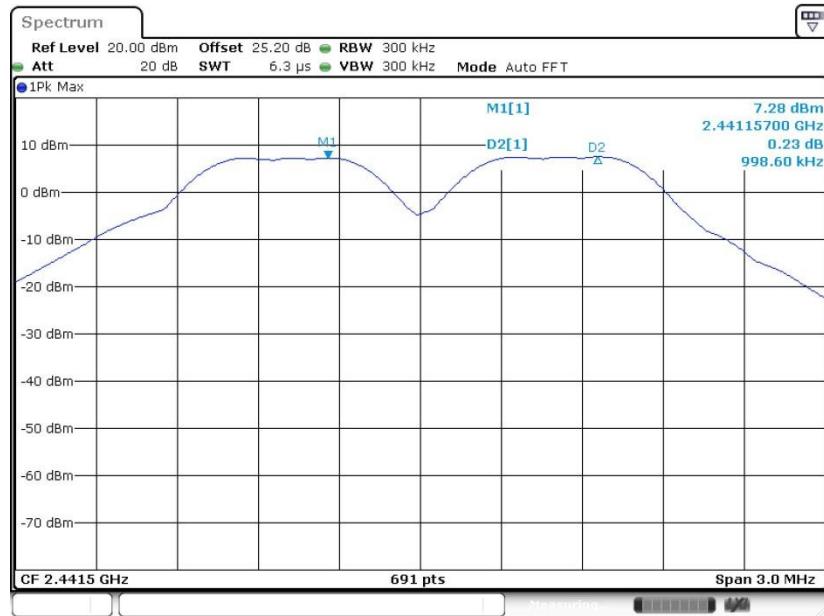
Channel Separation Plot on Channel 00 - 01



Date: 19.JUN.2019 10:39:50

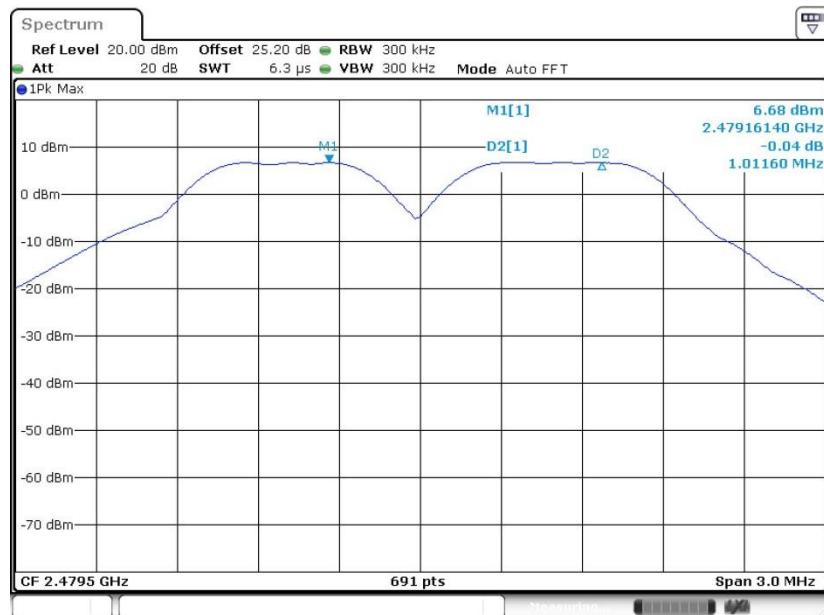


Channel Separation Plot on Channel 39 - 40



Date: 19.JUN.2019 11:19:47

Channel Separation Plot on Channel 77 - 78

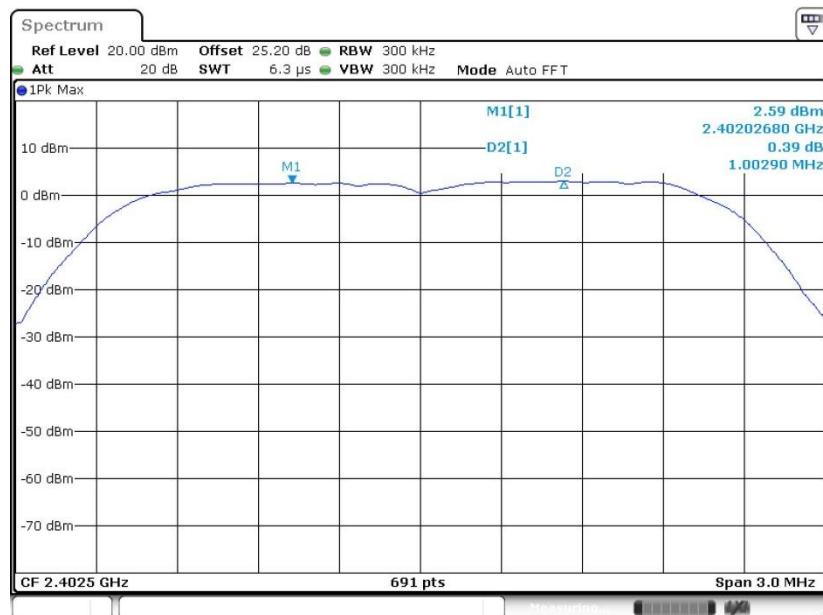


Date: 19.JUN.2019 11:21:24



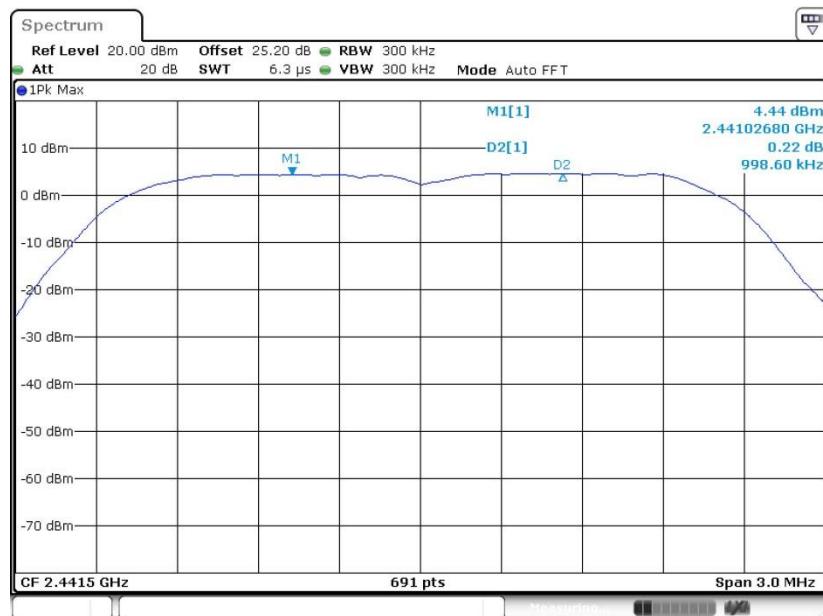
<3Mbps>

Channel Separation Plot on Channel 00 - 01



Date: 19.JUN.2019 11:01:49

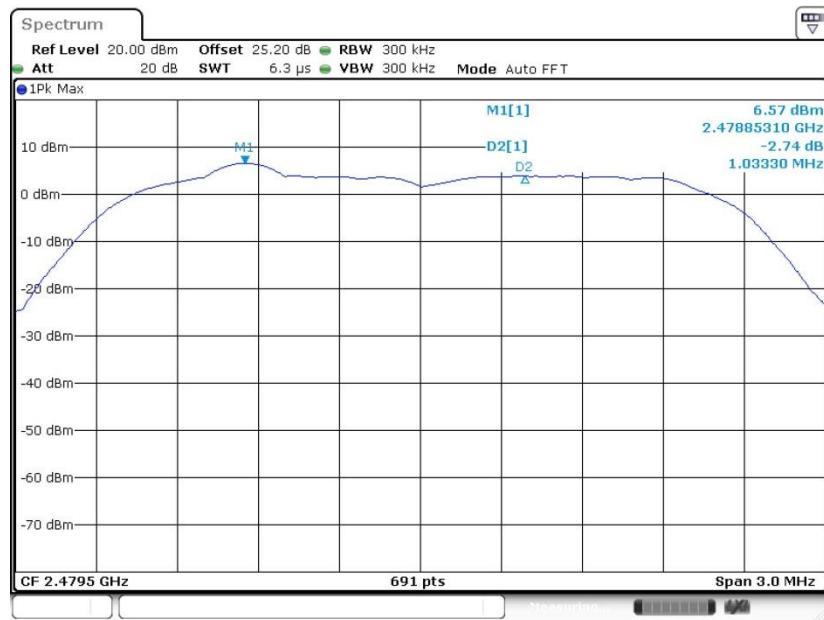
Channel Separation Plot on Channel 39 - 40



