



Test report No. : 4790038917A-US-R0-V0
Page : 1 of 137
Issued date : 2021/11/23
FCC ID : RYK-WUBT239ACNBT

RADIO TEST REPORT

Product : 802.11ac/a/b/g/n 2T2R Wi-Fi + Bluetooth 5.0 USB Module

Model Name : WUBT-239ACN(BT) [MU]

Series Model : WUBT-239ACN(BT) [M4W], WUBT-239ACN(BT) [PU],
WUBT-239ACN(BT) [P4W]

FCC ID : RYK-WUBT239ACNBT

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

Received Date : 2021/8/5

Test Date : 2021/8/9 ~ 2021/10/25

Issued Date : 2021/11/23

Applicant : SparkLAN Communications, Inc.
8F., No.257, Sec. 2, Tiding Blvd., Neihu District, Taipei City
11493, Taiwan (R.O.C.)

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



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REVISION HISTORY

Original Test Report No.: 4790038917A-US-R0-V0

[illegible]

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1. Attestation of Test Results

APPLICANT: SparkLAN Communications, Inc.
8F., No.257, Sec. 2, Tiding Blvd., Neihu District, Taipei City 11493,
Taiwan (R.O.C.)

MANUFACTURER: SparkLAN Communications, Inc.
8F., No.257, Sec. 2, Tiding Blvd., Neihu District, Taipei City 11493,
Taiwan (R.O.C.)

EUT DESCRIPTION: 802.11ac/a/b/g/n 2T2R Wi-Fi + Bluetooth 5.0 USB Module

BRAND: SparkLAN

MODEL: WUBT-239ACN(BT) [MU]

SERIES MODEL: WUBT-239ACN(BT) [M4W], WUBT-239ACN(BT) [PU],
WUBT-239ACN(BT) [P4W]

SAMPLE STAGE: Engineering Verification Test sample

DATE of TESTED: 2021/8/9 ~ 2021/10/25

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 : 2021/11/23

Approved and Authorized By:

Waternil Guan
Engineer

Date : 2021/11/23

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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 B and Building 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 $k=2$.

Measurement	Frequency	Uncertainty
Conducted disturbance at mains terminals ports	150kHz ~ 30MHz	± 3.1 dB
RF Conducted	9 kHz - 40GHz	± 1.9 dB
Radiated disturbance below 30MHz	9 kHz - 30 MHz	± 1.9 dB
Radiated disturbance below 1 GHz	30MHz ~ 1GHz	± 5.4 dB
Radiated disturbance above 1 GHz	1GHz ~ 40GHz	± 4.7 dB

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6. Equipment under Test

6.1. Description of EUT

Product	802.11ac/a/b/g/n 2T2R Wi-Fi + Bluetooth 5.0 USB Module
Brand Name	SparkLAN
Model Name	WUBT-239ACN(BT) [MU]
Series Model	WUBT-239ACN(BT) [M4W], WUBT-239ACN(BT) [PU], WUBT-239ACN(BT) [P4W]
Operating Frequency	2412MHz ~ 2462MHz
Modulation	CCK, DQPSK, DBPSK for DSSS 64QAM, 16QAM, QPSK, BPSK for OFDM
Transfer Rate	802.11b: up to 11 Mbps 802.11g: up to 54 Mbps 802.11n: up to MCS15
Number of Channel	11 for 802.11b, 802.11g, 802.11n (HT20) 7 for 802.11n (HT40)
Maximum Output Power	802.11b: 23.32 dBm 802.11g: 27.81dBm 802.11n (HT20): 28.03 dBm 802.11n (HT40): 22.43 dBm
Normal Voltage	5Vdc
Sample ID	Conducted Test: 4197850 Radiated Test: 4197853

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Note:

1. The models difference table as below:

Brand	Model	Difference
SparkLAN	WUBT-239ACN(BT) [MU]	1. External antenna
	WUBT-239ACN(BT) [M4W]	1. External antenna 2. USB Connector is 4-Pin Wafer
	WUBT-239ACN(BT) [PU]	1. PCB Antenna
	WUBT-239ACN(BT) [P4W]	1. PCB Antenna 2. USB Connector is 4-Pin Wafer

Except above change, there are no change to technical construction that is included circuit diagram, PCB Layout, components and component layout, all electrical construction and mechanical construction.

