

RADIO TEST REPORT

Product : PCIE 802.11a/b/g/n/ac/ax 2.4GHz/5GHz+USB/UART BT 5.2 module

Model Name : ACB-QCA6391

Series Model : ACB-QCA6391-WX1, ACB-QCA6391-WX2, ACB-QCA6391-WX4, ACB-QCA6391-WX5, ACB-QCA6391-WI1, ACB-QCA6391-WI2, ACB-QCA6391-WI4, ACB-QCA6391-WI5

FCC ID : 2AE3B-ACB-QCA6391

Test Regulation : FCC 47 CFR Part 15 Subpart C (Section 15.247)

Received Date : 2021/5/18

Test Date : 2023/6/1 ~ 2023/8/16

Issued Date : 2023/9/12

Applicant : VOXMICRO LTD
20955 Pathfinder Rd., STE 100, Diamond Bar, California 91765, USA

Issued By : Underwriters Laboratories Taiwan Co., Ltd.
Building A, B and E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan



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Doc No: Form-ULID-004737 (DCS:17-EM-F0876) / 6.1

Original Test Report No.: 4789913232-US-R0-V0

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1. Attestation of Test Results

APPLICANT: VOXMICRO LTD
20955 Pathfinder Rd., STE 100, Diamond Bar, California 91765, USA

MANUFACTURER: VOXMICRO LTD
8F.-3, No.5, Aly. 22, Ln. 513, Rueiguang Rd., Neihu Dist., Taipei City 114, Taiwan

EUT DESCRIPTION: PCIE 802.11a/b/g/n/ac/ax 2.4GHz/5GHz+USB/UART BT 5.2 module

BRAND: AIRETOS

MODEL: ACB-QCA6391

SERIES MODEL: ACB-QCA6391-WX1, ACB-QCA6391-WX2,
ACB-QCA6391-WX4, ACB-QCA6391-WX5,
ACB-QCA6391-WI1, ACB-QCA6391-WI2,
ACB-QCA6391-WI4, ACB-QCA6391-WI5

SAMPLE STAGE: Design Verification Test sample

DATE of TESTED: 2023/6/1 ~ 2023/8/16

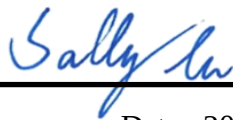
APPLICABLE STANDARDS

STANDARD	Test Results
FCC 47 CFR PART 15 Subpart C (Section 15.247)	PASS

Underwriters Laboratories Taiwan Co., Ltd. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by Underwriters Laboratories Taiwan Co., Ltd. based on interpretations and/or observations of test results. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by Underwriters Laboratories Taiwan Co., Ltd. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by Underwriters Laboratories Taiwan Co., Ltd. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Prepared By:



Sally Lu
Project Handler

Date : 2023/9/12

Approved and Authorized By:



Eric Lee
Senior Laboratory Engineer

Date : 2023/9/12

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2. Summary of Test Results

Summary of Test Results		
FCC Clause	Test Items	Result
15.247(a)(2)	6dB Bandwidth	PASS
15.247(b)	Conducted Output Power	PASS
15.247(e)	Power Spectral Density	PASS
15.247(d)	Antenna Port Emission	PASS
15.205 / 15.209 / 15.247(d)	Radiated Emissions and Band Edge Measurement	PASS
15.207	AC Power Conducted Emission	PASS
15.203	Antenna Requirement	PASS

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3. Test Methodology and Reference Procedures

The tests documented in this report were performed in accordance with 47 CFR FCC Part 2, KDB558074 D01 Meas Guidance v05r02, KDB414788 D01 Radiated Test Site v01r01, ANSI C63.10-2013 and KDB 662911 D01 Multiple Transmitter Output v02r01.

4. Facilities and Accreditation

Test Location	Underwriters Laboratories Taiwan Co., Ltd.
Address	Building A, B and E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan
Accreditation Certificate	Underwriters Laboratories Taiwan Co., Ltd. is accredited by TAF, Laboratory Code 3398.

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5. Measurement Uncertainty

For statement of conformity, accuracy method (Section 8.2.4 and 8.2.5 of ISO Guide 98-4) was applied as decision rule for measurement in this test report.

The following uncertainties have been calculated to provide a confidence level of 95 % using a coverage factor $k=2$.

Determining compliance based on the results of the compliance measurement, not considering measurement instrumentation uncertainty.

Measurement	Frequency	Uncertainty
Conducted disturbance at mains terminals ports	150kHz ~ 30MHz	± 3.1 dB
RF Conducted	9 kHz - 40GHz	± 2.3 dB
Radiated disturbance below 30MHz	9 kHz - 30 MHz	± 3.2 dB
Radiated disturbance below 1 GHz	30MHz ~ 1GHz	± 6.1 dB
Radiated disturbance above 1 GHz	1GHz ~ 40GHz	± 5.1 dB

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6. Equipment under Test

6.1. Description of EUT

Product	PCIE 802.11a/b/g/n/ac/ax 2.4GHz/5GHz+USB/UART BT 5.2 module
Brand Name	AIRETOS
Model Name	ACB-QCA6391
Series Model	ACB-QCA6391-WX1, ACB-QCA6391-WX2, ACB-QCA6391-WX4, ACB-QCA6391-WX5, ACB-QCA6391-WI1, ACB-QCA6391-WI2, ACB-QCA6391-WI4, ACB-QCA6391-WI5
Operating Frequency	2412MHz ~ 2462MHz
Modulation	CCK, DQPSK, DBPSK for DSSS 1024QAM, 256QAM, 64QAM, 16QAM, QPSK, BPSK
Transfer Rate	802.11b: up to 11 Mbps 802.11g: up to 54 Mbps 802.11n: up to MCS15 802.11ax: up to MCS11
Number of Channel	11 for 802.11b, 802.11g, 802.11n (HT20), 802.11ax (HE20) 7 for 802.11n (HT40), 802.11ax (HE40)
Maximum Output Power	Non-Beamforming mode: 802.11b: 25.42 dBm 802.11g: 28.66 dBm 802.11ax (HE20): 28.16 dBm 802.11ax (HE40): 19.86 dBm Beamforming mode: 802.11ax (HE20): 27.92 dBm 802.11ax (HE40): 19.68 dBm
Normal Voltage	3.7Vdc
S/N	E63B
Sample ID	3920615

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Note:

1. The models difference table as below:

Brand	Model	Difference
AIRETOS	ACB-QCA6391	-
	ACB-QCA6391-WX1	Market assignment classification for application and grade finish
	ACB-QCA6391-WX2	
	ACB-QCA6391-WX4	
	ACB-QCA6391-WX5	
	ACB-QCA6391-WI1	
	ACB-QCA6391-WI2	
	ACB-QCA6391-WI4	
	ACB-QCA6391-WI5	

2. The EUT incorporates a MIMO function. Physically, the EUT provides two completed transmitters and two receivers.

Modulation Mode	Tx,Rx Function
802.11b	2TX,2RX
802.11g	2TX,2RX
802.11n (HT20)	2TX,2RX
802.11n (HT40)	2TX,2RX
802.11ax (HE20)	2TX,2RX
802.11ax (HE40)	2TX,2RX

* The modulation and bandwidth are similar for 802.11n mode for HT20 / HT40 and 802.11ax mode for HE20 / HE40, therefore investigated worst case to representative mode in test report.

3. The above EUT information is declared by manufacturer and for more detailed features description, please refer the manufacturer's or user's manual, the laboratory shall not be held responsible.

6.2. Channel List

11 channels are provided for 802.11b, 802.11g and 802.11n (HT20), 802.11ax (HE20):

Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	2412	7	2442
2	2417	8	2447
3	2422	9	2452
4	2427	10	2457
5	2432	11	2462
6	2437	-	-

7 channels are provided for 802.11n (HT40), 802.11ax (HE40):

Channel	Frequency (MHz)	Channel	Frequency (MHz)
3	2422	7	2442
4	2427	8	2447
5	2432	9	2452
6	2437	-	-

6.3. Test Condition

Test Item	Test Site No.	Environmental Condition	Input Power	Test Date	Tested by
Antenna Port Conducted Measurement	SR4	20~26°C/ 62~68%RH	3.7Vdc	2023/06/01~ 2023/08/16	WaterNil Guan
Radiated Spurious Emission	966-2	20~26°C/ 62~68%RH	3.7Vdc	2023/06/01~ 2023/08/16	WaterNil Guan
AC power Line Conducted Emission	SR1	20~26°C/ 62~68%RH	3.7Vdc	2023/06/01~ 2023/08/16	WaterNil Guan

FCC Test Firm Registration Number: 498077

Sample Calculation:

Antenna Port Conducted Measurement:

- Where relevant, the follow sample calculation is provided:
Result Value (dBm) = Reading Value (dBm) + Attenuator Factor (dB) + Cable Loss (dB).
Example: Result Value (10dBm) = Reading Value (-2dBm) + Attenuator Factor (10dB) + Cable Loss(2dB).
*Test plot only shown the “Result Value”.

Radiated Spurious Emission:

- Where relevant, the follow sample calculation is provided:
Result Value (dBuV/m) = Reading Value (dBuV) + Correction Factor (dB/m).
Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Loss (dB) - Preamp Factor (dB).
Example: Result Value (34.5dBuV/m) = Reading Value (40.1dBuV) + Antenna Factor (18.7dB/m) + Cable Loss (4.2dB) - Preamp Factor (28.5dB).

AC power Line Conducted Emission:

- Where relevant, the follow sample calculation is provided:
Result Value (dBuV) = Reading Value (dBuV) + Correction Factor (dB).
Correction Factor (dB) = Insertion loss(dB) + Cable loss(dB).
Example: Result Value (53.7dBuV) = Reading Value (35.1dBuV) + Insertion loss(18.1dB) + Cable loss(0.5dB).

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6.4. Description of Available Antennas

Ant. No.	Transmitter Circuit	Brand Name	Model Name	Ant. Type	Maximum Gain (dBi)	Remark
1	Chain (0)+(1)	ethertronics	M830520	Chip	2.4GHz:1 5GHz: 2.6	UFL
2	Chain (0)+(1)	OXFORDTEC	WAFH-2DBI-15	FPC	2.4GHz: 2.7 5GHz: 2.6	UFL
3	Chain (0)+(1)	OXFORDTEC	WAND2DBI-SMA	Dipole	2.4GHz: 2 5GHz: 3	RP-SMA
4	Chain (0)+(1)	OXFORDTEC	WAND5DBI-SMA	Dipole	2.4GHz:3 5GHz: 5	RP-SMA
5	Chain (0)+(1)	OXFORDTEC	WAPH2DB4-15	PCB	2.4GHz:2.18 5GHz: 2.69	UFL

Note: The above antenna information was provided from customer and for more detailed features description, please refer the manufacturer's specification or user's manual, the laboratory shall not be held responsible.

6.5. Test Mode Applicability and Tested Channel Detail

- For AC power line conducted emissions, the pre-scan has been determined by AC power 120Vac/60Hz (worst case)
- The fundamental of the antennas(M830520, WAFH-2DBI-15, WAND2DBI-SMA, WAND5DBI-SMA, and WAPH2DB4-15) were investigated in three orthogonal axes X-Y/Y-Z/X-Z. The M830520 and WAFH-2DBI-15 determined that the X-Y axis was the worst-case; and the WAND2DBI-SMA, WAND5DBI-SMA, and WAPH2DB4-15 determined that the Y-Z axis was the worst-case. Therefore, all of the final radiated testing was performed with the worst case to execute the test.
- The antennas No.3/ No.4 has the same type, therefore, the highest gain was determined antenna No.4 worst-case, the Antenna No.4 was selected for the final radiated testing.
- The antennas No.4 has the highest gain, the following conducted tests are all carried out using this antenna.
- For Antenna Port Conducted Measurement, this item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
- For below 30MHz testing, investigation was done on three antenna orientations (parallel, perpendicular, and ground-parallel), parallel and perpendicular are the worst orientations, therefore testing was performed on these two orientations only.
- For below 1 GHz radiated emission and AC power line conducted emission have performed all modes of operation were investigated and the worst-case emissions are reported.
- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

Non-Beamforming mode:

Test item	Mode	Modulation Technology	Modulation Type	Available Channel	Test Channel	Data Rate
Radiated Emissions (Above 1GHz)	802.11b	DSSS	DBPSK	1 to 11	1,6,11	1 Mbps
	802.11g	OFDM	BPSK	1 to 11	1,2,3,6,9,10,11	6 Mbps
	802.11ax20	OFDMA	BPSK	1 to 11	1,2,3,6,9,10,11	HE0
	802.11ax40	OFDMA	BPSK	3 to 9	3,6,9	HE0
Radiated Emissions (Below 1GHz)	802.11g	OFDM	BPSK	1 to 11	6	6 Mbps
AC Power Line Conducted Emission	802.11g	OFDM	BPSK	1 to 11	6	6 Mbps
*Antenna Port Conducted Measurement	802.11b	DSSS	DBPSK	1 to 11	1,6,11	1 Mbps
	802.11g	OFDM	BPSK	1 to 11	1,2,3,6,9,10,11	6 Mbps
	802.11ax20	OFDMA	BPSK	1 to 11	1,2,3,6,9,10,11	HE0
	802.11ax40	OFDMA	BPSK	3 to 9	3,6,9	HE0

*Note: For Antenna Port Conducted Measurement item, Inner channels only test Power and Conducted Out of Band Emission.

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Beamforming mode:

Test item	Mode	Modulation	Modulation	Available	Test	Data
		Technology	Type	Channel	Channel	Rate
*Antenna Port Conducted Measurement	802.11ax20	OFDMA	BPSK	1 to 11	1,2,3,6,9,10,11	HE0
	802.11ax40	OFDMA	BPSK	3 to 9	3,6,9	HE0

*Note: For Antenna Port Conducted Measurement item, Inner channels only test Power and Conducted Out of Band Emission.

*Note: The worse spurious emissions test and maximum output power was found in Non-Beamforming mode. Therefore Beamforming mode only the test data of the RF output power were recorded in this report.

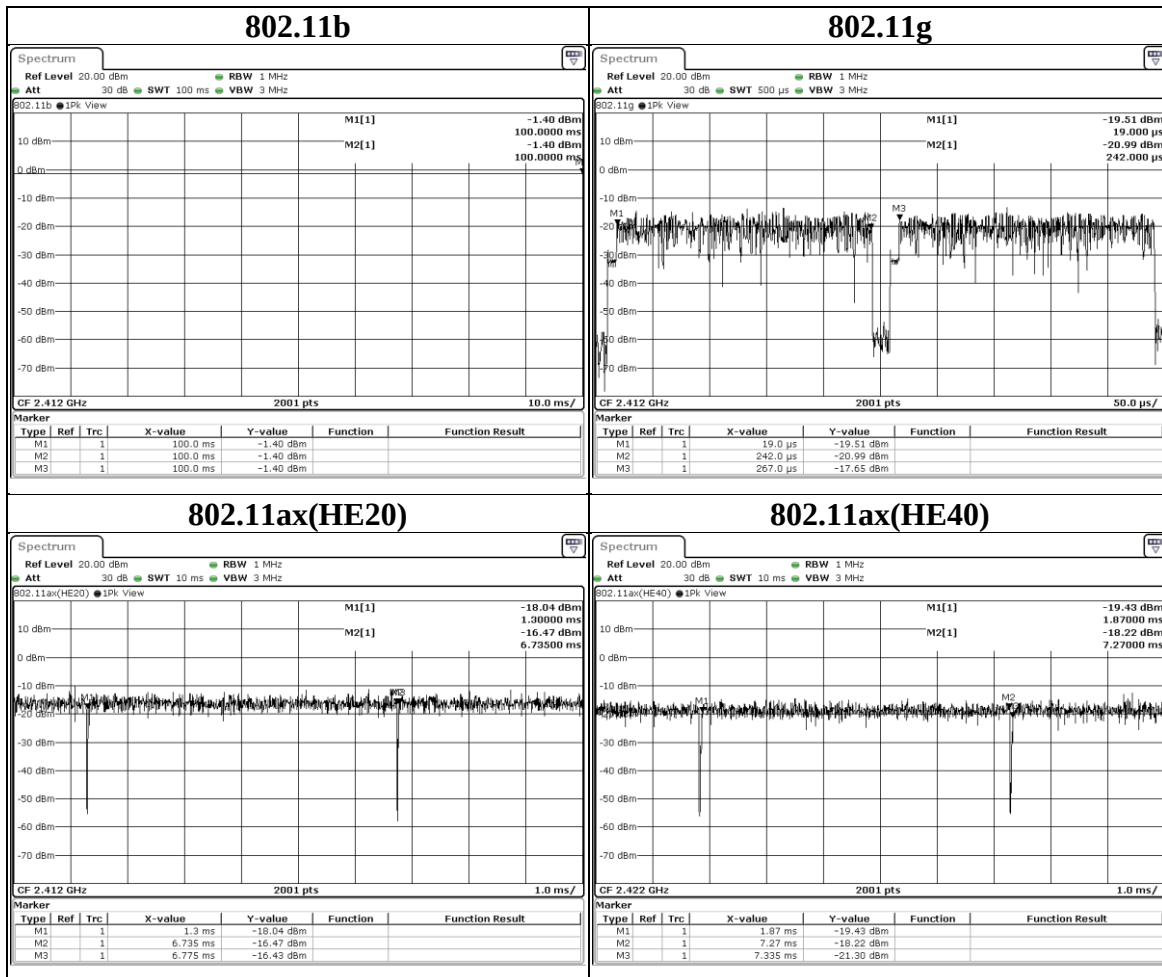
Simultaneously transmission condition:

Condition	Technology	
1	BT-GFSK	WLAN (2.4GHz)

Note: The emission of the simultaneous operation has been evaluated and no non-compliance was found.