Date: 19.JUN.2019 11:02:43



Channel Separation Plot on Channel 77 - 78



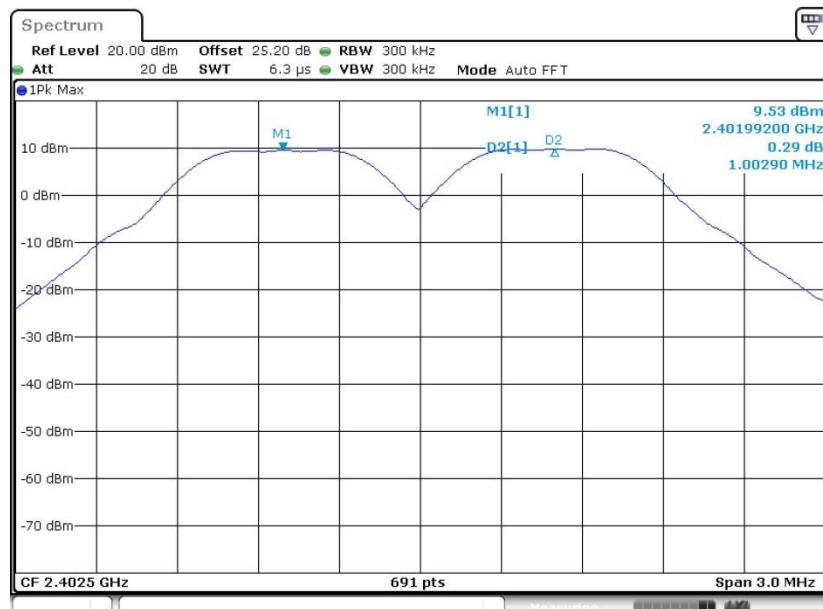
Date: 19.JUN.2019 11:03:37



BT EDR chip of WCN3660B :

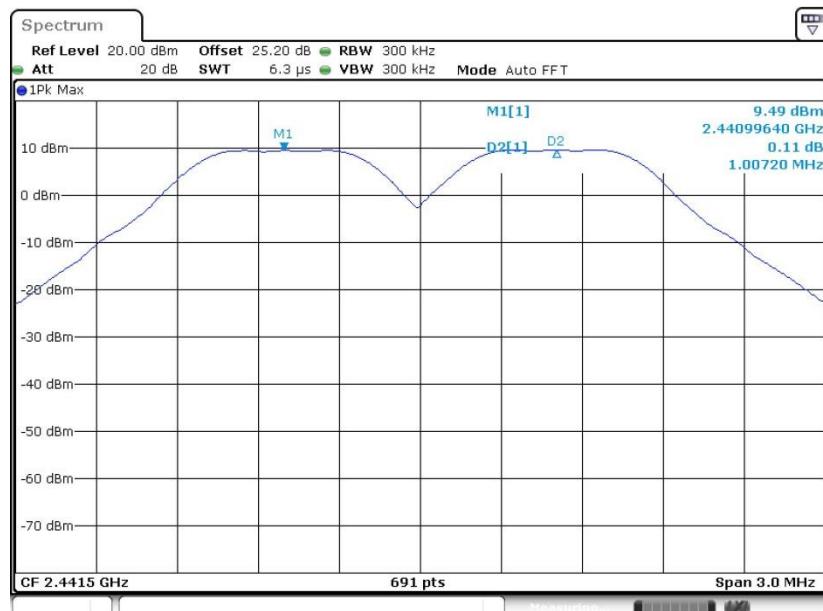
<1Mbps>

Channel Separation Plot on Channel 00 - 01



Date: 19.JUN.2019 11:55:25

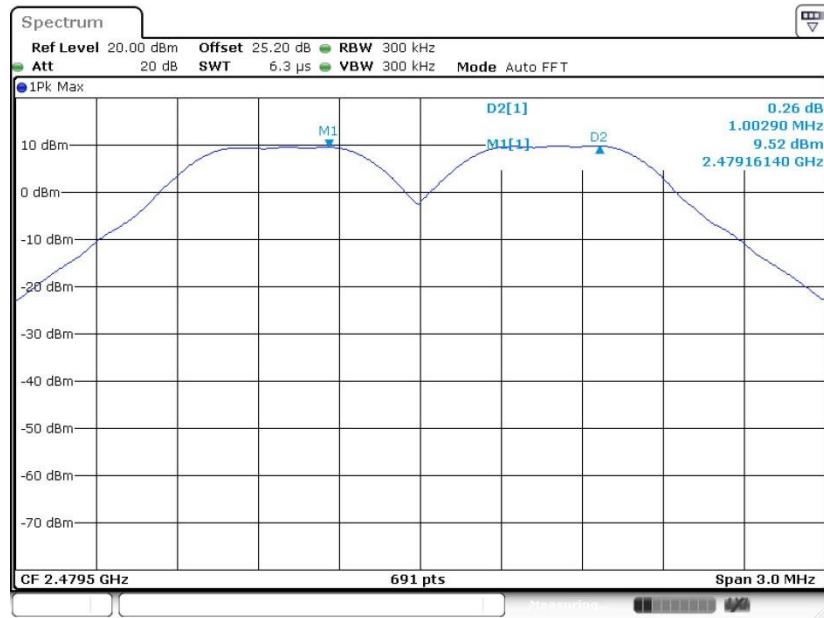
Channel Separation Plot on Channel 39 - 40