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

3. The EUT contains following accessory devices:

Product	Brand	Model	Description
Dipole Antenna 1	SparkLAN	AD-301N	-
Dipole Antenna 2	SparkLAN	AD-103AG	-
Dipole Antenna 3	SparkLAN	AD-305N	-
Dipole Antenna 4	SparkLAN	AD-303N	-
Dipole Antenna 5	SparkLAN	AD-302N	-
Dipole Antenna 6	SparkLAN	AD-315N	-

4. The above EUT information is declared by manufacturer and for more detailed features description, please refer the manufacturer's or user's manual.

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6.2. Channel List

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

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):

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

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6.3. Test Condition

Test Item	Test Site No.	Environmental Condition	Input Power	Test Date	Tested by
Antenna Port Conducted Measurement	SR4	23~26°C/ 60~65%RH	5Vdc	2021/08/09~ 2021/10/25	Mike Cai
Radiated Spurious Emission	966-2	23~26°C/ 60~65%RH	5Vdc	2021/09/06~ 2021/10/22	Patrick Kuan/ Mike Cai
AC power Line Conducted Emission	SR1	23~26°C/ 60~65%RH	5Vdc	2021/10/07~ 2021/10/08	Mike Cai

FCC Test Firm Registration Number: 498077

6.4. Description of Available Antennas

Ant. No.	Transmitter Circuit	Brand Name	Model Name	Ant. Type	Maximum Gain (dBi)	Remark
1	Chain (0)+(1)	SparkLAN	AD-301N	Dipole	2.4GHz: 4.4 5GHz: 5.8	Ipex
2	Chain (0)+(1)	SparkLAN	AD-103AG	Dipole	2.4GHz: 2.02 5GHz: 2.03	Ipex
3	Chain (0)+(1)	SparkLAN	AD-305N	Dipole	2.4GHz: 5 5GHz: 5.53	Ipex
4	Chain (0)+(1)	SparkLAN	AD-303N	Dipole	2.4GHz: 3.14 5GHz: 3.45	Ipex
5	Chain (0)+(1)	SparkLAN	AD-302N	Dipole	2.4GHz: 3.14 5GHz: 2.87	Ipex
6	Chain (0)	SparkLAN	N/A	PCB	2.4GHz: 0.7 5GHz: 4.24	Ant L
	Chain (1)	SparkLAN	N/A	PCB	2.4GHz: 0.25 5GHz: 3.83	Ant R
7	Chain (0)+(1)	SparkLAN	AD-315N	Dipole	2.4GHz: 3 5GHz: 5	MHF

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.

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6.5. Test Mode Applicability and Tested Channel Detail

- The fundamental of the dipole antenna was investigated in two orthogonal (lay and stand), it was determined that stand mode was worst-case. Therefore, all final radiated testing was performed with the dipole antenna in stand mode.
- For AC power line conducted emissions, the pre-scan has been determined by AC power 120Vac/60Hz (worst case)
- The fundamental of the EUT with PCB Antenna was investigated in three orthogonal axes X-Y/Y-Z/X-Z, it was determined that Y-Z plane was worst-case. Therefore, all final radiated testing was performed with the EUT in Y-Z plane.
- The antenna AD-305N 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).



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Test Item	Mode	Modulation Technology	Modulation Type	Available Channel	Test Channel	Data Rate
Radiated Emissions (Above 1GHz)	802.11b	DSSS	DBPSK	1 to 11	1,2,6,10,11	1 Mbps
	802.11g	OFDM	BPSK	1 to 11	1,2,6,10,11	6 Mbps
	802.11n20	OFDM	BPSK	1 to 11	1,2,6,10,11	MCS0
	802.11n40	OFDM	BPSK	3 to 9	3,6,9	MCS0
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	1,2,6,10,11	1 Mbps
	802.11g	OFDM	BPSK	1 to 11	1,2,6,10,11	6 Mbps
	802.11n20	OFDM	BPSK	1 to 11	1,2,6,10,11	MCS0
	802.11n40	OFDM	BPSK	3 to 9	3,6,9	MCS0

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

Simultaneously transmission condition:

Condition	Technology	
1	WLAN (2.4GHz), Chain0	Bluetooth, Chain1
2	WLAN (5GHz), Chain0	Bluetooth Chain1