6.6. Duty cycle

Mode	On Time (ms)	On+Off Time (ms)	Duty Cycle	Duty Factor (dB)	VBW Set (above 1GHz)
802.11b	100.000	100.000	1	N/A	10Hz
802.11g	0.223	0.248	0.8992	0.46	5.1kHz
802.11ax(HE20)	5.435	5.475	0.9927	N/A	10Hz
802.11ax(HE40)	5.400	5.465	0.9881	N/A	10Hz



7. Test Equipment

Test Equipment List					
Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Expired date
Radiated Spurious Emission					
Spectrum Analyzer	Keysight	N9010A	MY56070827	2023/4/7	2024/4/6
EMI Test Receiver	Rohde & Schwarz	ESR7	101754	2022/12/13	2023/12/12
Loop Antenna	ETS lindgren	6502	00213440	2023/1/4	2024/1/3
Trilog-Broadband Antenna with 5dB Attenuator	Schwarzbeck & EMCI	VULB 9168 & N-6-05	774 & AT-N0538	2023/2/13	2024/2/12
Horn Antenna (1-18 GHz)	Schwarzbeck	BBHA 9120 D	01690	2022/12/21	2023/12/20
Horn Antenna (18-40 GHz)	Schwarzbeck	BBHA 9170	781	2022/12/30	2023/12/29
Preamplifier (30-1000 MHz)	EMCI	EMC330E	980404	2023/5/24	2024/5/23
Preamplifier (1-18 GHz)	EMCI	EMC051835BE	980406	2023/2/17	2024/2/16
Preamplifier (18-40GHz)	EMCI	EMC184040SEE	980426	2023/5/9	2024/5/8
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-4 & 170425-2	2022/12/1	2023/11/30
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-1 & 170214-2	2022/12/1	2023/11/30

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Test Equipment List					
Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Expired date
Antenna Port Conducted Measurement					
Spectrum Analyzer	Keysight	N9010A	MY56070834	2022/10/24	2023/10/23
Attenuator	EMCI	EMC-40ATK2W10	17002	2022/12/9	2023/12/8
Pulse Power Sensor	Anritsu	MA2411B	1531202	2023/1/4	2024/1/3
Power Meter	Anritsu	ML2495A	1645002	2023/1/4	2024/1/3
AC power Line Conducted Emission					
EMI Test Receiver	Rohde & Schwarz	ESR7	101753	2022/11/10	2023/11/9
Two-Line V-Network	Rohde & Schwarz	ENV216	102136	2023/5/24	2024/5/23
Impuls-Begrenzer Pulse Limiter	Rohde & Schwarz	ESH3-Z2	102219-Qt	2022/8/30	2023/8/29
Cables	TITAN	CFD200	T0732ACFD200 20A300-2	2023/5/23	2024/5/22

UL Software		
Description	Name	Version
Radiated measurement	e3	6.191211 (V6)
Conducted measurement	RF-Conducted-FCC 15247	ver 1.0
AC power Line Conducted Emission	EZ EMC	UL-3A1.2

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8. Description of Test Setup

Support Equipment

ID	Equipment	Brand Name	Model Name	S/N	Remark
A	Laptop	Lenovo	T460	PC0FWU5Y	Provide by lab
B	Mini PCI-E to ExpressCard board	PHIYO TECH	ExpressCard Extender	19	Provide by Client
C	Adapter	Phihong	PSAA12A-120L6	N/A	Provide by Client

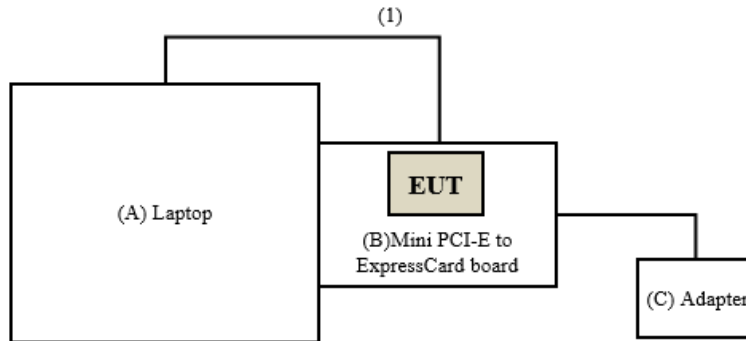
I/O Cables

ID	Equipment	Brand Name	Model Name	Length (m)	Remark
1	Micro USB Cable	fujiei	US0082	1	Provide by Client

Test Setup

Controlled using a bespoke application (QSPR_Version 5.0-00197) on a test Notebook.
The application was used to enable a continuous transmission mode and to select the test channels, data rates, modulation schemes and power setting as required.

Setup Diagram for Test



Under Table

Remote Site

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9. Test Results

9.1. 6dB Bandwidth

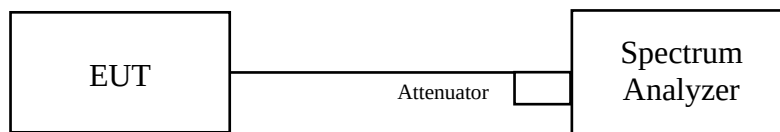
Requirements

The minimum 6 dB bandwidth shall be at least 500 kHz.

Test procedure

- Set resolution bandwidth (RBW) = 100kHz.
- Set the video bandwidth (VBW) $\geq 3 \times \text{RBW}$, Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

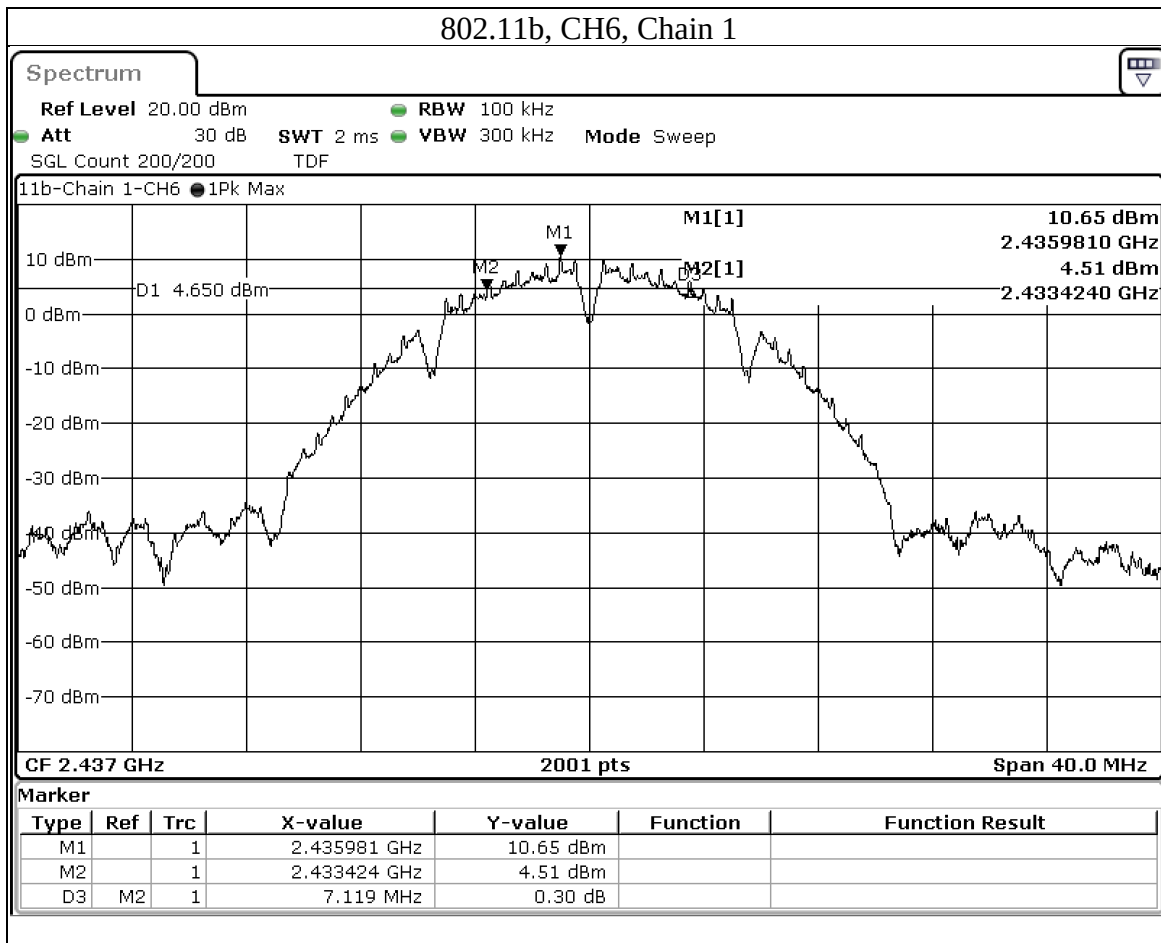
Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

Test Data

Mode	CH	Freq (MHz)	6dB BW (MHz)		Limit (MHz)	Result
			Chain 0	Chain 1		
802.11b	1	2412	7.614	7.571	0.5	PASS
	6	2437	7.542	7.119	0.5	PASS
	11	2462	8.075	8.056	0.5	PASS



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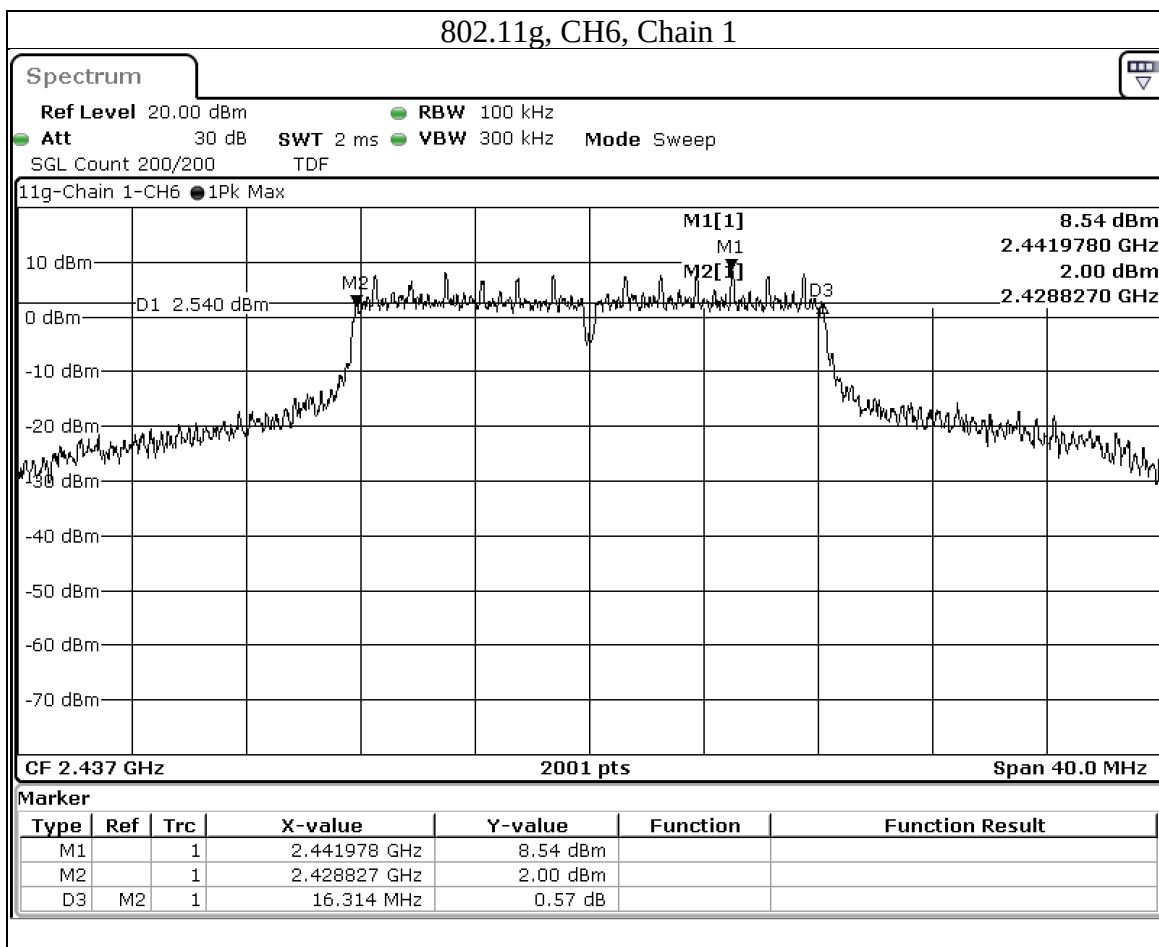
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Mode	CH	Freq (MHz)	6dB BW (MHz)		Limit (MHz)	Result
			Chain 0	Chain 1		
802.11g	1	2412	16.364	16.360	0.5	PASS
	2	2417	16.357	16.359	0.5	PASS
	3	2422	16.344	16.347	0.5	PASS
	6	2437	16.331	16.314	0.5	PASS
	9	2452	16.344	16.335	0.5	PASS
	10	2457	16.345	16.363	0.5	PASS
	11	2462	16.346	16.357	0.5	PASS



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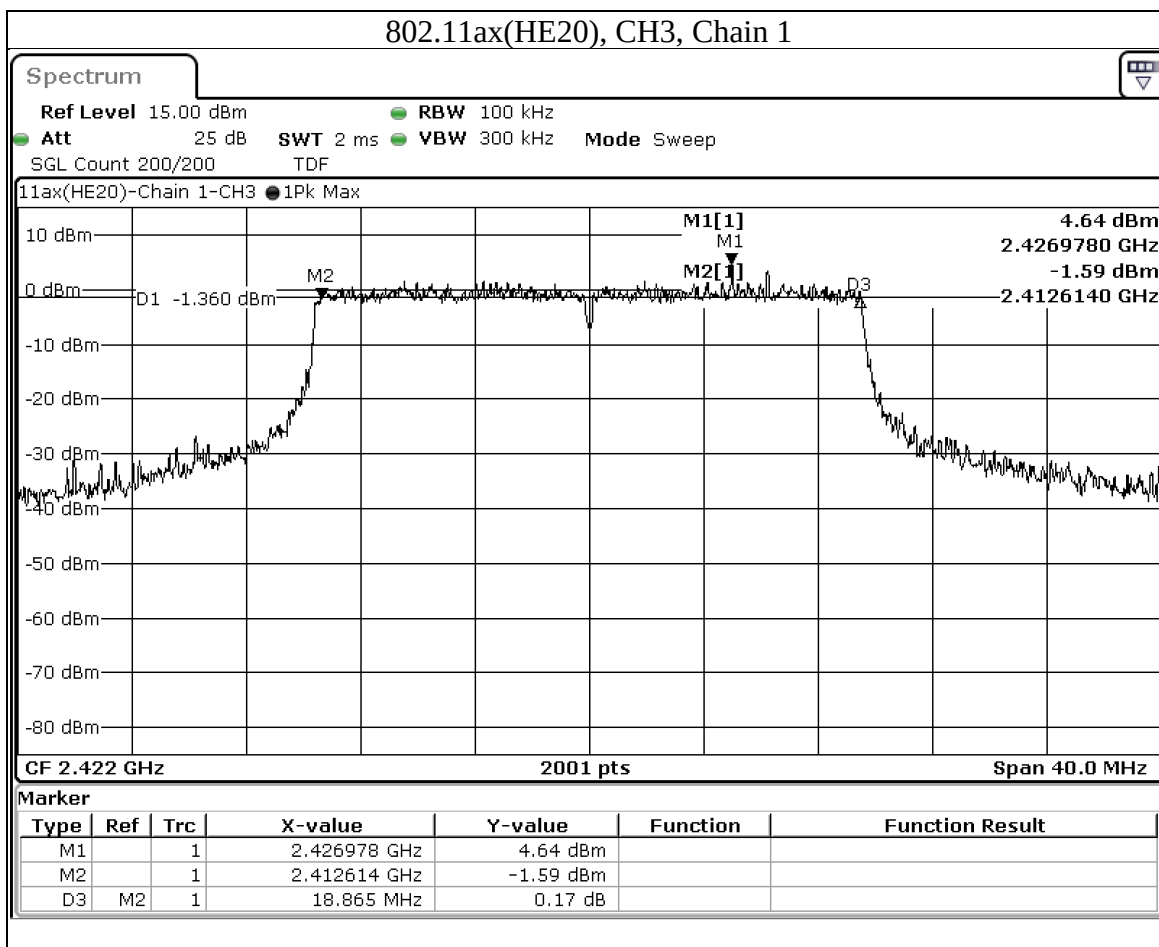
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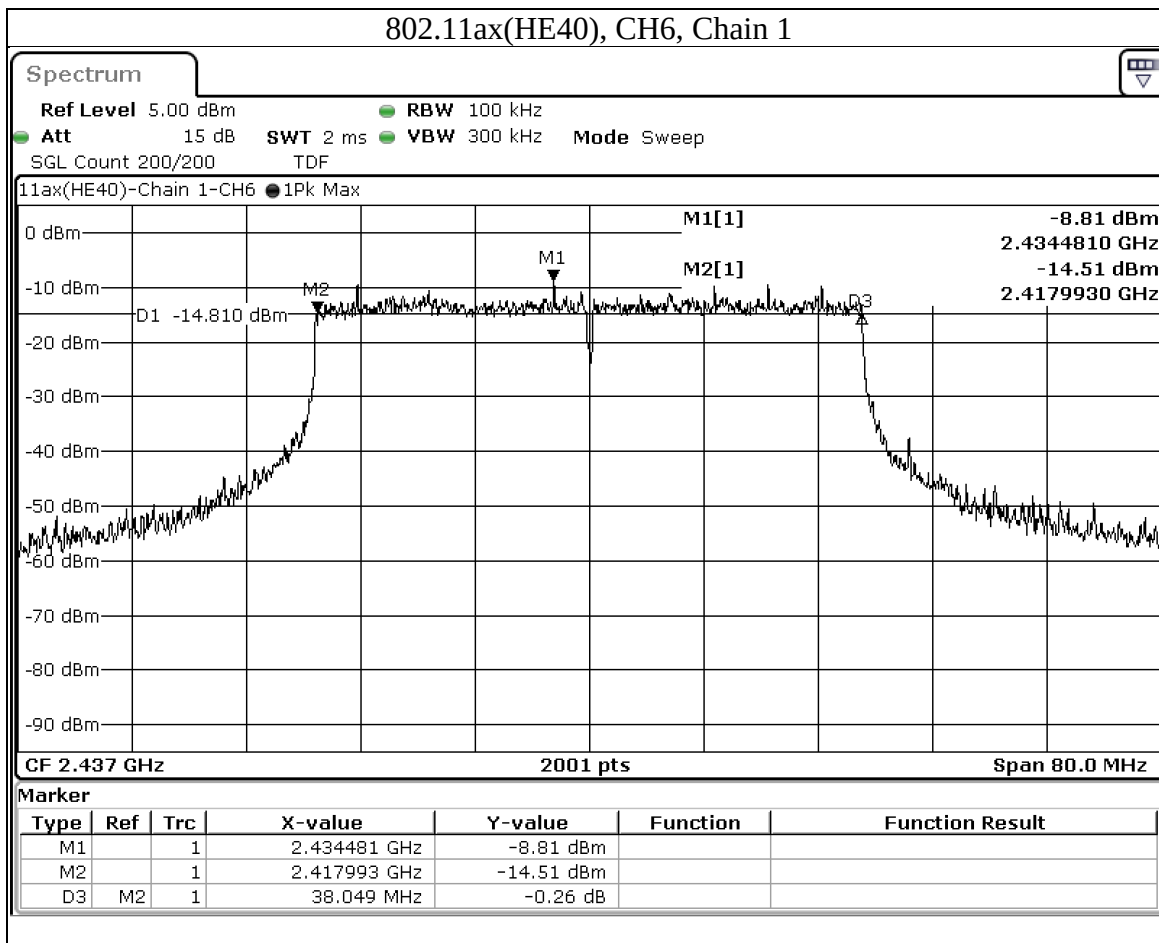
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Mode	CH	Freq (MHz)	6dB BW (MHz)		Limit (MHz)	Result
			Chain 0	Chain 1		
802.11ax(HE20)	1	2412	18.949	19.055	0.5	PASS
	2	2417	18.993	18.977	0.5	PASS
	3	2422	19.039	18.865	0.5	PASS
	6	2437	19.019	18.876	0.5	PASS
	9	2452	18.977	18.997	0.5	PASS
	10	2457	19.035	18.976	0.5	PASS
	11	2462	18.894	18.932	0.5	PASS