Date: 19.JUN.2019 11:56:18

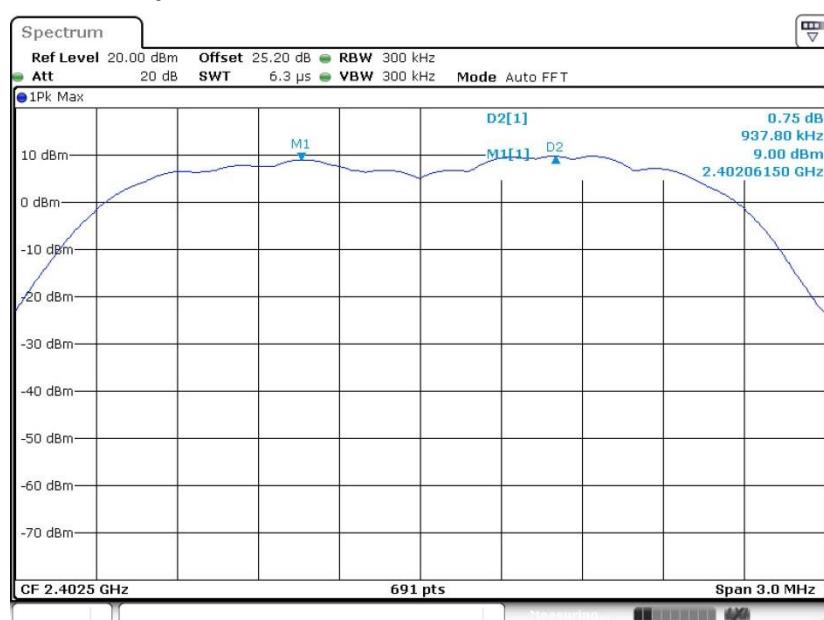


Channel Separation Plot on Channel 77 - 78



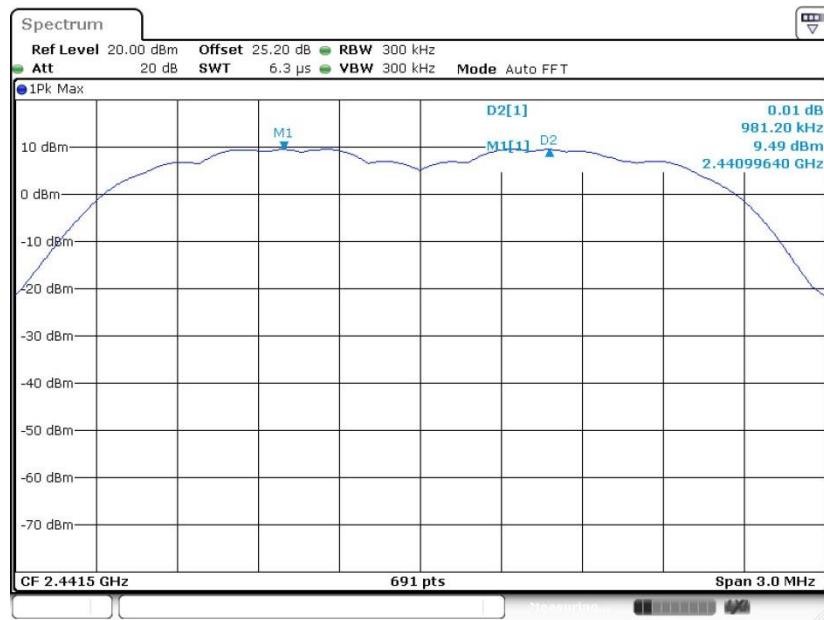
<2Mbps>

Channel Separation Plot on Channel 00 - 01



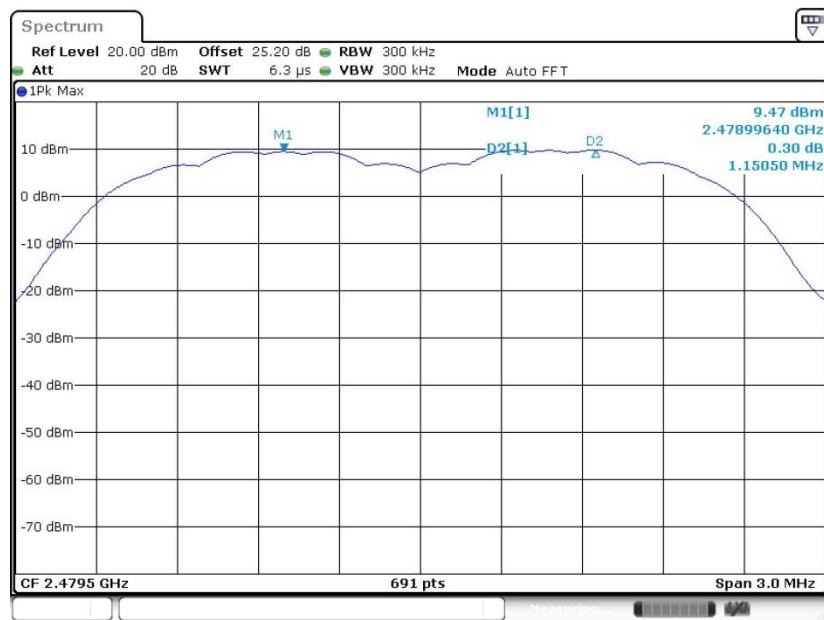


Channel Separation Plot on Channel 39 - 40



Date: 19.JUN.2019 12:04:27

Channel Separation Plot on Channel 77 - 78

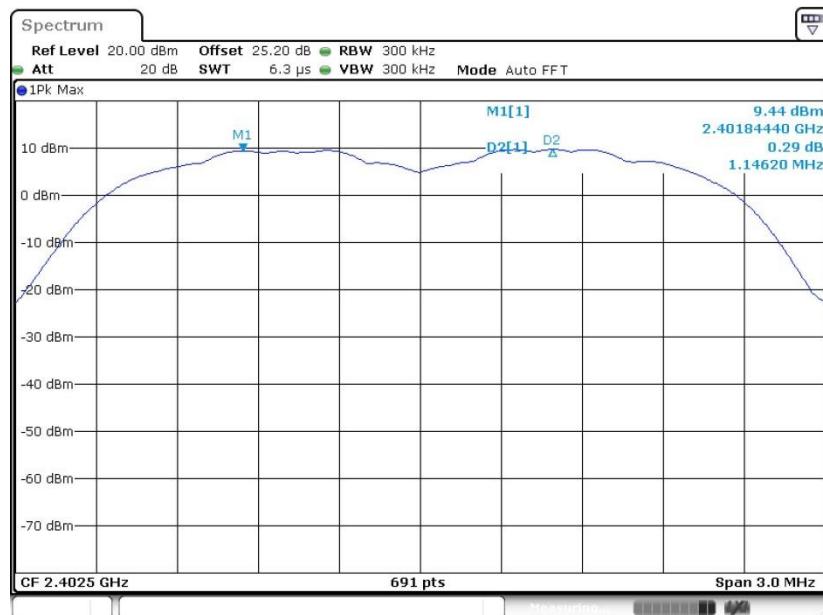


Date: 19.JUN.2019 12:06:06



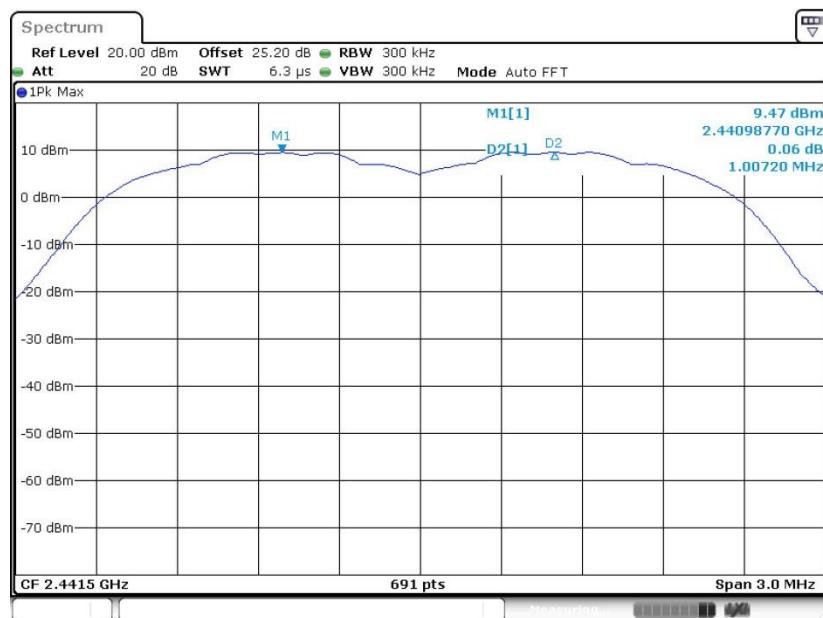
<3Mbps>

Channel Separation Plot on Channel 00 - 01



Date: 19.JUN.2019 12:07:11

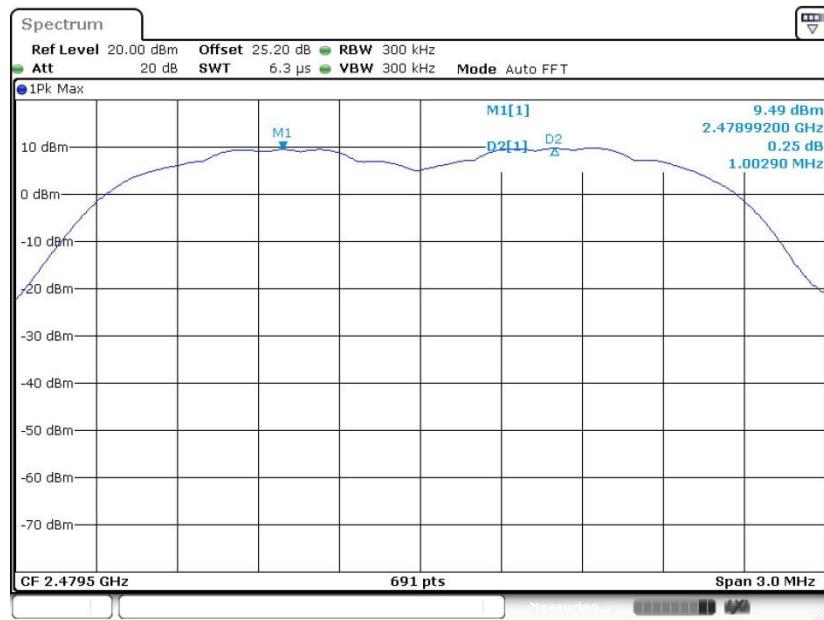
Channel Separation Plot on Channel 39 - 40



Date: 19.JUN.2019 12:08:04



Channel Separation Plot on Channel 77 - 78



Date: 19.JUN.2019 12:08:57



3.3 Dwell Time Measurement

3.3.1 Limit of Dwell Time

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

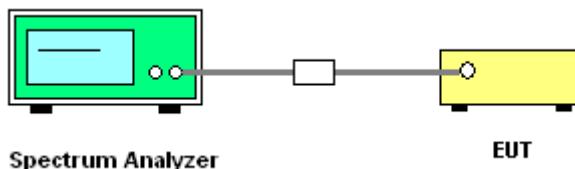
3.3.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.3.3 Test Procedures

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

3.3.4 Test Setup



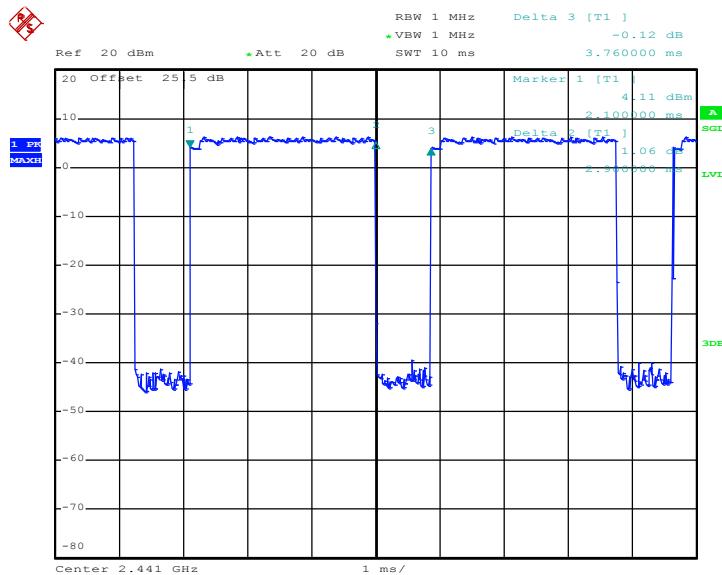


3.3.5 Test Result of Dwell Time

Please refer to Appendix A.