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

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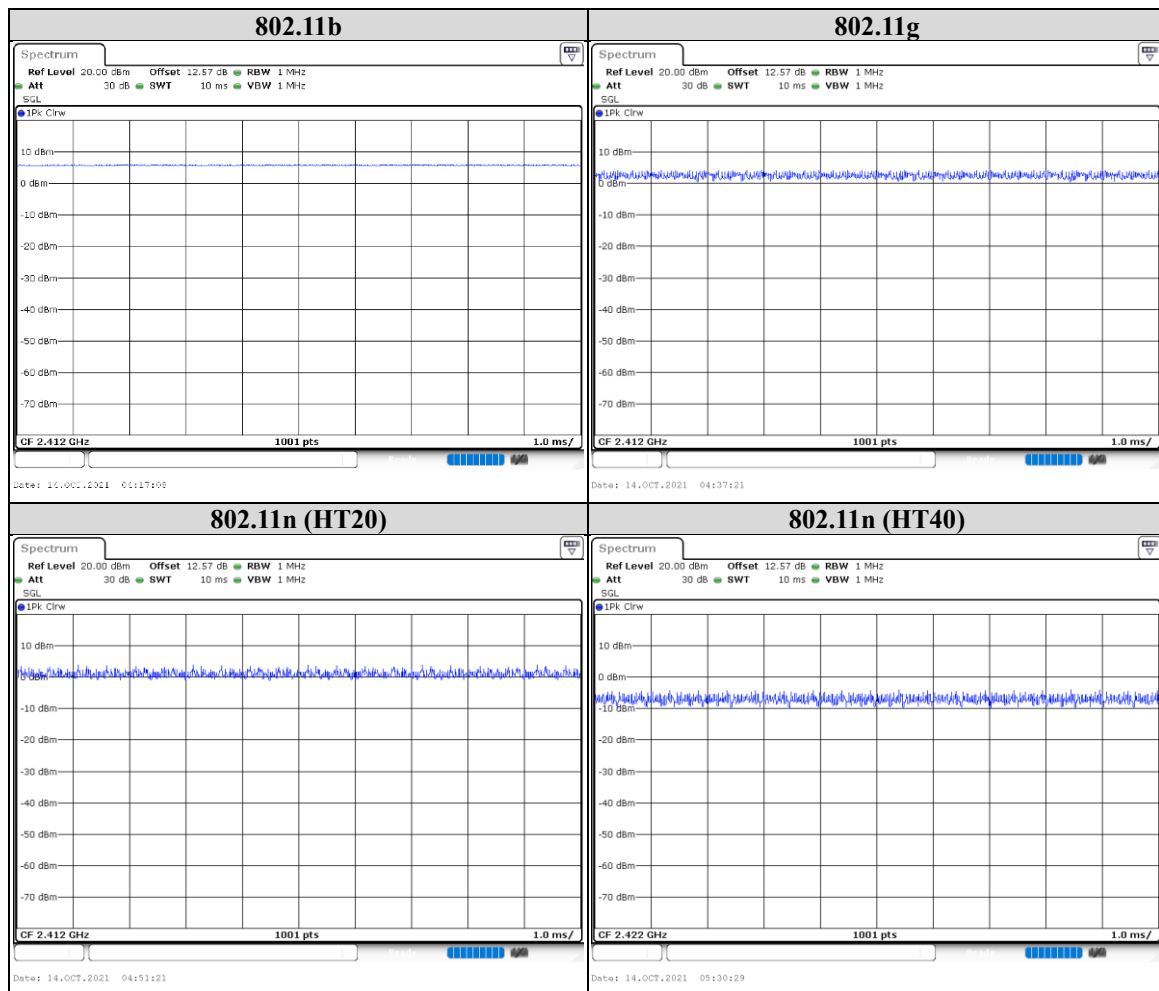
6.6. Duty cycle

802.11b: Duty cycle = $1/1 = 100\%$, duty cycle of test signal is $\geq 98\%$, duty factor is not required.

802.11g: Duty cycle = $1/1 = 100\%$, duty cycle of test signal is $\geq 98\%$, duty factor is not required.

802.11n(HT20): Duty cycle = $1/1 = 100\%$, duty cycle of test signal is $\geq 98\%$, duty factor is not required.