Mode	CH	Freq (MHz)	6dB BW (MHz)		Limit (MHz)	Result
			Chain 0	Chain 1		
802.11ax(HE40)	3	2422	38.058	38.144	0.5	PASS
	6	2437	38.071	38.049	0.5	PASS
	9	2452	38.126	38.161	0.5	PASS



9.2. Conducted Output Power

Requirements

For systems using digital modulation in the 2400-2483.5 MHz bands: 1 Watt.

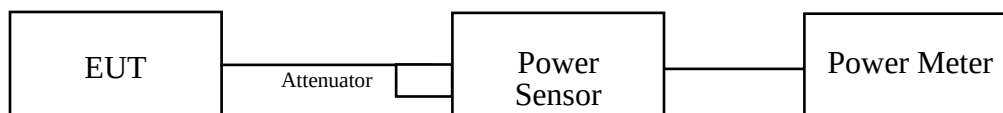
Note:

1. P_{Out} = maximum conducted output power in dBm, G_{TX} = the maximum transmitting antenna directional gain in dBi, B is the 26 dB emission bandwidth in megahertz
2. Directional Gain = $10 \log[(10^{G1/20} + 10^{G2/20} + \dots + 10^{Gn/20})^2 / N_{\text{ant}}]$ dBi.
Nant: Number of Transmit Antennas
G1, G2,..., Gn: Gain of Individual Antennas
Example: two antenna and gain 5 dBi / 3dBi, so if it was used for TxBF power measurement
Directional Gain = $10 \log[(10^{5/20} + 10^{3/20})^2 / 2]$ dBi = 7.07 dBi
3. Per KDB 662911 Method of conducted output power measurement on IEEE 802.11 devices, CDD
Array Gain = 0 dB (i.e., no array gain) for $N_{\text{ANT}} \leq 4$;
Array Gain = 0 dB (i.e., no array gain) for channel widths ≥ 40 MHz for any N_{ANT} ;
Array Gain = $5 \log(N_{\text{ANT}}/N_{\text{SS}})$ dB or 3 dB, whichever is less for 20-MHz channel widths with $N_{\text{ANT}} \geq 5$.
Example: Maximum antenna gain = 5 dBi and $N_{\text{ANT}} \leq 4$, so if it was used for CDD power measurement
Directional Gain = 5 dBi + Array Gain = 5 dBi + 0 dB = 5 dBi
4. For power measurement of KDB 662911 is used with multiple transmitter output. Total conducted power is the sum of the conducted power levels measured at the various output ports.

Test Procedure

A peak power sensor was used on the output port of the EUT. A power meter was used to read the response of the peak power sensor. Record the power level.

Test Setup



The loss between RF output port of the EUT and the input port of the Power Meter has been taken into consideration.

Test Data

Non-Beamforming mode

Peak Power

802.11b

Channel	Frequency (MHz)	Peak Power (dBm)		Total Power (mW)	Total Power (dBm)	Limit (dBm)	Pass / Fail
		Chain 0	Chain 1				
1	2412	19.93	21.08	226.464	23.55	30	PASS
6	2437	21.93	22.85	348.337	25.42	30	PASS
11	2462	20.44	21.82	262.422	24.19	30	PASS

802.11g

Channel	Frequency (MHz)	Peak Power (dBm)		Total Power (mW)	Total Power (dBm)	Limit (dBm)	Pass / Fail
		Chain 0	Chain 1				
1	2412	16.00	16.10	80.538	19.06	30	PASS
2	2417	16.01	16.20	81.658	19.12	30	PASS
3	2422	25.02	25.06	638.263	28.05	30	PASS
6	2437	25.92	25.36	734.514	28.66	30	PASS
9	2452	24.78	24.81	603.949	27.81	30	PASS
10	2457	16.48	16.49	89.125	19.50	30	PASS
11	2462	16.00	16.11	80.724	19.07	30	PASS

802.11ax (HE20)

Channel	Frequency (MHz)	Peak Power (dBm)		Total Power (mW)	Total Power (dBm)	Limit (dBm)	Pass / Fail
		Chain 0	Chain 1				
1	2412	15.36	15.39	69.024	18.39	30	PASS
2	2417	15.15	15.89	71.614	18.55	30	PASS
3	2422	24.60	24.68	582.103	27.65	30	PASS
6	2437	25.48	24.79	654.636	28.16	30	PASS
9	2452	24.51	24.59	570.164	27.56	30	PASS
10	2457	14.82	15.48	65.615	18.17	30	PASS
11	2462	14.75	15.52	65.464	18.16	30	PASS

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802.11ax (HE40)

Channel	Frequency (MHz)	Peak Power (dBm)		Total Power (mW)	Total Power (dBm)	Limit (dBm)	Pass / Fail
		Chain 0	Chain 1				
3	2422	16.79	16.90	96.828	19.86	30	PASS
6	2437	16.67	16.81	94.406	19.75	30	PASS
9	2452	15.72	16.05	77.625	18.90	30	PASS

Average Power (Reference Only)

802.11b

Channel	Frequency (MHz)	Average Power (dBm)		Total Power (mW)	Total Power (dBm)
		Chain 0	Chain 1		
1	2412	17.35	18.51	125.314	20.98
6	2437	19.38	20.50	199.067	22.99
11	2462	18.03	19.33	149.279	21.74

802.11g

Channel	Frequency (MHz)	Average Power (dBm)		Total Power (mW)	Total Power (dBm)
		Chain 0	Chain 1		
1	2412	6.41	7.11	9.506	9.78
2	2417	6.50	7.17	9.683	9.86
3	2422	16.04	17.44	95.719	19.81
6	2437	18.95	20.06	179.887	22.55
9	2452	15.93	17.20	91.622	19.62
10	2457	6.92	7.61	10.691	10.29
11	2462	6.84	7.62	10.617	10.26

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802.11ax (HE20)

Channel	Frequency (MHz)	Average Power (dBm)		Total Power (mW)	Total Power (dBm)
		Chain 0	Chain 1		
1	2412	6.44	6.75	9.141	9.61
2	2417	6.00	6.76	8.73	9.41
3	2422	15.62	16.88	85.31	19.31
6	2437	18.47	19.48	158.855	22.01
9	2452	15.87	17.19	90.991	19.59
10	2457	6.24	6.81	8.995	9.54
11	2462	6.22	6.78	8.954	9.52

802.11ax (HE40)

Channel	Frequency (MHz)	Average Power (dBm)		Total Power (mW)	Total Power (dBm)
		Chain 0	Chain 1		
3	2422	7.37	7.58	11.194	10.49
6	2437	7.57	7.02	10.74	10.31
9	2452	6.46	7.14	9.594	9.82

Beamforming mode

Peak Power

802.11ax (HE20)

Channel	Frequency (MHz)	Peak Power (dBm)		Total Power (mW)	Total Power (dBm)	Limit (dBm)	Pass / Fail
		Chain 0	Chain 1				
1	2412	15.23	15.34	67.608	18.30	29.99	PASS
2	2417	15.11	15.78	70.307	18.47	29.99	PASS
3	2422	24.56	24.51	568.853	27.55	29.99	PASS
6	2437	25.23	24.56	619.441	27.92	29.99	PASS
9	2452	24.49	24.35	553.35	27.43	29.99	PASS
10	2457	14.72	15.37	64.121	18.07	29.99	PASS
11	2462	14.73	15.40	64.417	18.09	29.99	PASS

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802.11ax (HE40)

Channel	Frequency (MHz)	Peak Power (dBm)		Total Power (mW)	Total Power (dBm)	Limit (dBm)	Pass / Fail
		Chain 0	Chain 1				
3	2422	16.54	16.80	92.897	19.68	29.99	PASS
6	2437	16.47	16.79	92.045	19.64	29.99	PASS
9	2452	15.61	16.03	76.56	18.84	29.99	PASS

Average Power (Reference Only)

802.11ax (HE20)

Channel	Frequency (MHz)	Average Power (dBm)		Total Power (mW)	Total Power (dBm)
		Chain 0	Chain 1		
1	2412	6.31	6.70	8.954	9.52
2	2417	5.96	6.65	8.57	9.33
3	2422	15.58	16.71	82.985	19.19
6	2437	18.22	19.25	150.661	21.78
9	2452	15.85	16.95	88.105	19.45
10	2457	6.14	6.70	8.79	9.44
11	2462	6.20	6.66	8.81	9.45

802.11ax (HE40)

Channel	Frequency (MHz)	Average Power (dBm)		Total Power (mW)	Total Power (dBm)
		Chain 0	Chain 1		
3	2422	7.12	7.48	10.74	10.31
6	2437	7.37	7.00	10.471	10.20
9	2452	6.35	7.12	9.462	9.76

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9.3. Power Spectral Density

Requirements

The Maximum of Power Spectral Density Measurement is 8dBm in any 3 kHz (If $G_{TX} > 6$ dBi, then $PSD = 8 - (G_{TX} - 6)$).

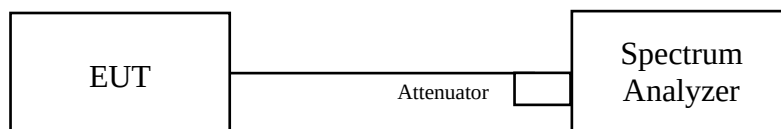
Note:

1. PSD = power spectral density that he same method as used to determine the conducted output power shall be used to determine the power spectral density. And power spectral density in dBm/MHz.
2. G_{TX} = the maximum transmitting antenna directional gain in dBi.
3. Directional Gain = $10 \log[(10^{G1/20} + 10^{G2/20} + \dots + 10^{Gn/20})^2 / Nant]$ dBi.
Nant: Number of Transmit Antennas
G1, G2,..., Gn: Gain of Individual Antennas
Example: two antenna and gain 5 dBi / 3dBi, so if it was used for power density measurement
Directional Gain = $10 \log[(10^{5/20} + 10^{3/20})^2 / 2]$ dBi = 7.07 dBi
4. "PSD per chain" of the report shown is maximum value for each chain, at the "Total PSD" is summing entire spectra across corresponding frequency bins on the various outputs by computer, refer KDB 662911 Method a) for calculating total power density.
5. Method a) of power density measurement of KDB 662911 is used for calculating total power density with multiple transmitter output. Total power density is summing entire spectra across corresponding frequency bins on the various outputs by computer.

Test procedure

- a. Set analyzer center frequency to DTS channel center frequency.
- b. Set the span to 1.5 times the DTS bandwidth.
- c. Set the RBW to: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.
- d. Set the VBW $\geq 3 \times \text{RBW}$.
- e. Detector = peak.
- f. Sweep time = auto couple.
- g. Trace mode = max hold.
- h. Allow trace to fully stabilize.
- i. Use the peak marker function to determine the maximum amplitude level within the RBW.

Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

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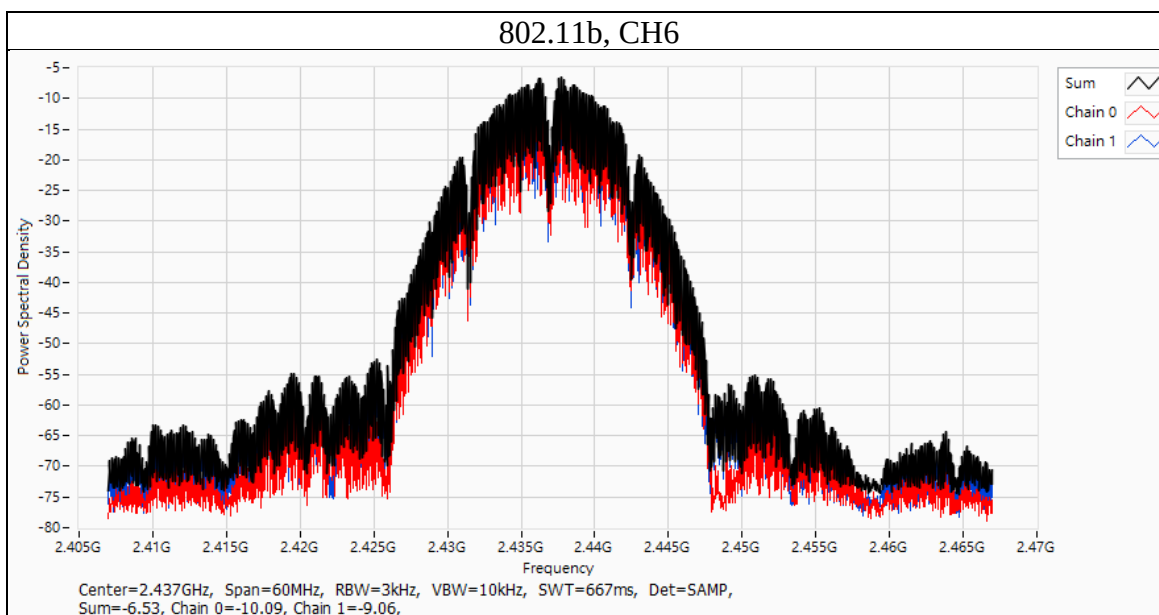
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Test Data

Mode	CH	Freq (MHz)	Total PSD (dBm/3kHz)	Limit (dBm/3kHz)	Directional Gain (dBi)	Result
802.11b	1	2412	-8.32	7.99	6.01	PASS
	6	2437	-6.53	7.99	6.01	PASS
	11	2462	-7.42	7.99	6.01	PASS

Mode	CH	Freq (MHz)	PSD per Chain (dBm/3kHz)	
			Chain 0	Chain 1
802.11b	1	2412	-12.187	-10.623
	6	2437	-9.902	-9.062
	11	2462	-11.199	-9.773