BT EDR chip of CYW2070:

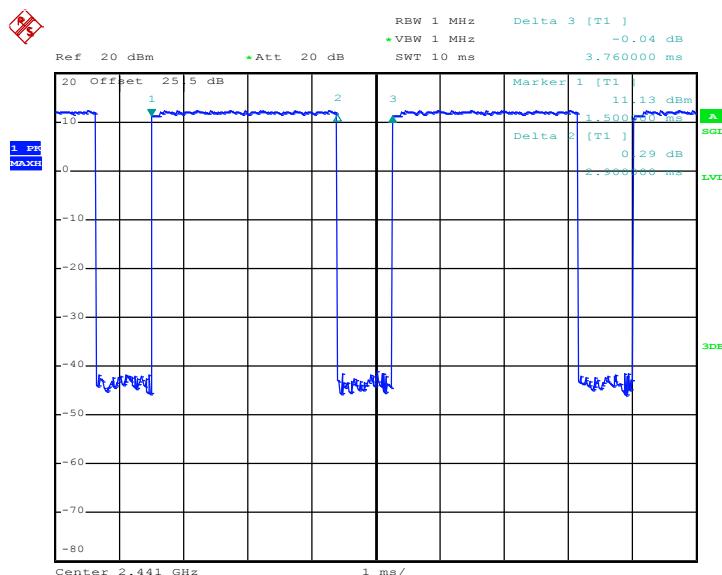
Package Transfer Time Plot



Date: 14.MAY.2019 18:02:28

BT EDR chip of WCN3660B:

Package Transfer Time Plot



Date: 13.MAY.2019 18:17:31

**Remark:**

1. In normal mode, hopping rate is 1600 hops/s with 6 slots in 79 hopping channels.
With channel hopping rate $(1600 / 6 / 79)$ in Occupancy Time Limit (0.4×79) (s),
Hops Over Occupancy Time comes to $(1600 / 6 / 79) \times (0.4 \times 79) = 106.67$ hops.
2. In AFH mode, hopping rate is 800 hops/s with 6 slots in 20 hopping channels.
With channel hopping rate $(800 / 6 / 20)$ in Occupancy Time Limit (0.4×20) (s),
Hops Over Occupancy Time comes to $(800 / 6 / 20) \times (0.4 \times 20) = 53.33$ hops.
3. Dwell Time(s) = Hops Over Occupancy Time (hops) x Package Transfer Time



3.4 20dB and 99% Bandwidth Measurement

3.4.1 Limit of 20dB and 99% Bandwidth

Reporting only

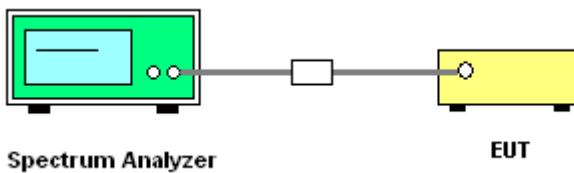
3.4.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.4.3 Test Procedures

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

3.4.4 Test Setup



3.4.5 Test Result of 20dB Bandwidth

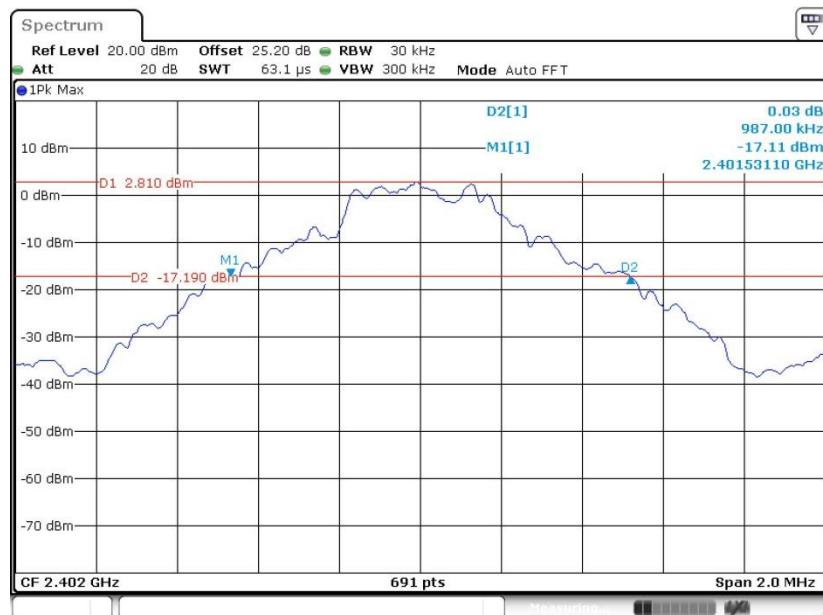
Please refer to Appendix A.



BT EDR chip of CYW2070 :

<1Mbps>

20 dB Bandwidth Plot on Channel 00



Date: 19.JUN.2019 10:26:38

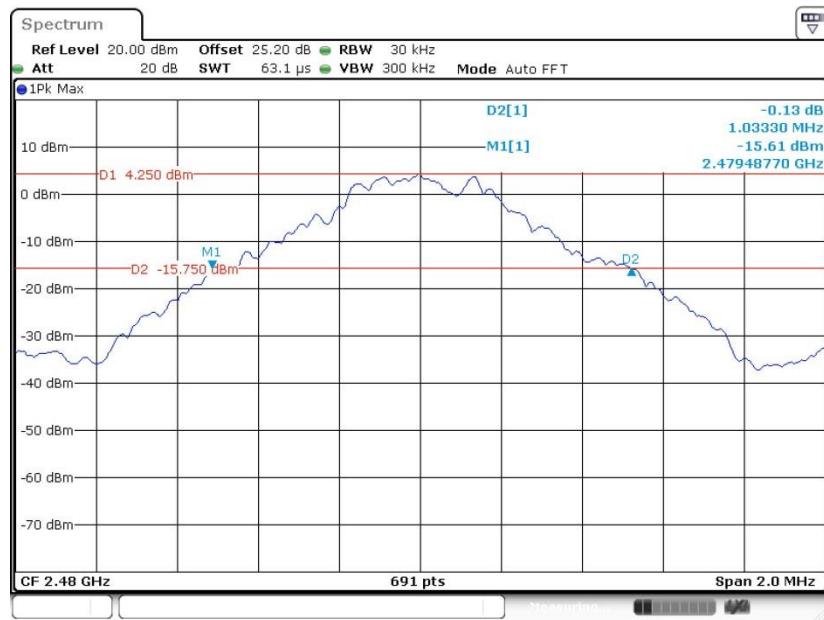
20 dB Bandwidth Plot on Channel 39



Date: 19.JUN.2019 10:27:47

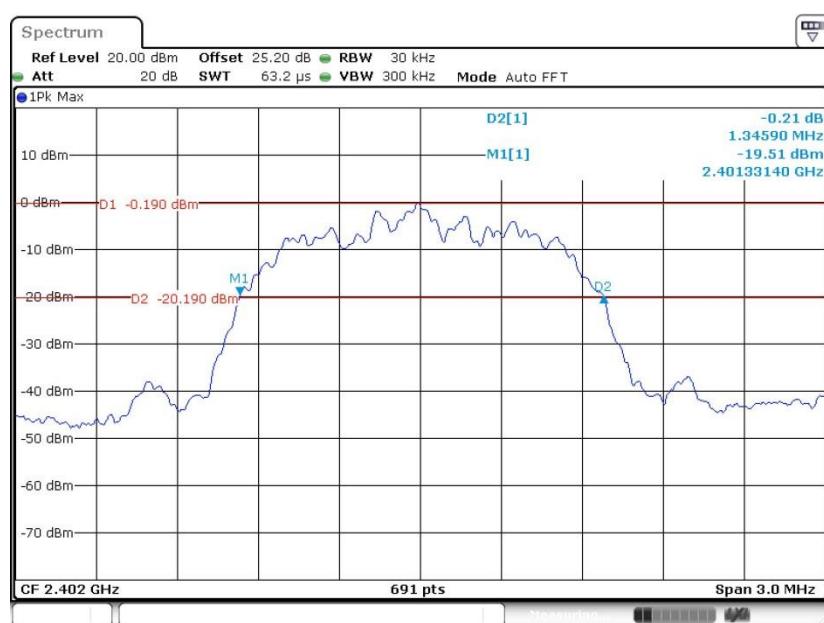


20 dB Bandwidth Plot on Channel 78



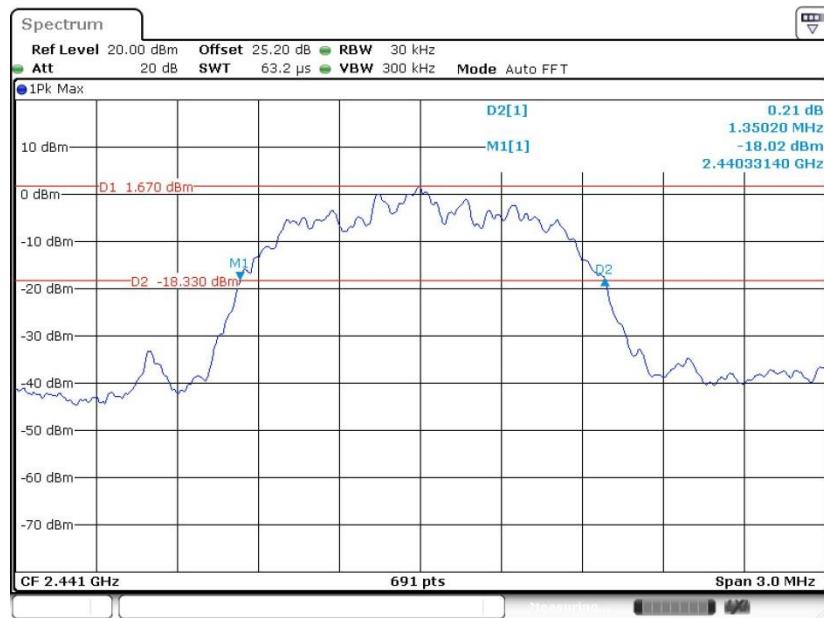
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20 dB Bandwidth Plot on Channel 00