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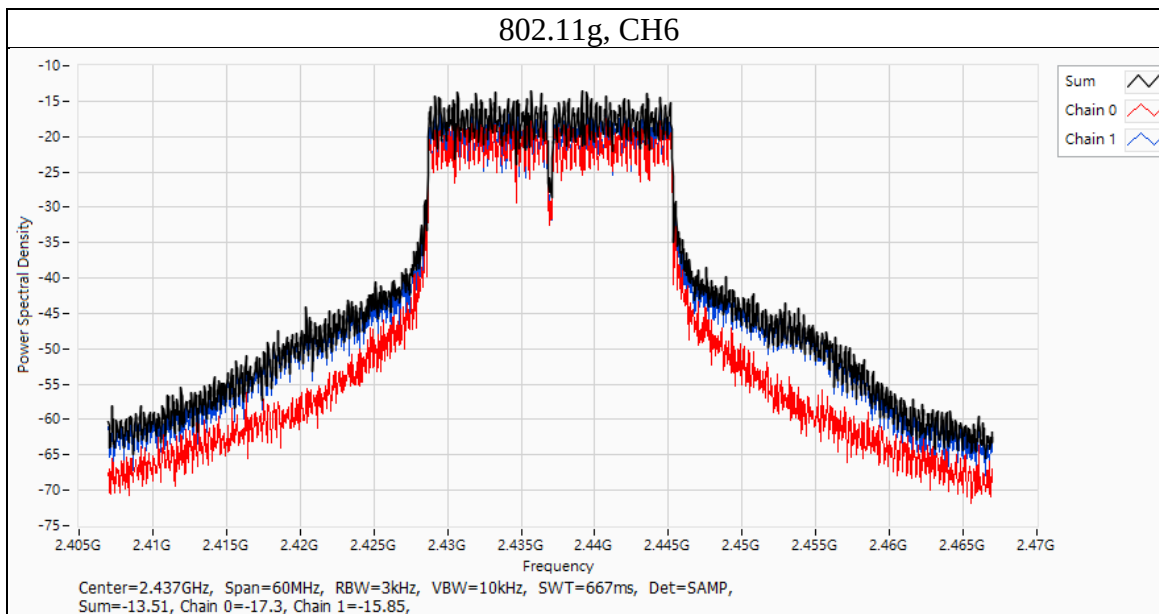
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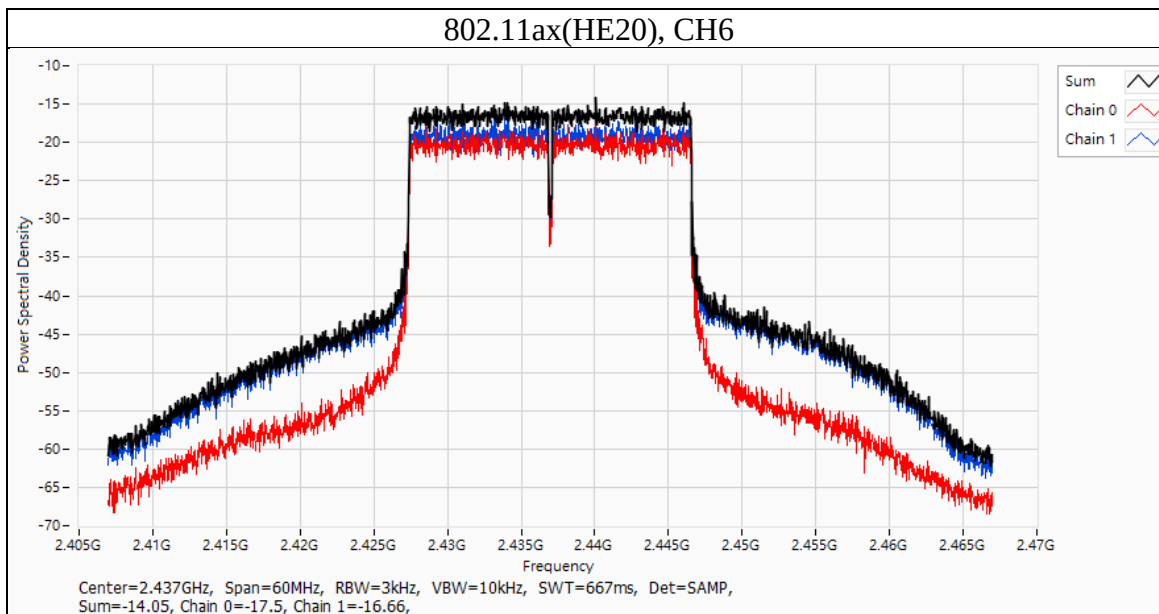
Mode	CH	Freq (MHz)	Total PSD (dBm/3kHz)	Limit (dBm/3kHz)	Directional Gain (dBi)	Result
802.11g	1	2412	-24.98	7.99	6.01	PASS
	2	2417	-25.07	7.99	6.01	PASS
	3	2422	-14.96	7.99	6.01	PASS
	6	2437	-13.51	7.99	6.01	PASS
	9	2452	-14.83	7.99	6.01	PASS
	10	2457	-24.98	7.99	6.01	PASS
	11	2462	-24.75	7.99	6.01	PASS

Mode	CH	Freq (MHz)	PSD per Chain (dBm/3kHz)	
			Chain 0	Chain 1
802.11g	1	2412	-28.697	-26.941
	2	2417	-28.915	-27.388
	3	2422	-18.915	-16.112
	6	2437	-16.351	-15.538
	9	2452	-17.822	-17.867
	10	2457	-29.056	-26.941
	11	2462	-28.109	-27.435



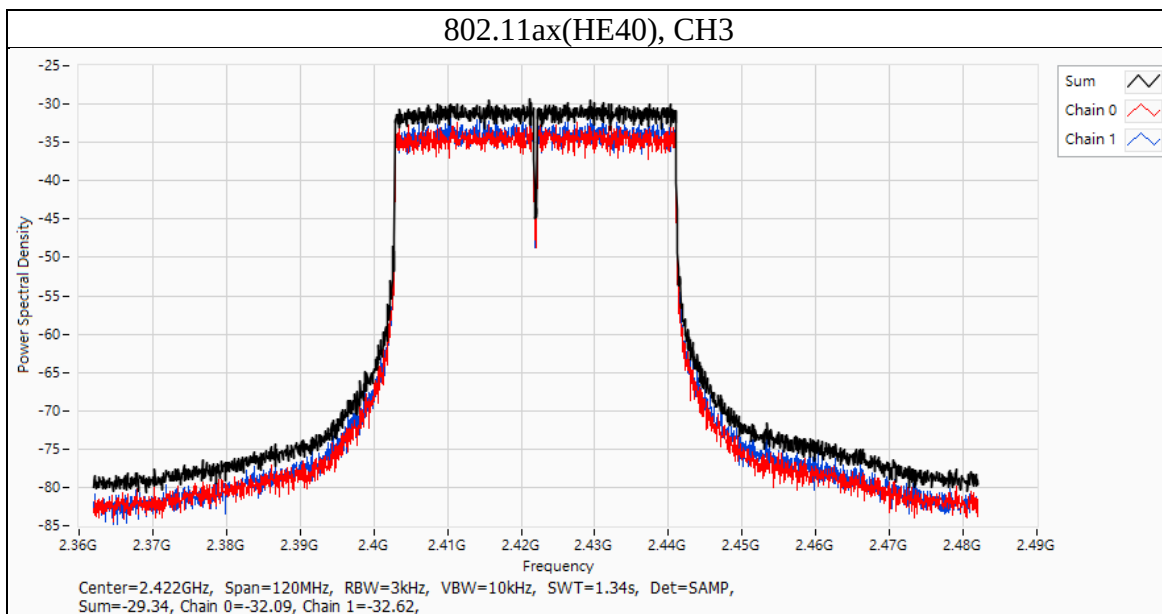
Mode	CH	Freq (MHz)	Total PSD (dBm/3kHz)	Limit (dBm/3kHz)	Directional Gain (dBi)	Result
802.11ax(HE20)	1	2412	-27.96	7.99	6.01	PASS
	2	2417	-27.7	7.99	6.01	PASS
	3	2422	-17.65	7.99	6.01	PASS
	6	2437	-14.05	7.99	6.01	PASS
	9	2452	-17.37	7.99	6.01	PASS
	10	2457	-27.56	7.99	6.01	PASS
	11	2462	-27.07	7.99	6.01	PASS

Mode	CH	Freq (MHz)	PSD per Chain (dBm/3kHz)	
			Chain 0	Chain 1
802.11ax(HE20)	1	2412	-30.625	-30.469
	2	2417	-30.886	-30.291
	3	2422	-20.862	-19.835
	6	2437	-17.5	-16.656
	9	2452	-20.139	-18.875
	10	2457	-30.371	-29.78
	11	2462	-30.165	-29.342



Mode	CH	Freq (MHz)	Total PSD (dBm/3kHz)	Limit (dBm/3kHz)	Directional Gain (dBi)	Result
802.11ax(HE40)	3	2422	-29.34	7.99	6.01	PASS
	6	2437	-29.42	7.99	6.01	PASS
	9	2452	-30.08	7.99	6.01	PASS

Mode	CH	Freq (MHz)	PSD per Chain (dBm/3kHz)	
			Chain 0	Chain 1
802.11ax(HE40)	3	2422	-32.086	-31.7
	6	2437	-32.145	-32.349
	9	2452	-32.992	-32.407



9.4. Conducted Out of Band Emission

Requirements

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

Test procedure

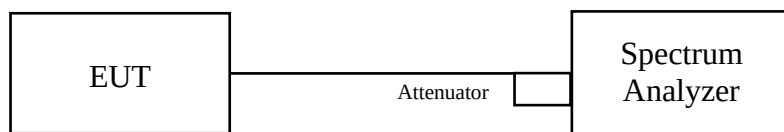
Measurement Procedure REF

1. Set the RBW = 100 kHz.
2. Set the VBW $\geq$ 300 kHz.
3. Set the span to 1.5 times the DTS bandwidth.
4. Detector = peak.
5. Sweep time = auto couple.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.

Measurement Procedure OOBE

1. Set RBW = 100 kHz.
2. Set VBW $\geq$ 300 kHz.
3. Detector = peak.
4. Sweep = auto couple.
5. Trace Mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum amplitude level.

Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

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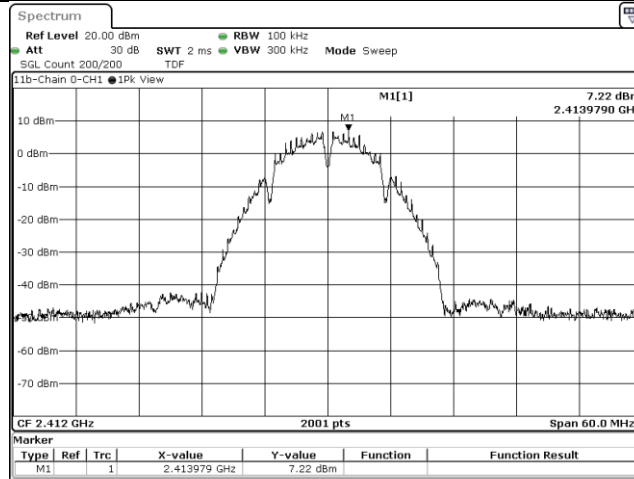
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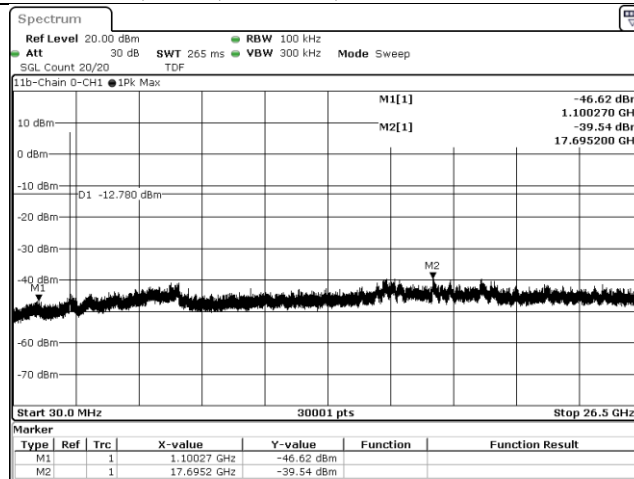
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Test Data

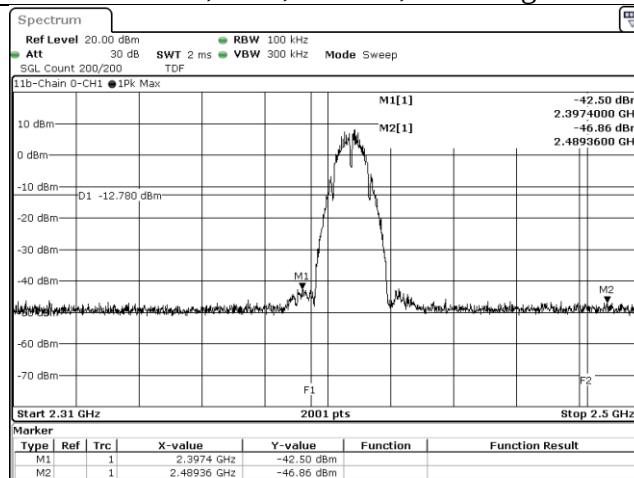
802.11b, CH1, Chain 0, Reference



802.11b, CH1, Chain 0, Conducted Emission



802.11b, CH1, Chain 0, Band edge



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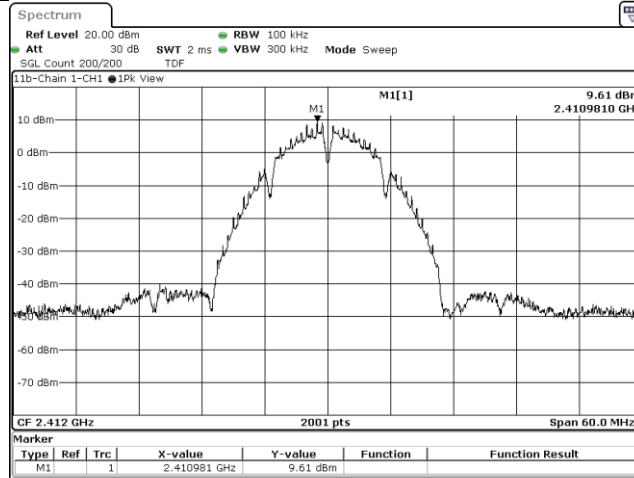
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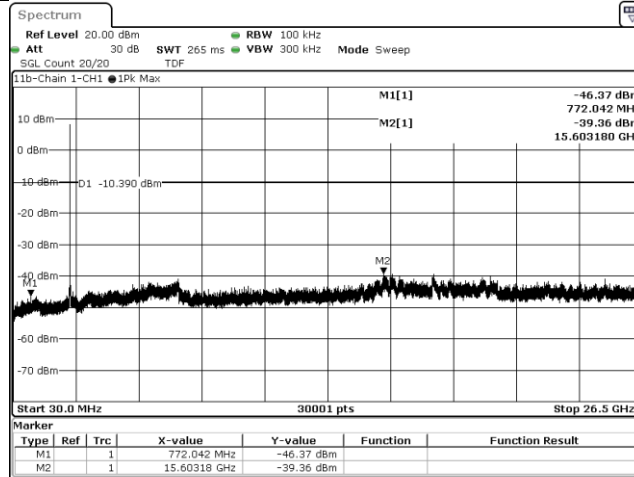
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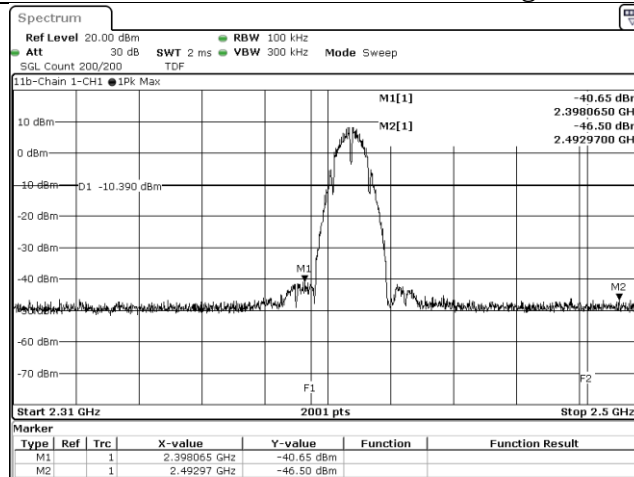
802.11b, CH1, Chain 1, Reference



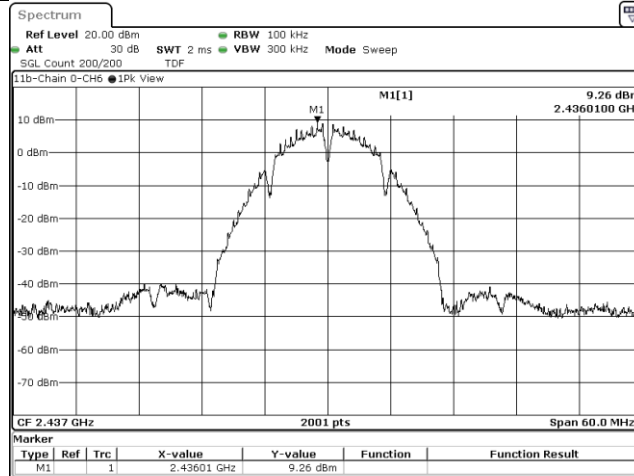
802.11b, CH1, Chain 1, Conducted Emission



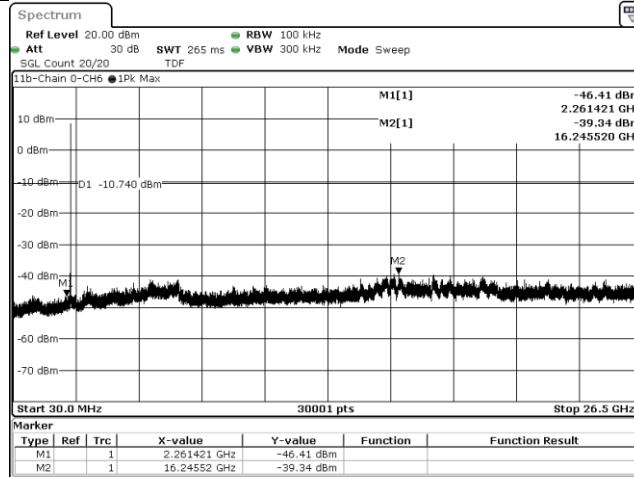
802.11b, CH1, Chain 1, Band edge



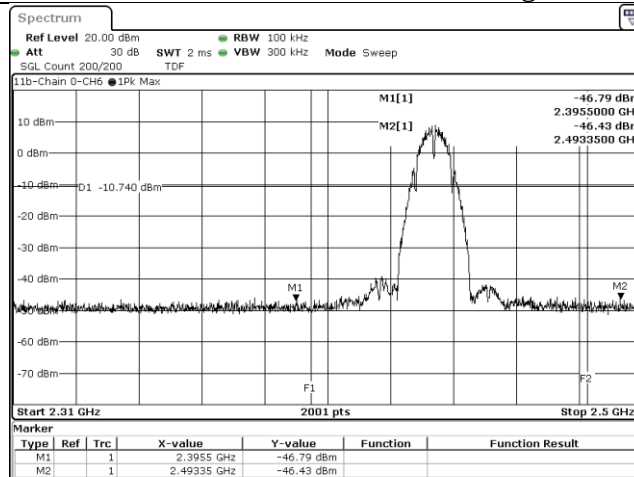
802.11b, CH6, Chain 0, Reference



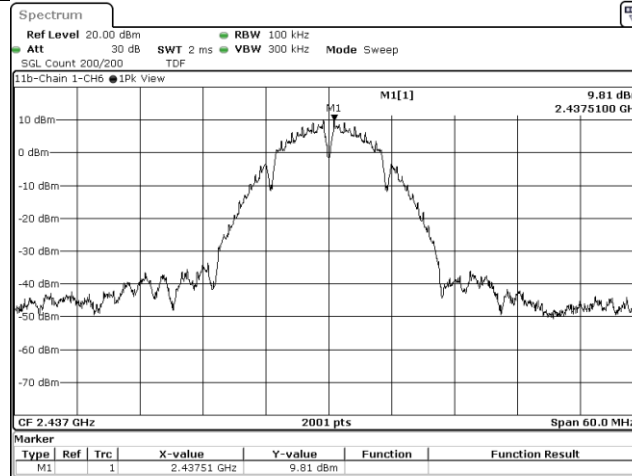
802.11b, CH6, Chain 0, Conducted Emission



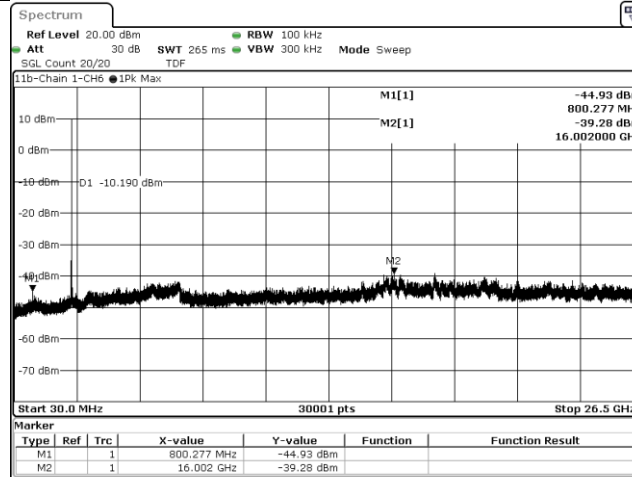
802.11b, CH6, Chain 0, Band edge



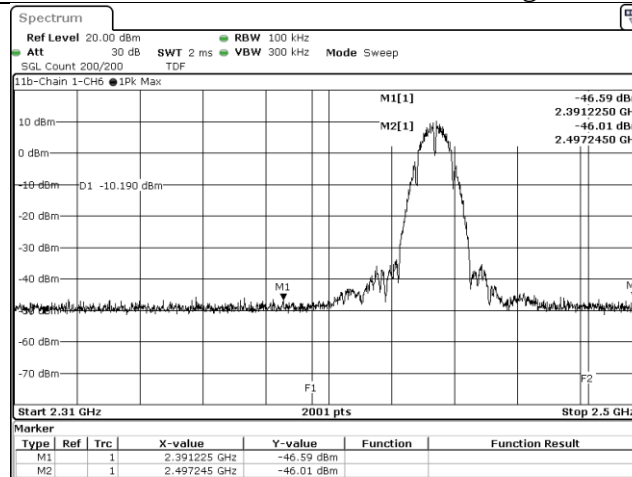
802.11b, CH6, Chain 1, Reference



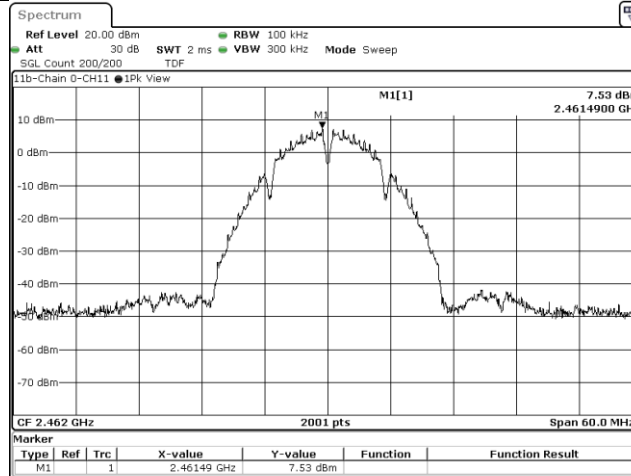
802.11b, CH6, Chain 1, Conducted Emission



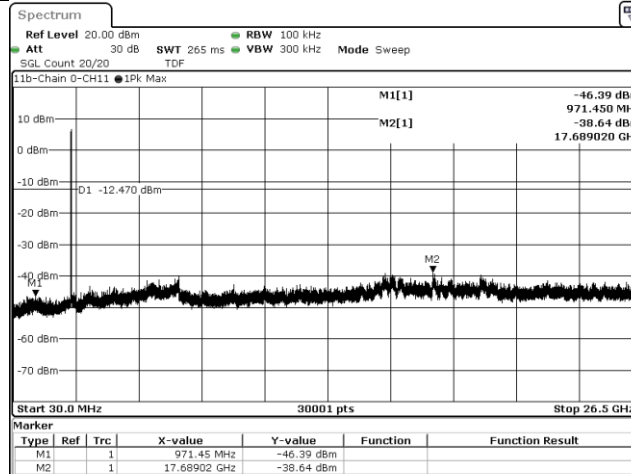
802.11b, CH6, Chain 1, Band edge



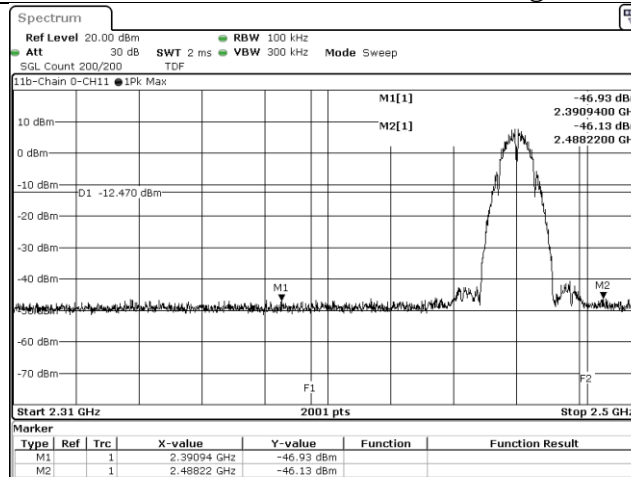
802.11b, CH11, Chain 0, Reference



802.11b, CH11, Chain 0, Conducted Emission



802.11b, CH11, Chain 0, Band edge



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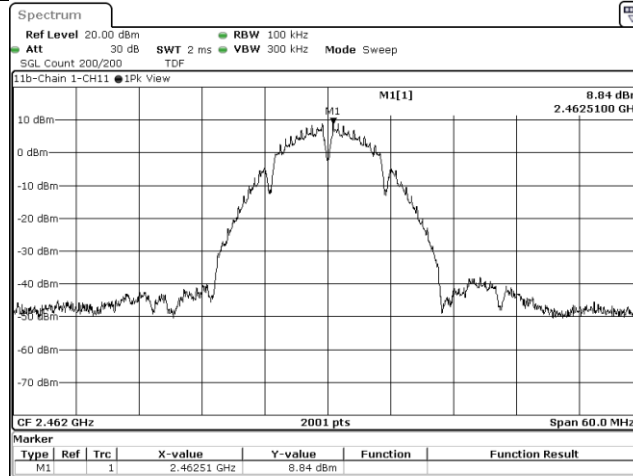
Building A, B and E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone : +886-2-7737-3000

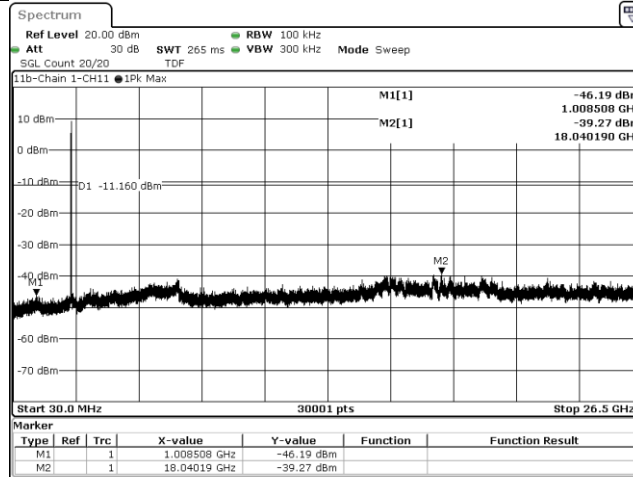
Facsimile (FAX) : +886-3-583-7948

Doc No: Form-ULID-004737 (DCS:17-EM-F0876) / 6.1

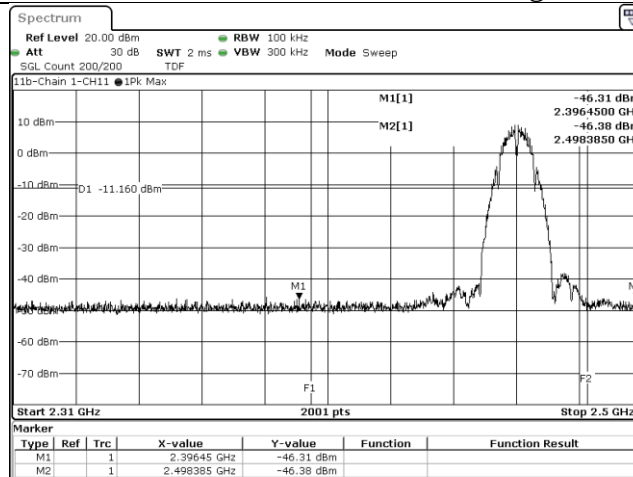
802.11b, CH11, Chain 1, Reference



802.11b, CH11, Chain 1, Conducted Emission



802.11b, CH11, Chain 1, Band edge



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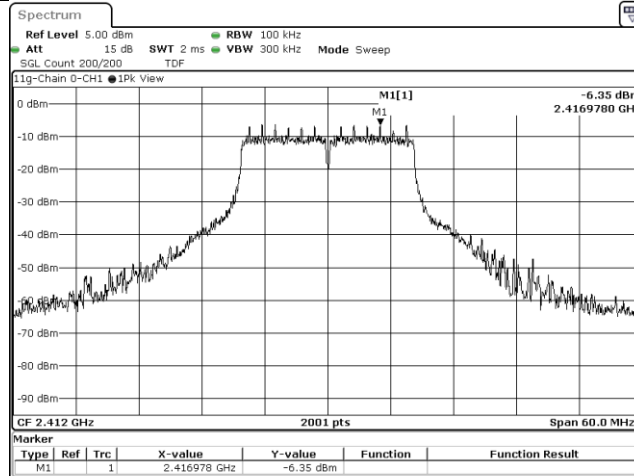
Building A, B and E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone : +886-2-7737-3000