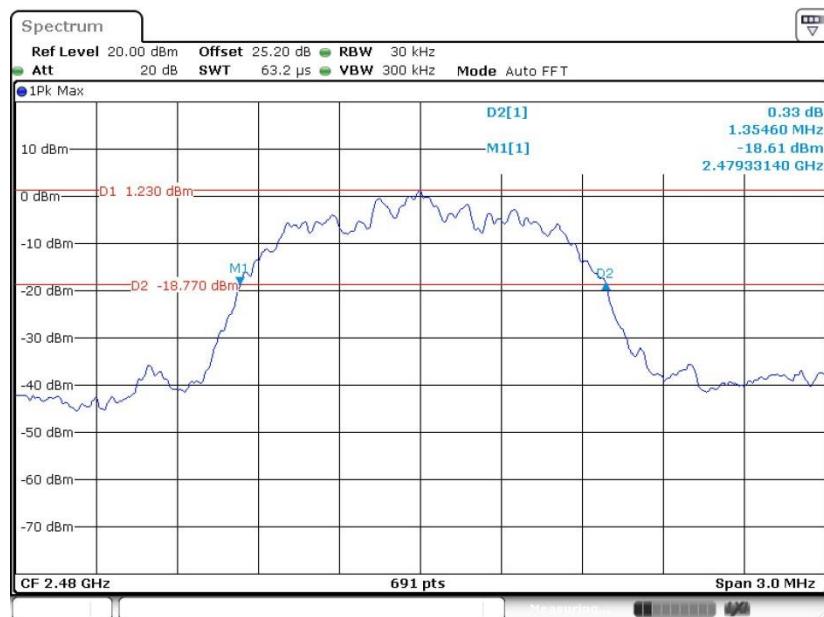


20 dB Bandwidth Plot on Channel 39



Date: 19.JUN.2019 10:44:46

20 dB Bandwidth Plot on Channel 78

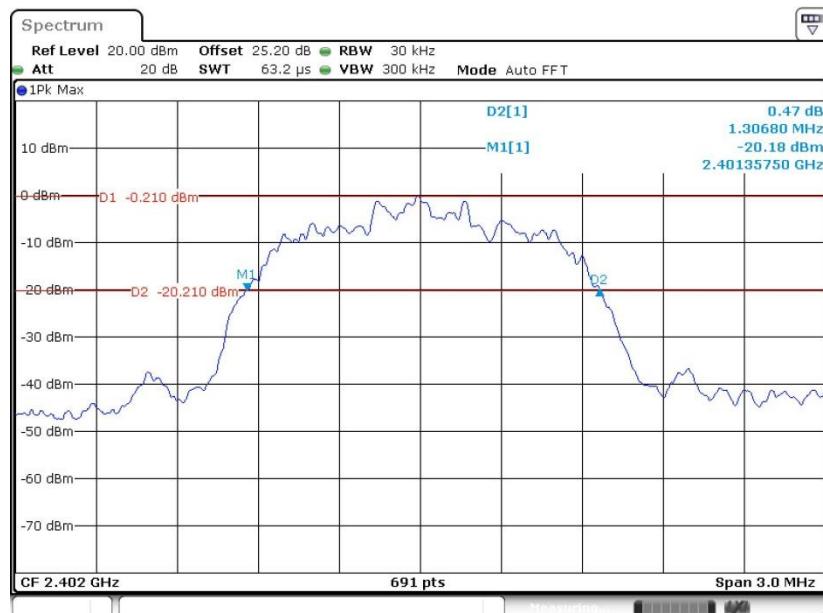


Date: 19.JUN.2019 10:45:40



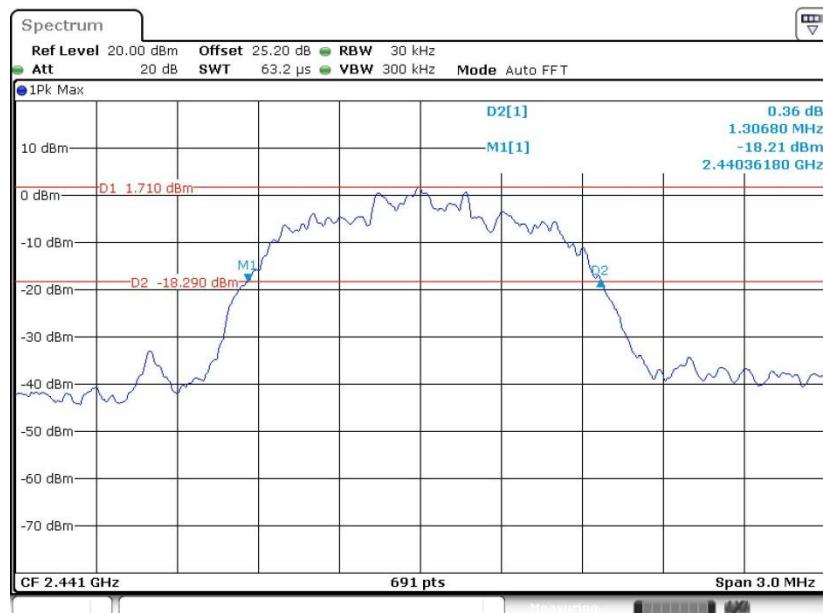
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20 dB Bandwidth Plot on Channel 00



Date: 19.JUN.2019 10:56:02

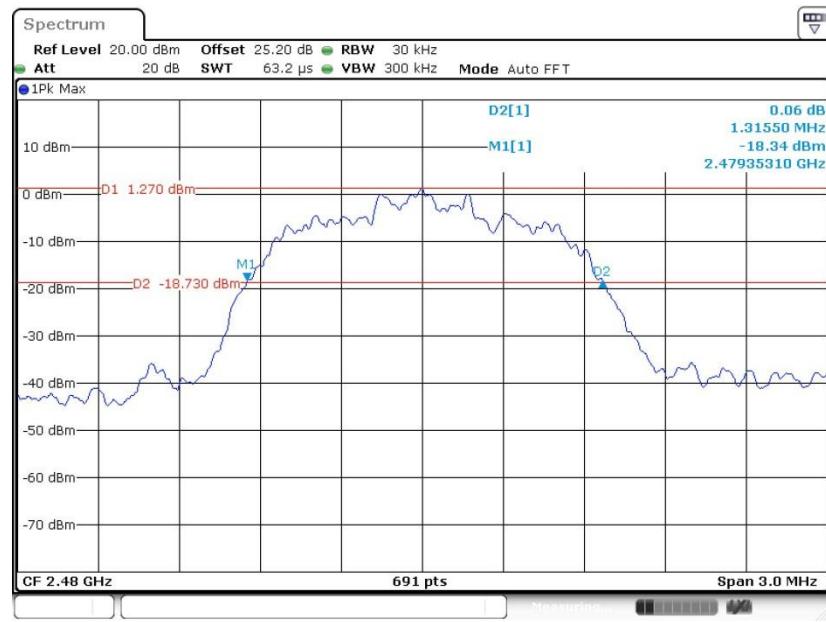
20 dB Bandwidth Plot on Channel 39



Date: 19.JUN.2019 10:57:13



20 dB Bandwidth Plot on Channel 78

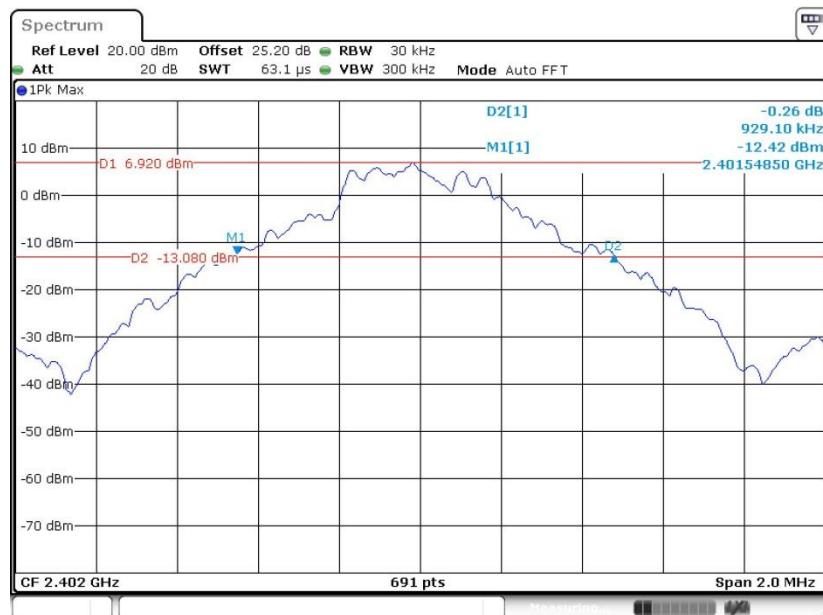




BT EDR chip of WCN3660B :

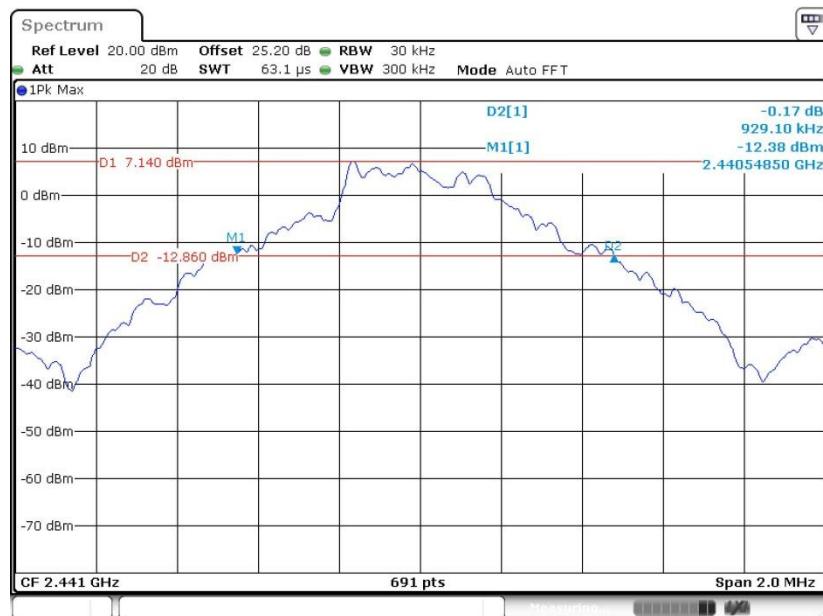
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20 dB Bandwidth Plot on Channel 00