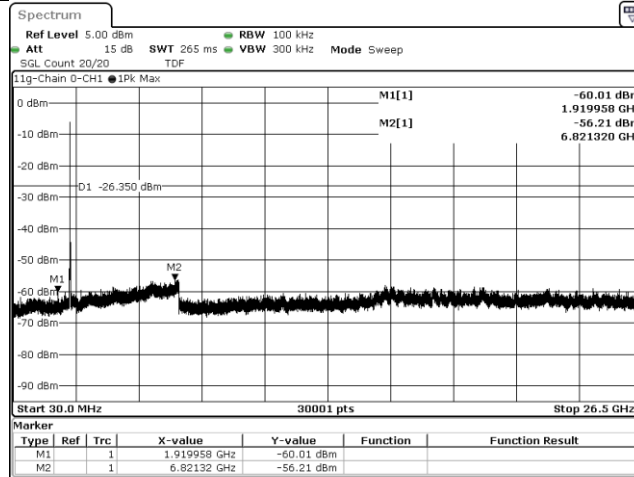
Facsimile (FAX) : +886-3-583-7948

Doc No: Form-ULID-004737 (DCS:17-EM-F0876) / 6.1

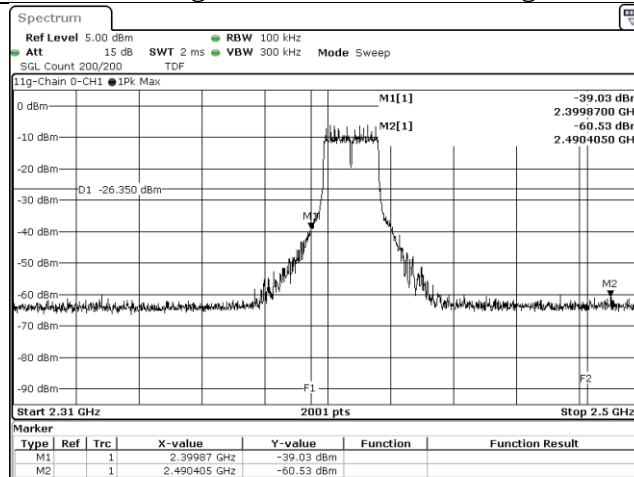
802.11g, CH1, Chain 0, Reference



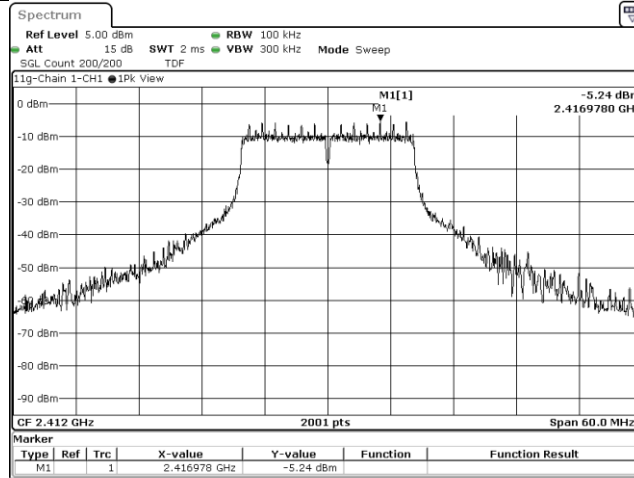
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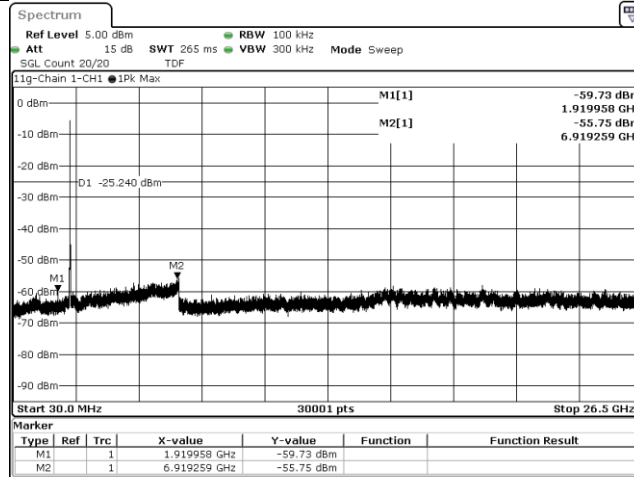
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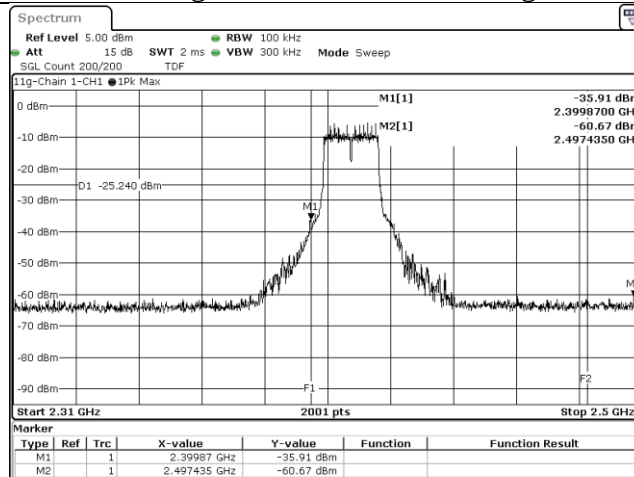
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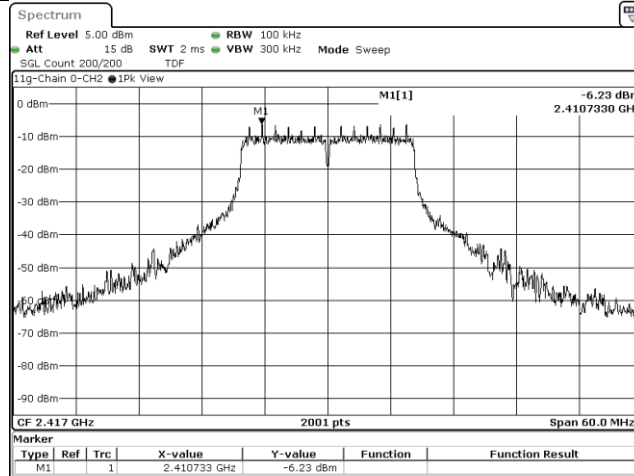
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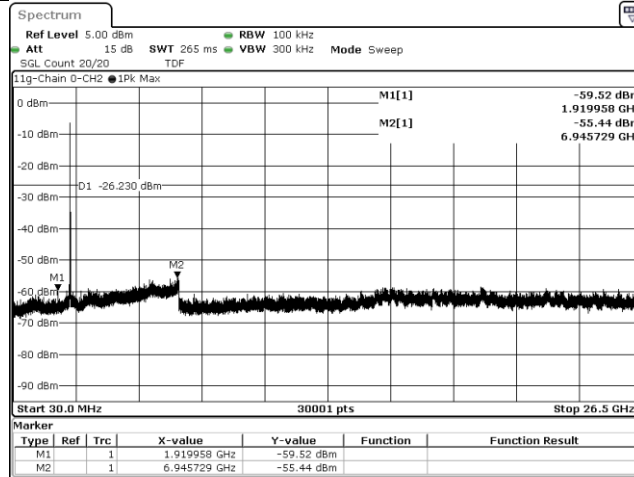
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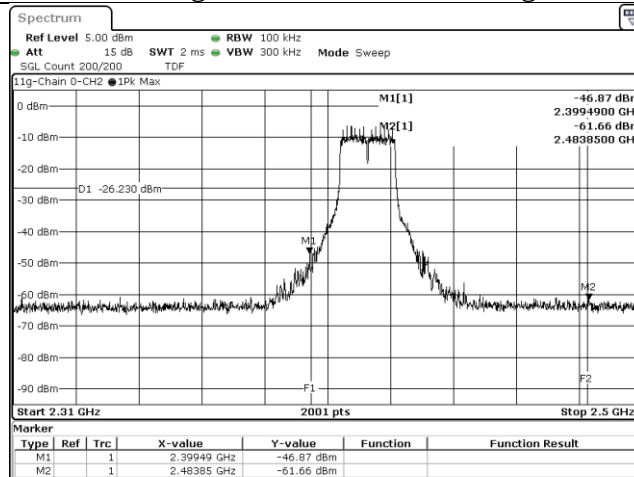
802.11g, CH2, Chain 0, Reference



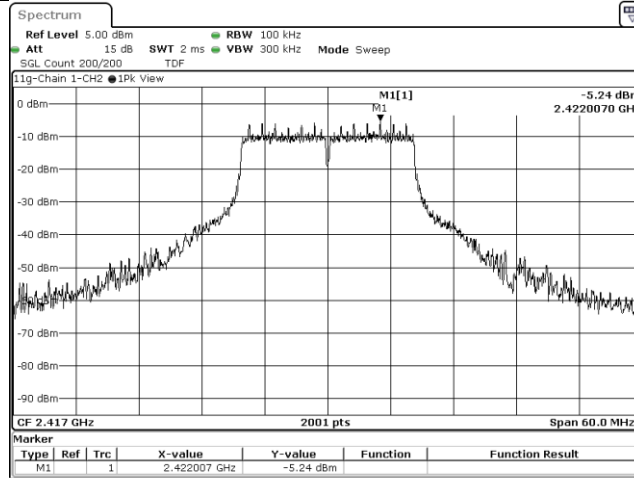
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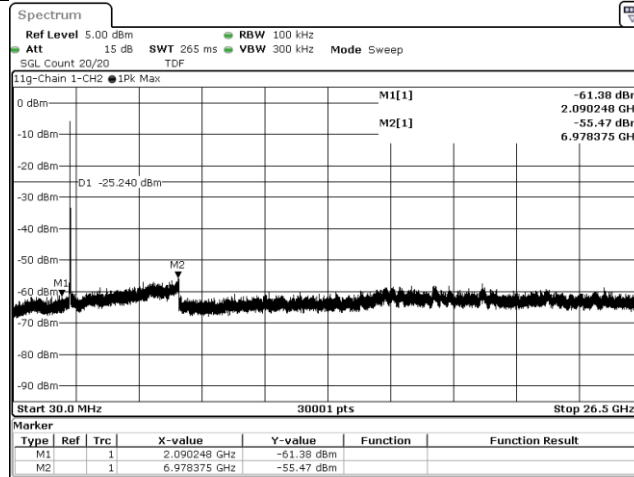
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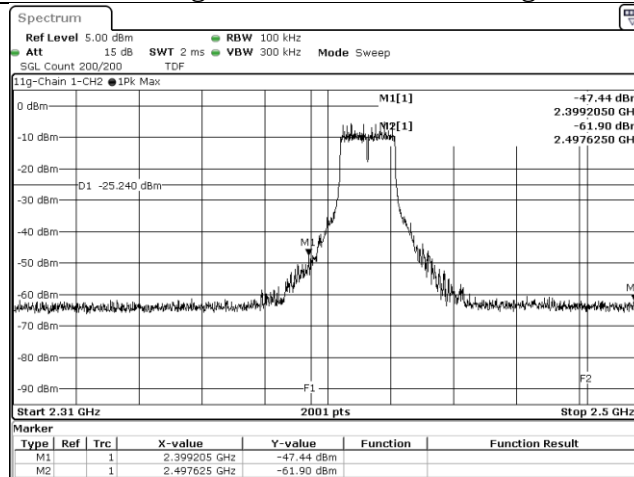
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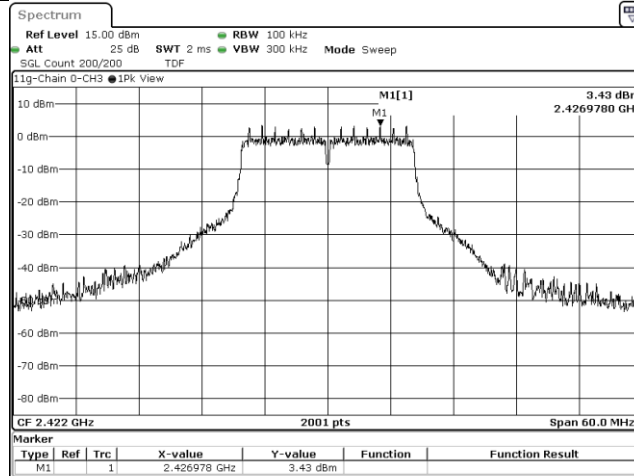
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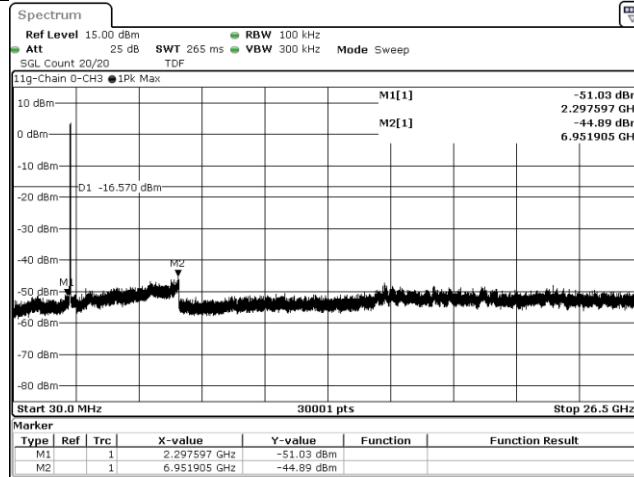
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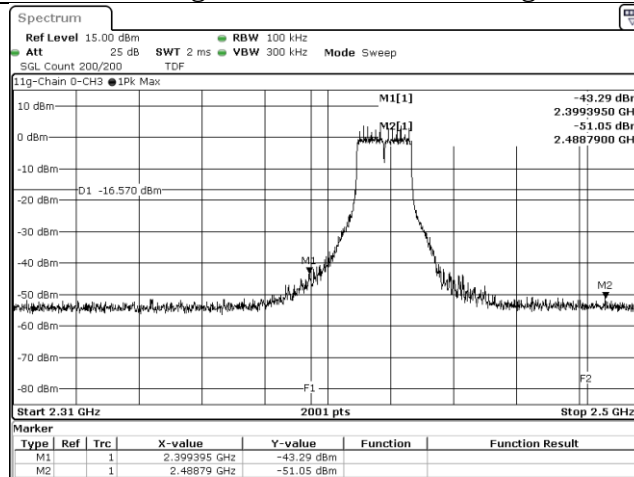
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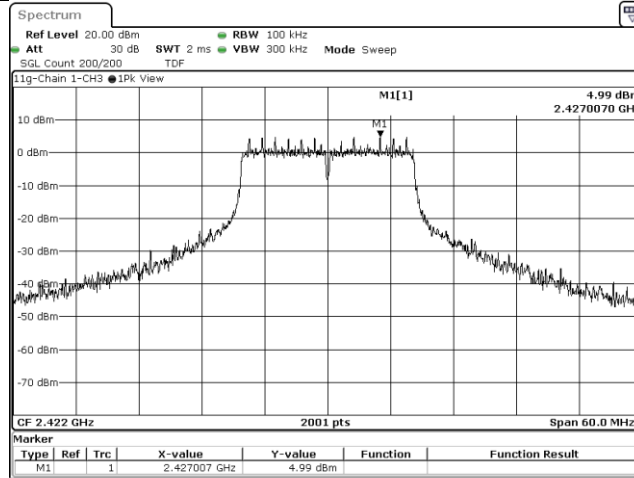
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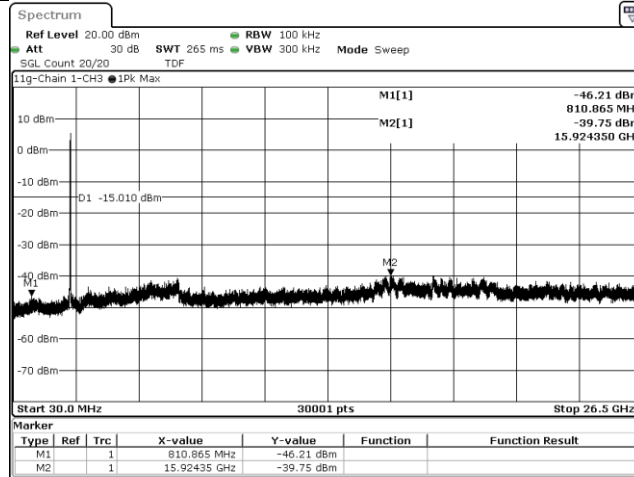
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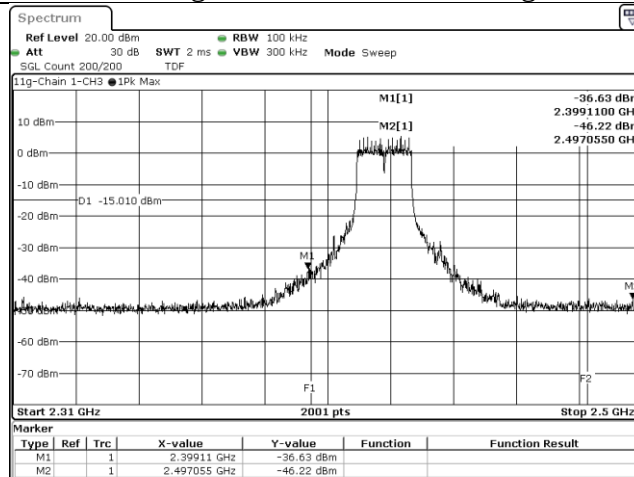
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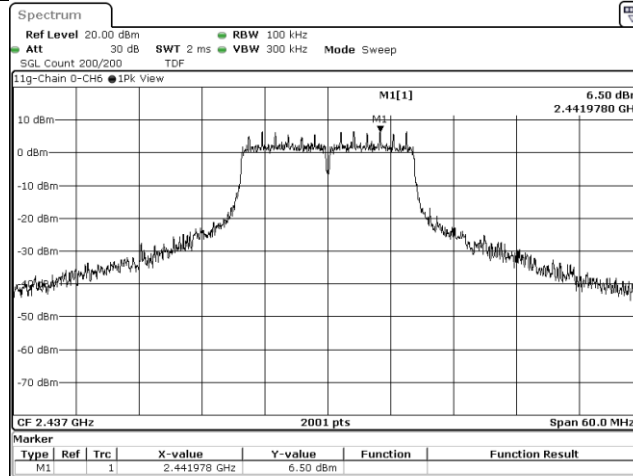
802.11g, CH3, Chain 1, Conducted Emission



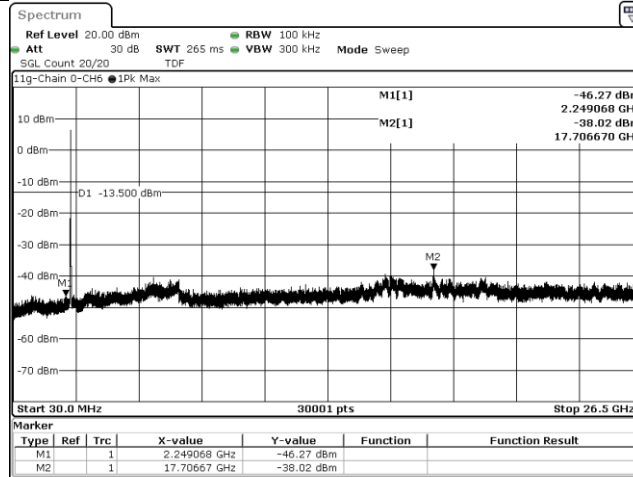
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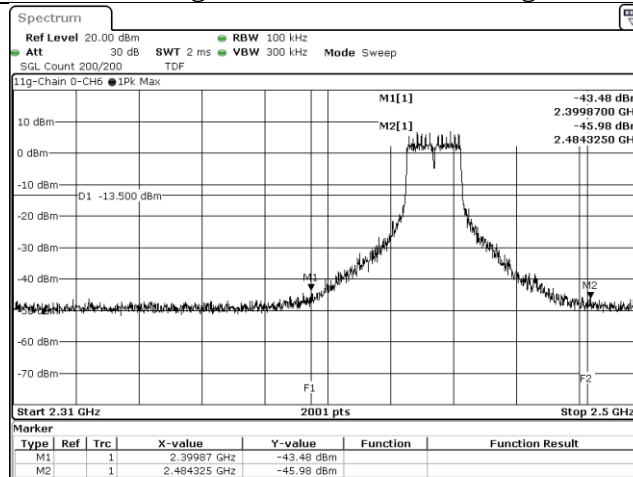
802.11g, CH6, Chain 0, Reference



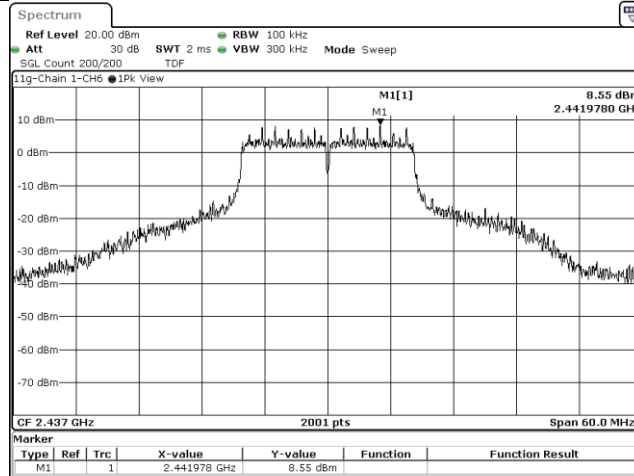
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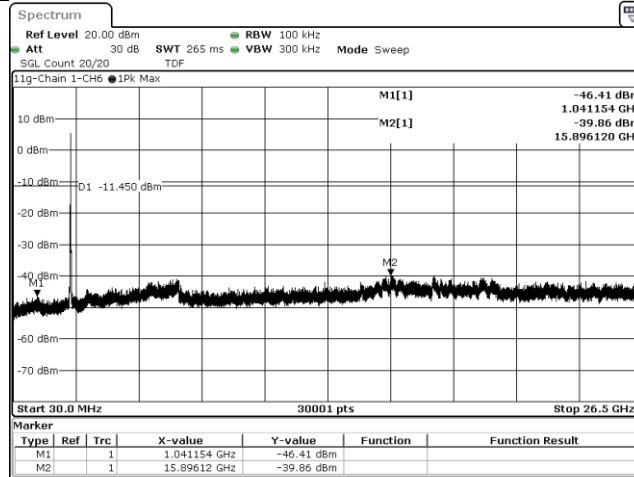
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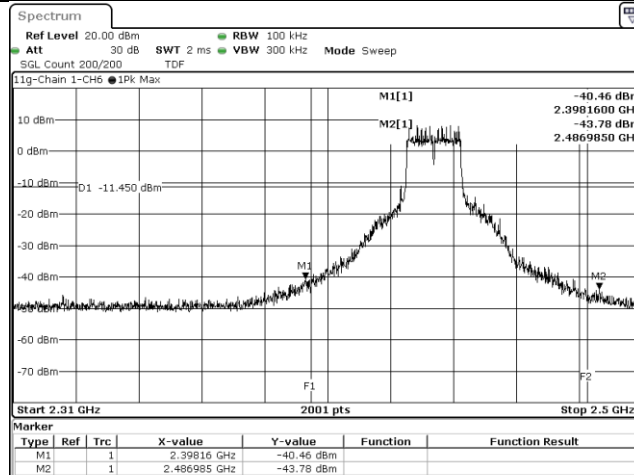
802.11g, CH6, Chain 1, Reference