Date: 19.JUN.2019 11:45:09

20 dB Bandwidth Plot on Channel 39



Date: 19.JUN.2019 11:46:17



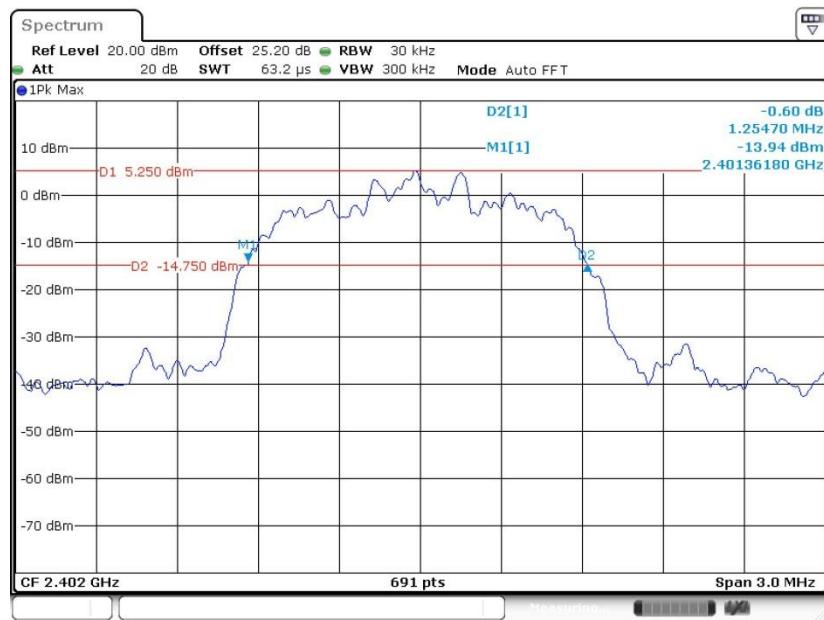
20 dB Bandwidth Plot on Channel 78



Date: 19.JUN.2019 11:47:10

<2Mbps>

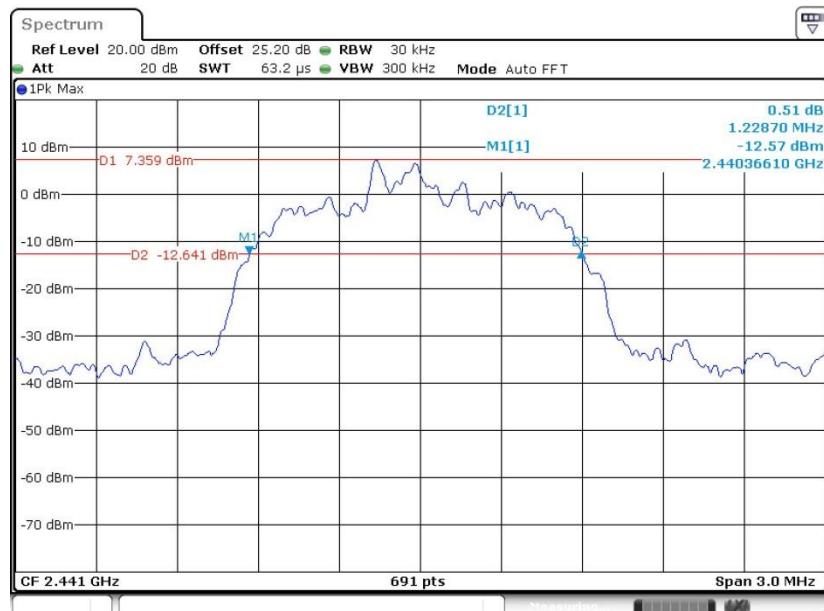
20 dB Bandwidth Plot on Channel 00



Date: 19.JUN.2019 11:48:08



20 dB Bandwidth Plot on Channel 39



Date: 19.JUN.2019 11:49:58

20 dB Bandwidth Plot on Channel 78

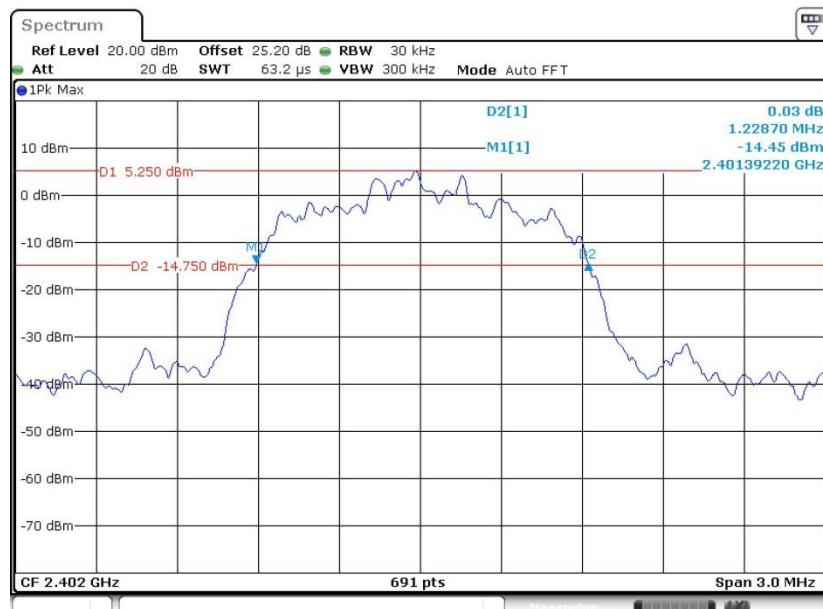


Date: 19.JUN.2019 11:50:53

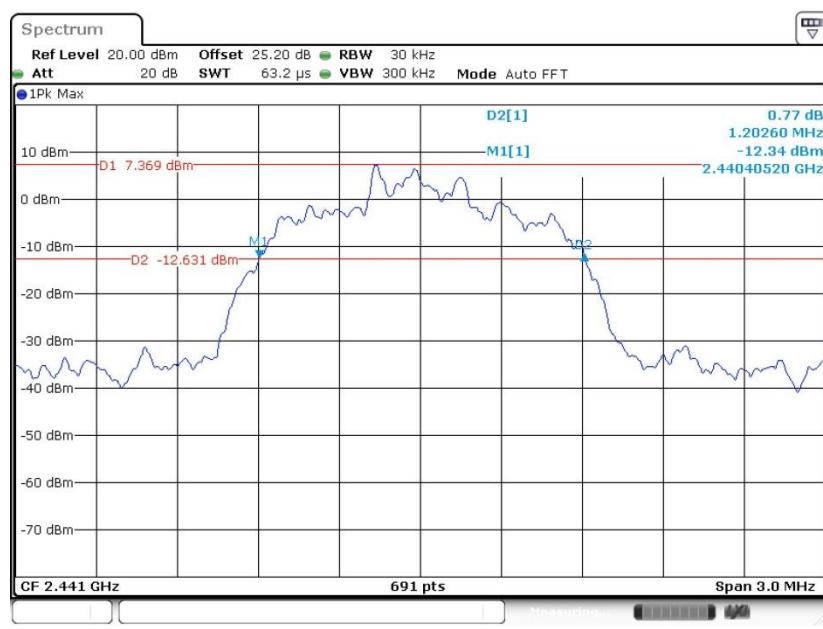


<3Mbps>

20 dB Bandwidth Plot on Channel 00

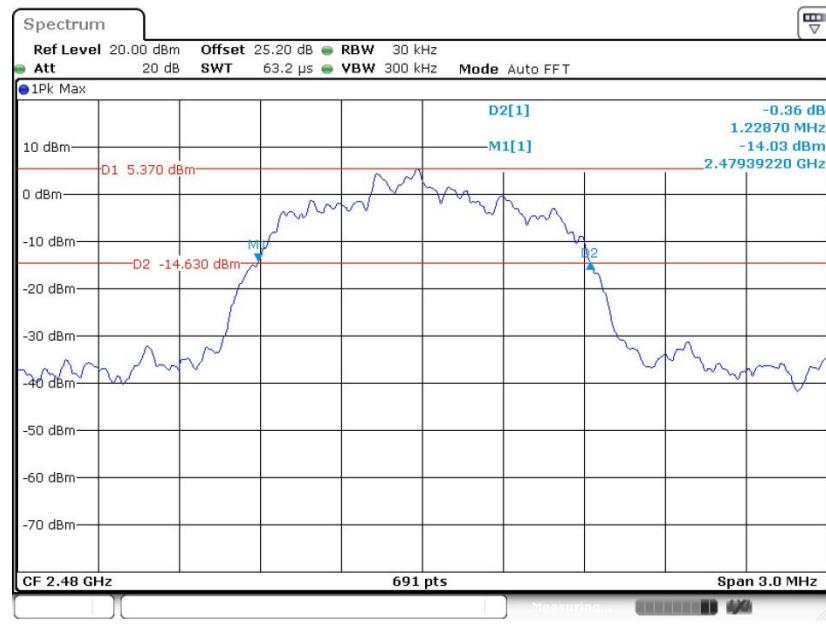


20 dB Bandwidth Plot on Channel 39





20 dB Bandwidth Plot on Channel 78



Date: 19.JUN.2019 11:54:22



3.4.6 Test Result of 99% Occupied Bandwidth

Please refer to Appendix A.

BT EDR chip of CYW2070

<1Mbps>

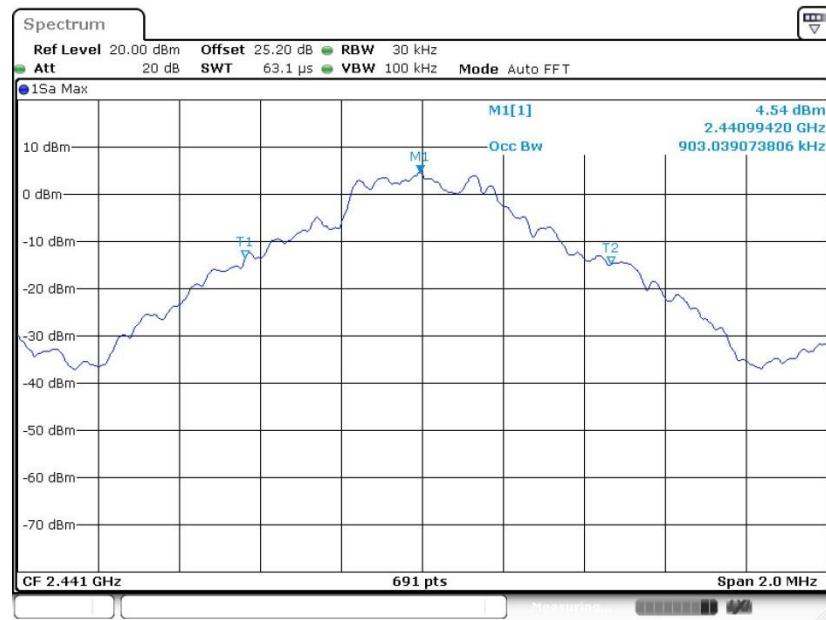
99% Occupied Bandwidth Plot on Channel 00



Date: 19.JUN.2019 10:22:31

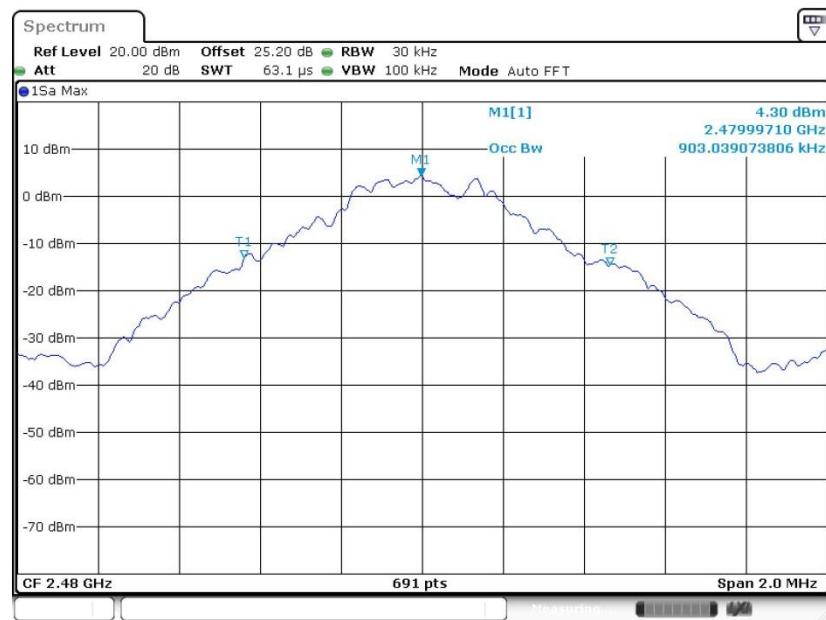


99% Occupied Bandwidth Plot on Channel 39



Date: 19.JUN.2019 10:23:14

99% Occupied Bandwidth Plot on Channel 78

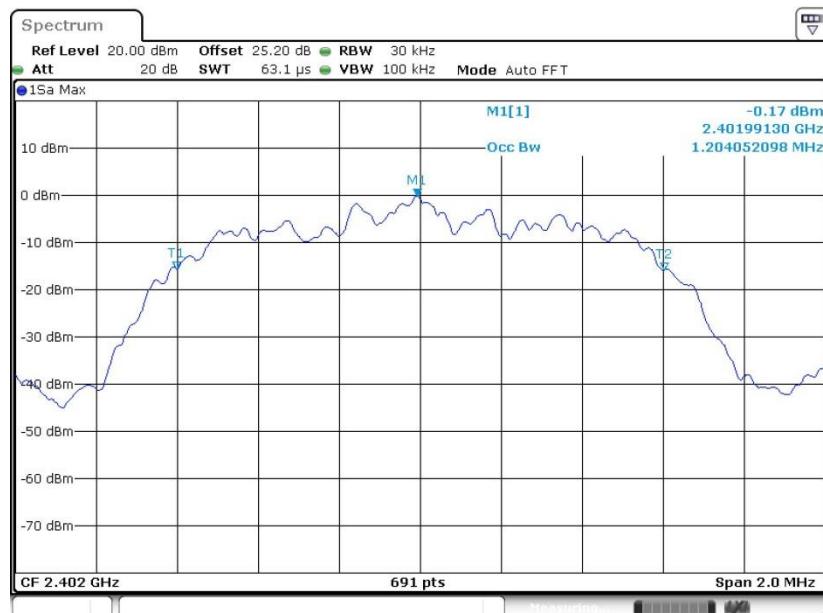


Date: 19.JUN.2019 10:23:54



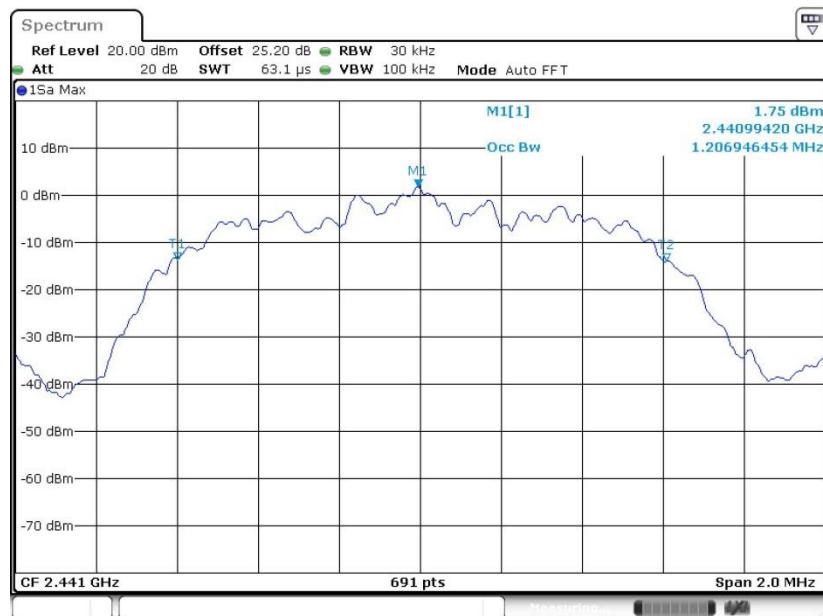
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99% Occupied Bandwidth Plot on Channel 00