802.11g, CH6, Chain 1, Conducted Emission



802.11g, CH6, Chain 1, Band edge



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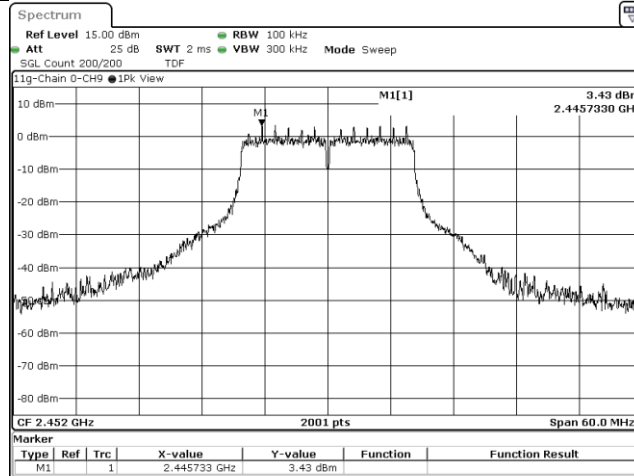
Building A, B and E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone : +886-2-7737-3000

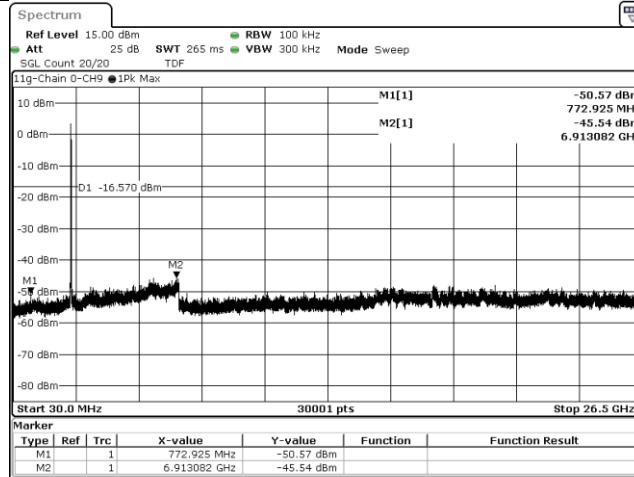
Facsimile (FAX) : +886-3-583-7948

Doc No: Form-ULID-004737 (DCS:17-EM-F0876) / 6.1

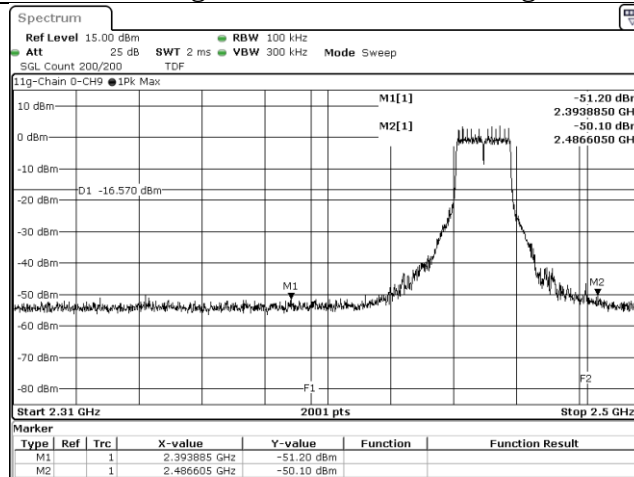
802.11g, CH9, Chain 0, Reference



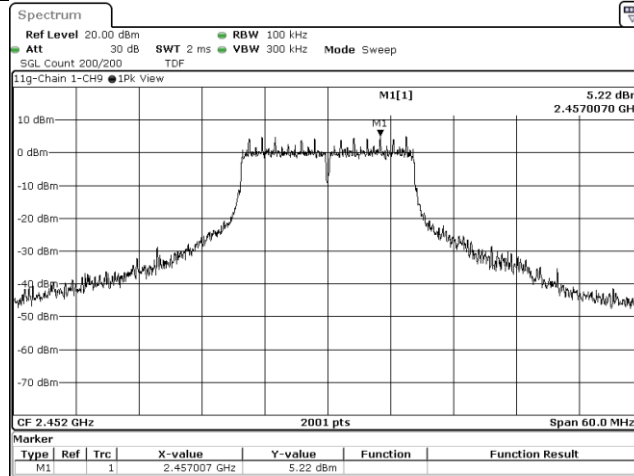
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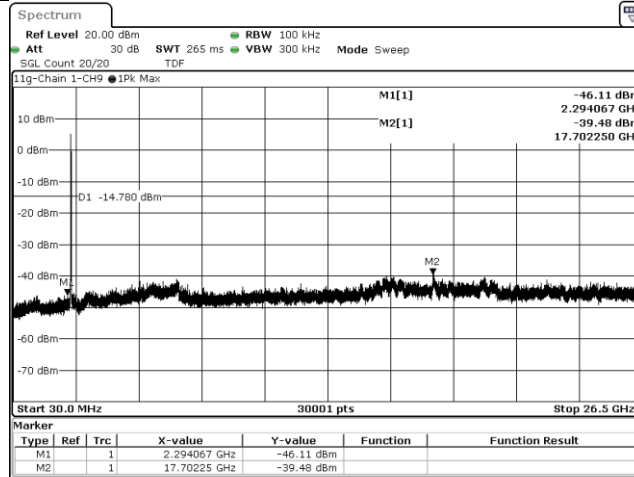
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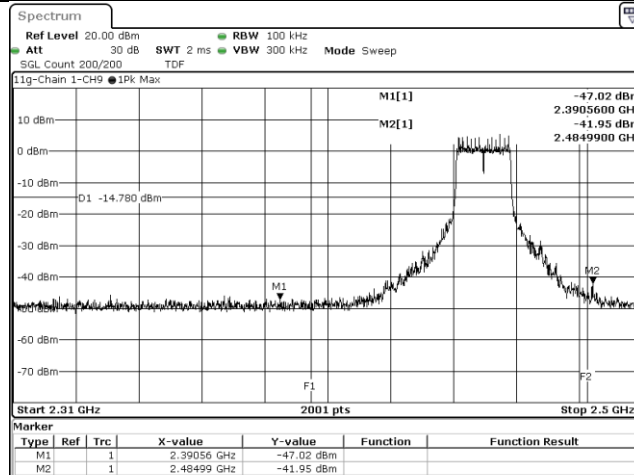
802.11g, CH9, Chain 1, Reference



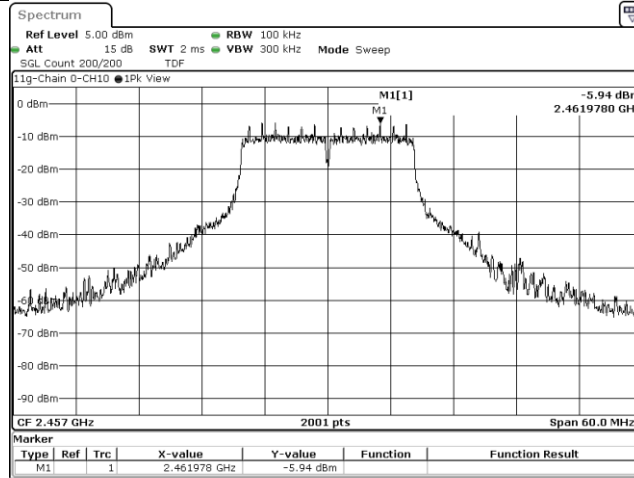
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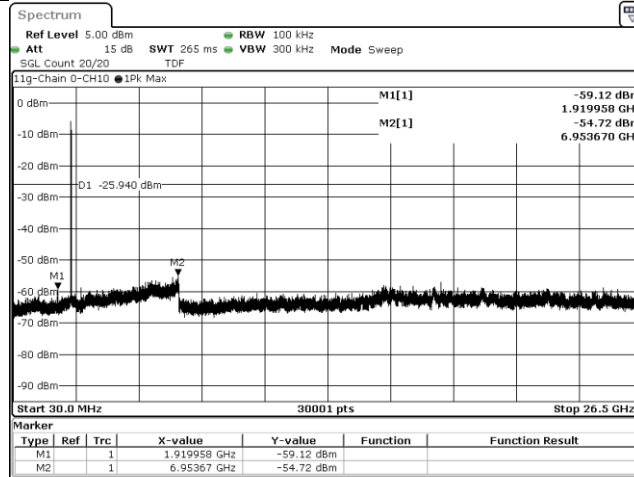
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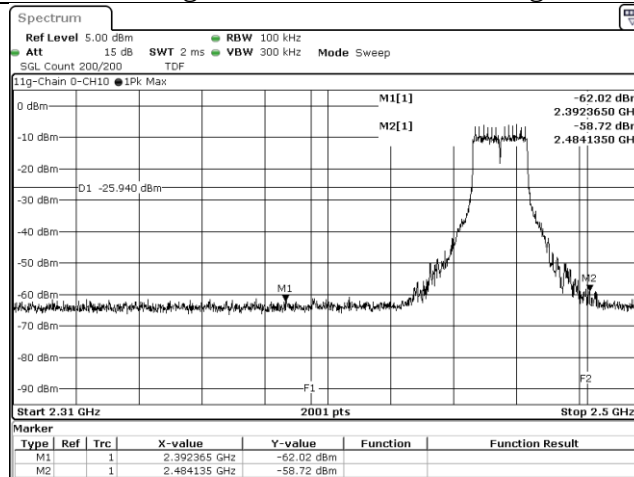
802.11g, CH10, Chain 0, Reference



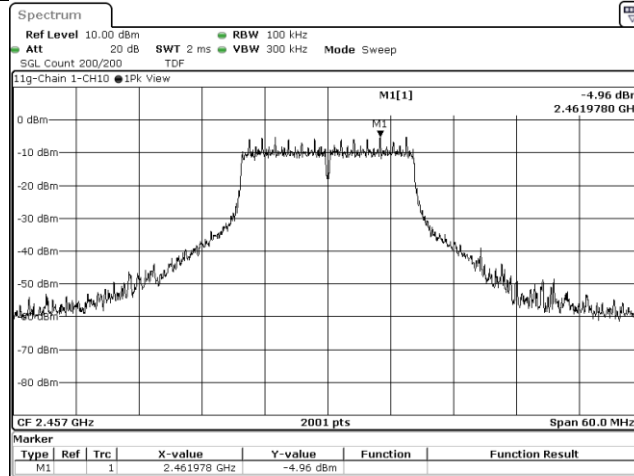
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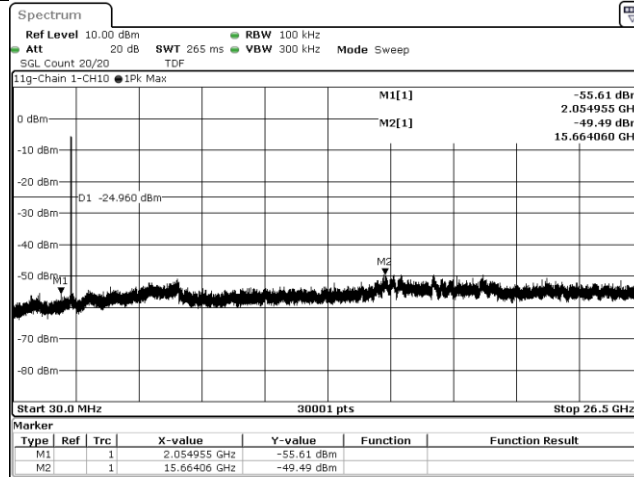
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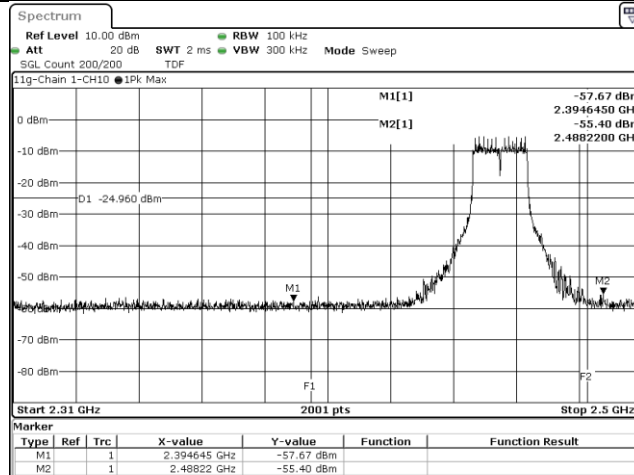
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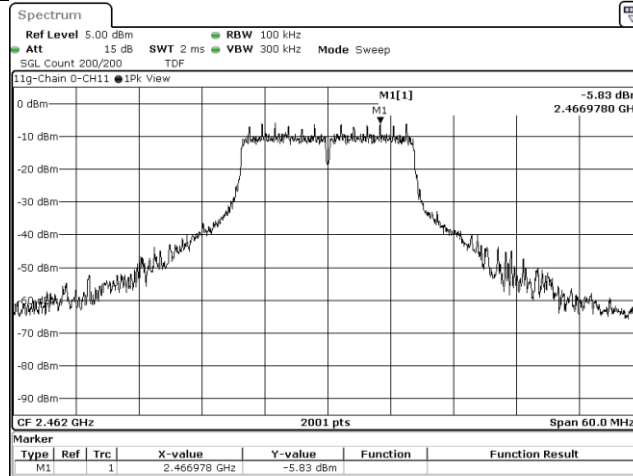
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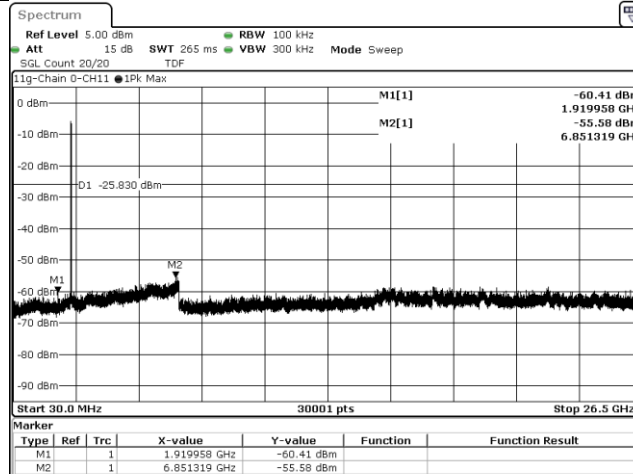
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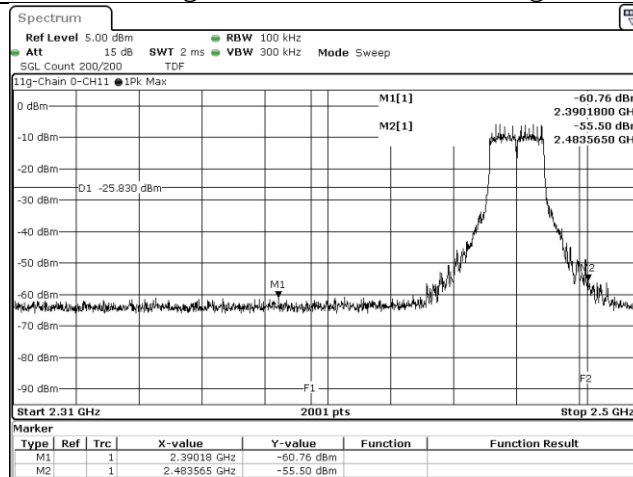
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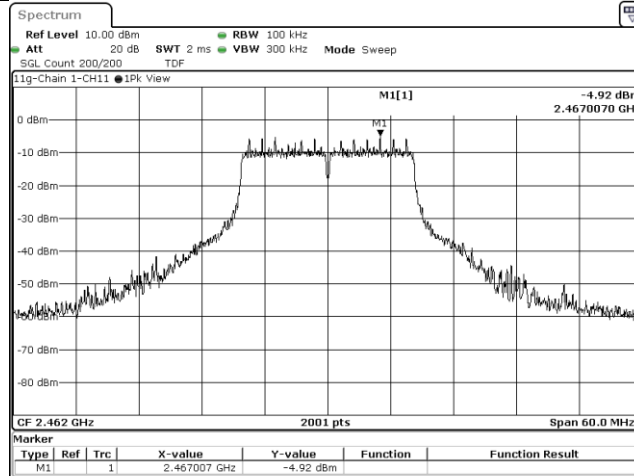
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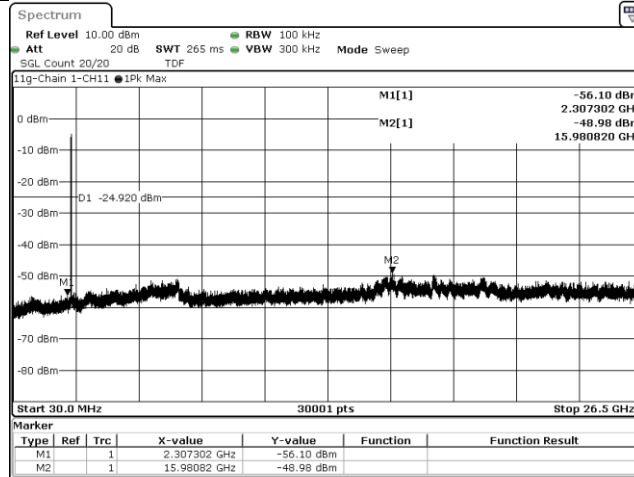
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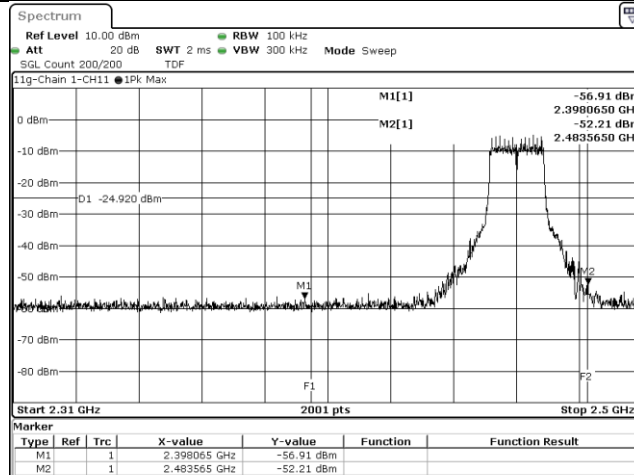
802.11g, CH11, Chain 1, Reference