Date: 19.JUN.2019 10:49:22

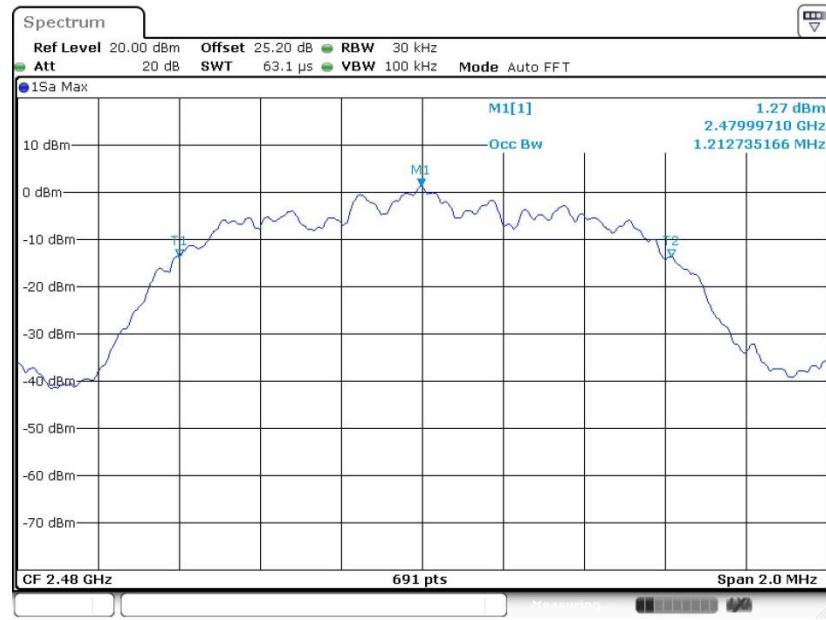
99% Occupied Bandwidth Plot on Channel 39



Date: 19.JUN.2019 10:50:01

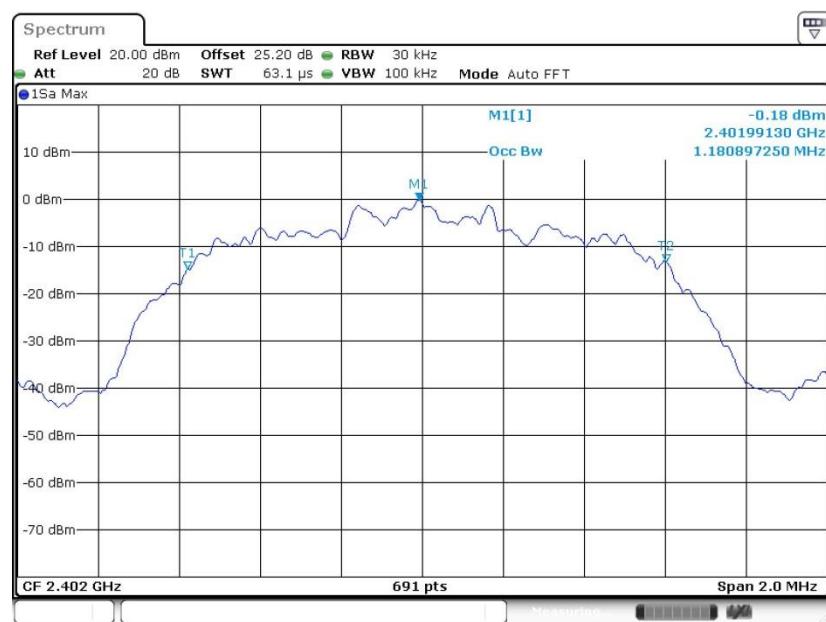


99% Occupied Bandwidth Plot on Channel 78



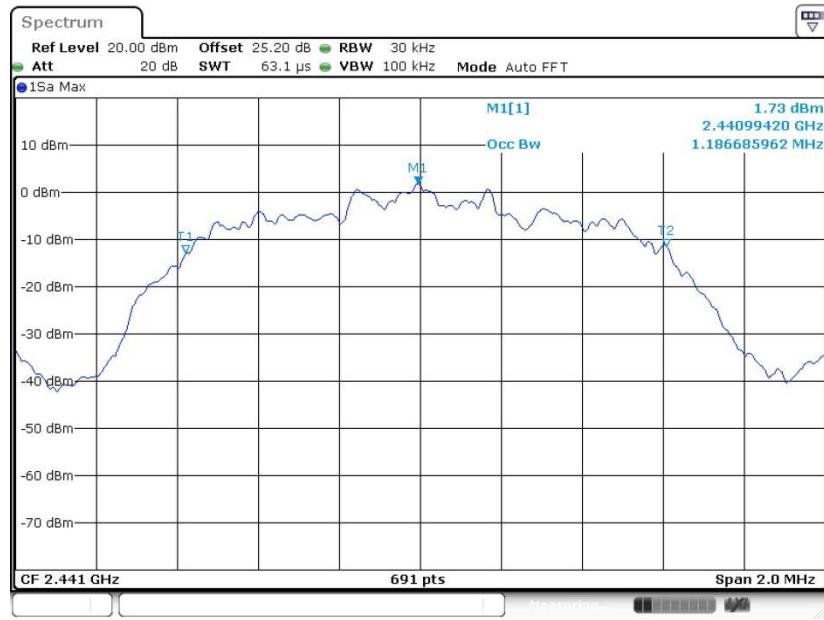
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99% Occupied Bandwidth Plot on Channel 00



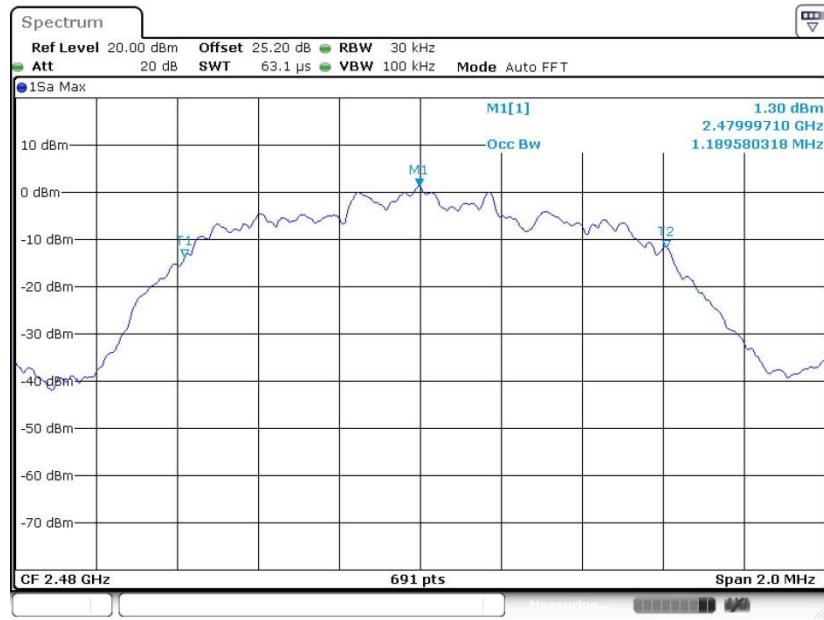


99% Occupied Bandwidth Plot on Channel 39



Date: 19.JUN.2019 11:05:03

99% Occupied Bandwidth Plot on Channel 78



Date: 19.JUN.2019 11:05:42

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



BT EDR chip of WCN3660B :

<1Mbps>

99% Occupied Bandwidth Plot on Channel 00





99% Occupied Bandwidth Plot on Channel 39



Date: 19.JUN.2019 12:18:47

99% Occupied Bandwidth Plot on Channel 78



Date: 19.JUN.2019 12:19:26