802.11g, CH11, Chain 1, Conducted Emission



802.11g, CH11, Chain 1, Band edge



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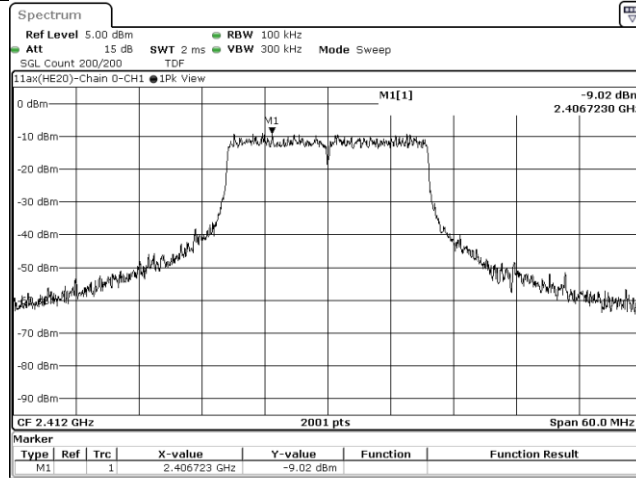
Building A, B and E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone : +886-2-7737-3000

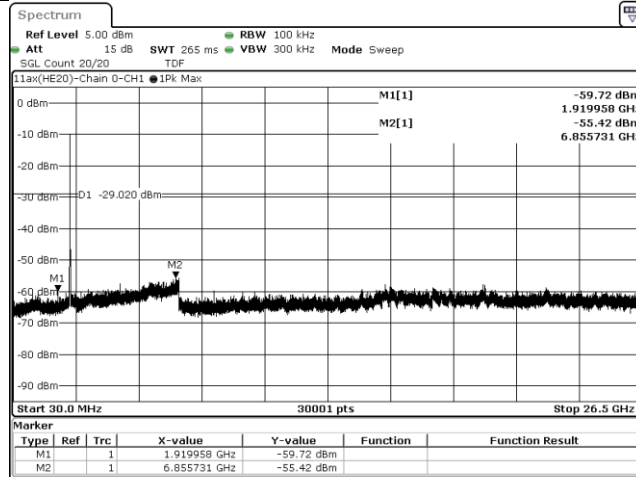
Facsimile (FAX) : +886-3-583-7948

Doc No: Form-ULID-004737 (DCS:17-EM-F0876) / 6.1

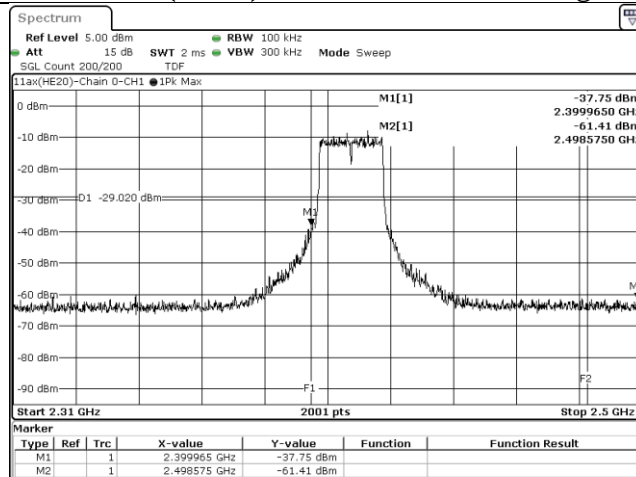
802.11ax(HE20), CH1, Chain 0, Reference



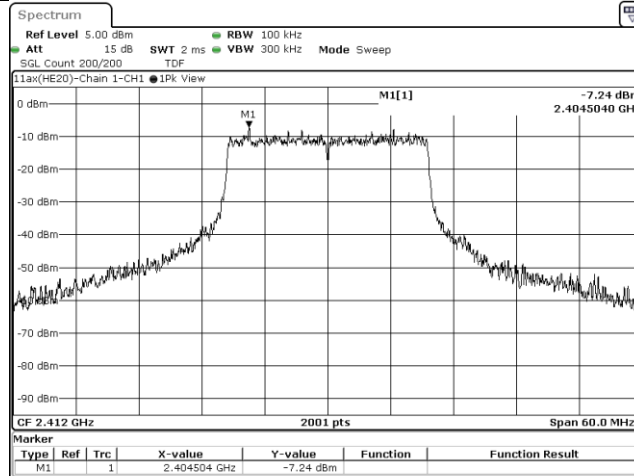
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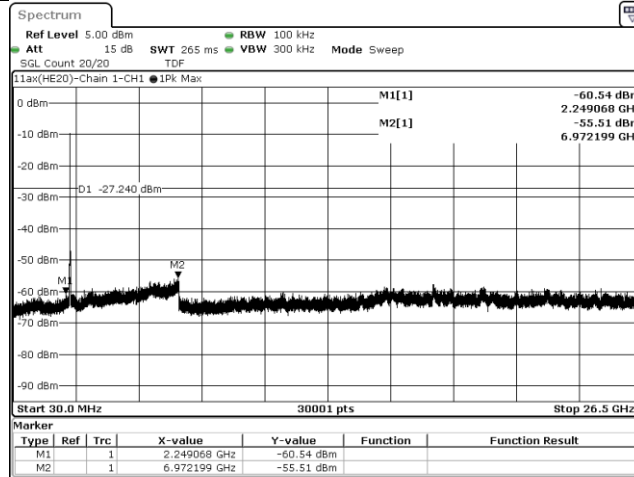
802.11ax(HE20), CH1, Chain 0, Band edge



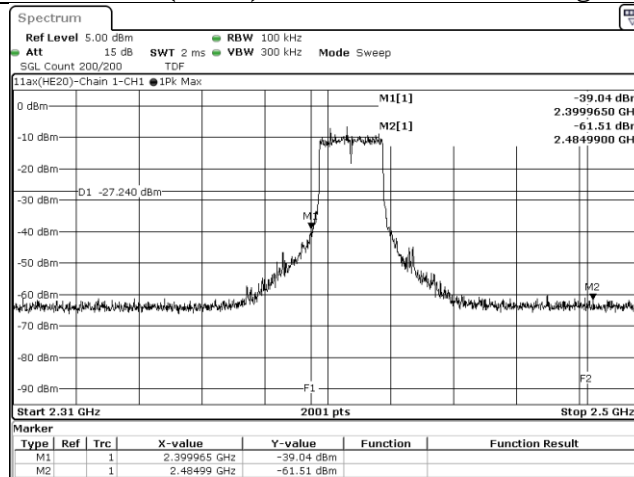
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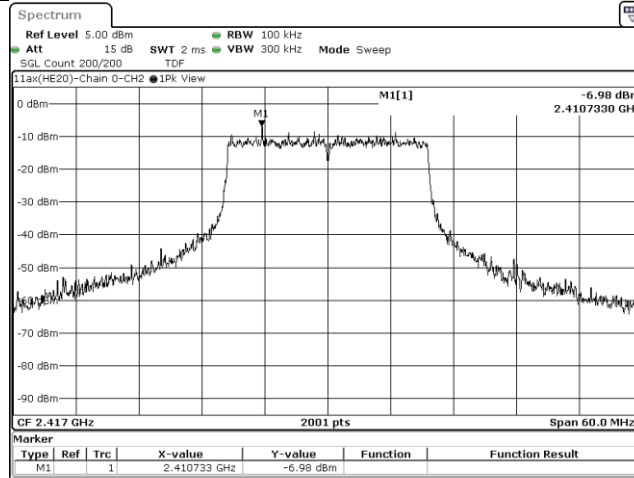
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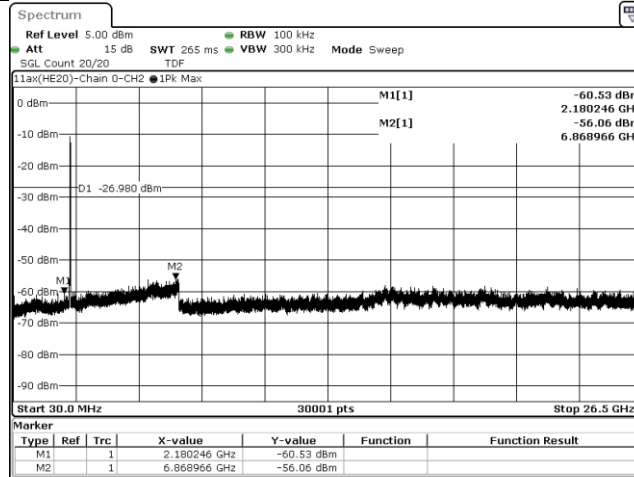
802.11ax(HE20), CH1, Chain 1, Band edge



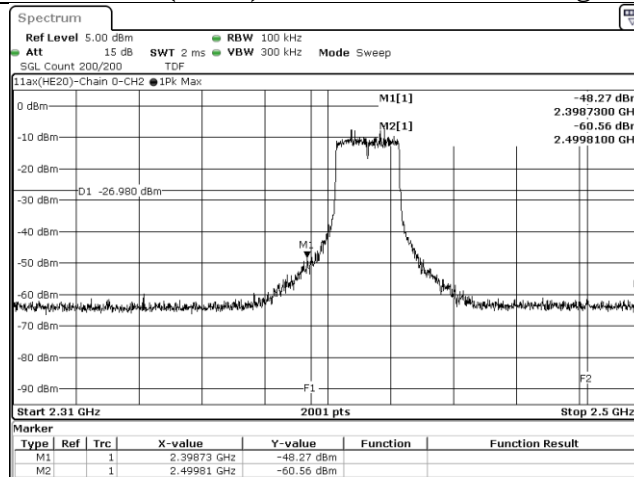
802.11ax(HE20), CH2, Chain 0, Reference



802.11ax(HE20), CH2, Chain 0, Conducted Emission



802.11ax(HE20), CH2, Chain 0, Band edge



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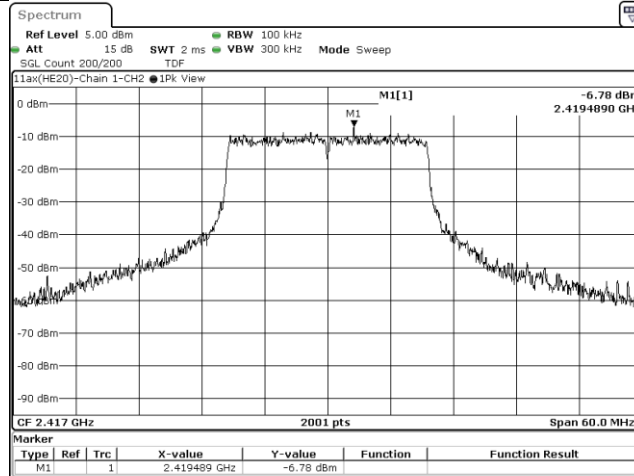
Building A, B and E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone : +886-2-7737-3000

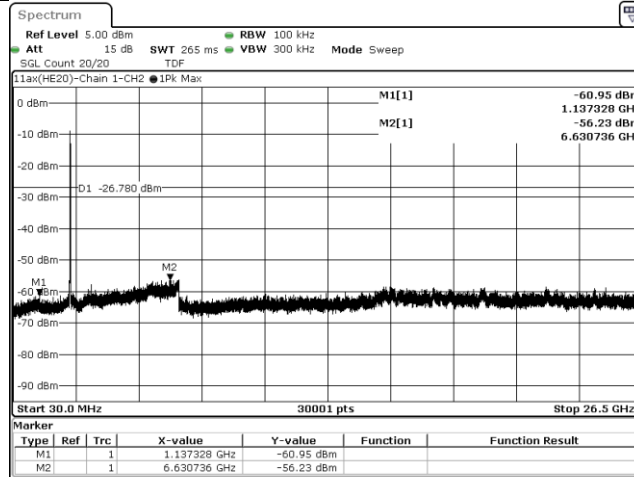
Facsimile (FAX) : +886-3-583-7948

Doc No: Form-ULID-004737 (DCS:17-EM-F0876) / 6.1

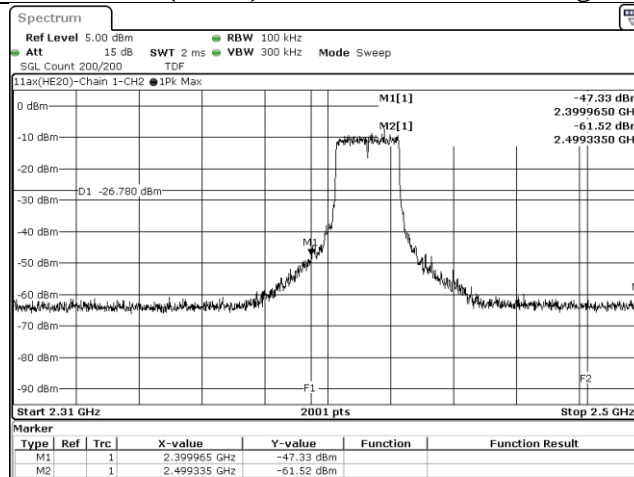
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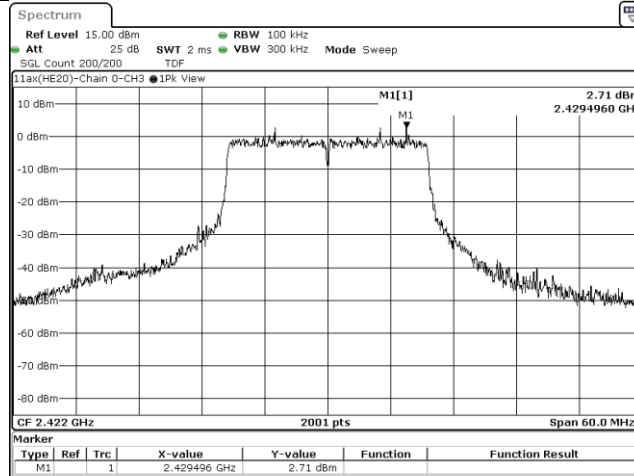
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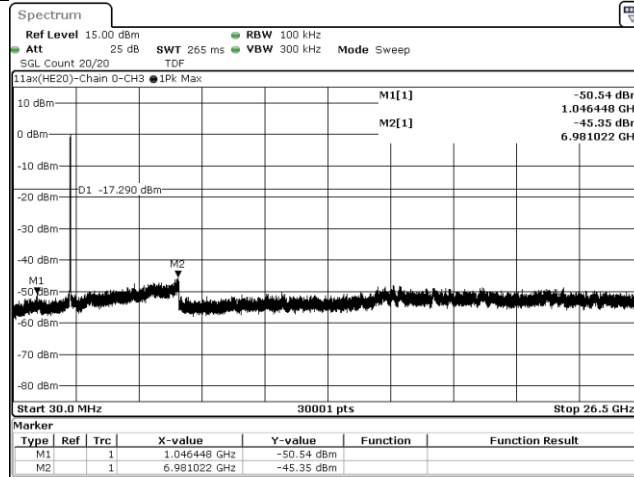
802.11ax(HE20), CH2, Chain 1, Band edge



802.11ax(HE20), CH3, Chain 0, Reference



802.11ax(HE20), CH3, Chain 0, Conducted Emission



802.11ax(HE20), CH3, Chain 0, Band edge