802.11n(HT40): Duty cycle = $1/1 = 100\%$, duty cycle of test signal is $\geq 98\%$, duty factor is not required.





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7. Test Equipment

Test Equipment List					
Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Expired date
Radiated Spurious Emission					
Spectrum Analyzer	Keysight	N9010A	MY56070827	2020/11/11	2021/11/10
EMI Test Receiver	Rohde & Schwarz	ESR7	101754	2020/12/11	2021/12/10
Loop Antenna	ETS lindgren	6502	00213440	2020/12/25	2021/12/24
Trilog-Broadband Antenna with 5dB Attenuator	Schwarzbeck & EMCI	VULB 9168 & N-6-05	774 & AT-N0538	2021/1/13	2022/1/12
Horn Antenna (1-18 GHz)	Schwarzbeck	BBHA 9120 D	01690	2020/12/30	2021/12/29
Horn Antenna (18-40 GHz)	Schwarzbeck	BBHA 9170	781	2020/12/30	2021/12/29
Preamplifier (30-1000 MHz)	EMCI	EMC330E	980405	2021/6/8	2022/6/7
Preamplifier (1-18 GHz)	EMCI	EMC051835BE	980406	2021/2/3	2022/2/2
Preamplifier (18-40GHz)	EMCI	EMC184040SEE	980426	2021/5/19	2022/5/18
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-4 & 170425-2	2021/1/22	2022/1/21
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-1 & 170214-2	2021/1/22	2022/1/21

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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	2020/11/6	2021/11/5
Pulse Power Sensor	Anritsu	MA2411B	1531202	2020/12/21	2021/12/20
Power Meter	Anritsu	ML2495A	1645002	2020/12/21	2021/12/20
AC power Line Conducted Emission					
EMI Test Receiver	Rohde & Schwarz	ESR7	101753	2020/11/17	2021/11/16
Two-Line V-Network	Rohde & Schwarz	ENV216	102136	2021/8/30	2022/8/29
Impuls-Begrenzer Pulse Limiter	Rohde & Schwarz	ESH3-Z2	102219-Qt	2021/8/26	2022/8/25
Cables	TITAN	CFD200	T0732ACFD20 020A300-1	2021/3/2	2022/3/1

UL Software		
Description	Name	Version
Radiated measurement	e3	6.191211 (V6)
Conducted measurement	RF Conducted Test Tools	ver 2.4.0.620b
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

I/O Cables

ID	Equipment	Brand Name	Model Name	Length (m)	Remark
1	USB Cable	fujiei	Z08145	1	Provide by lab

Test Setup

Controlled using a bespoke application (RTL8822CU MP Diagnostic Program 0.0001.1020.2018) 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.

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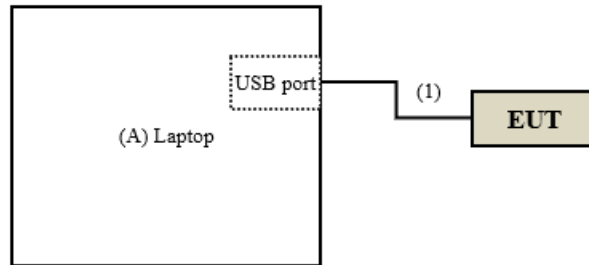
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Setup Diagram for Test



Under Table

Remote Site

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9. Test Results

9.1. 6dB Bandwidth

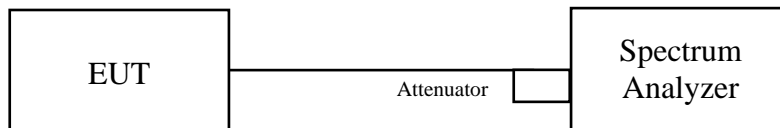
Requirements

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

Test procedure

- Set resolution bandwidth (RBW) = 100kHz.
- Set the video bandwidth (VBW) $\geq 3 \times$ 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.

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Test Data

802.11b

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
1	2412	10.11	10.07	0.5	PASS
6	2437	10.11	10.11	0.5	PASS
11	2462	10.11	10.07	0.5	PASS

802.11g

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
1	2412	16.38	16.38	0.5	PASS
6	2437	16.38	16.34	0.5	PASS
11	2462	16.38	16.38	0.5	PASS

802.11n (HT20)

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
1	2412	17.58	17.58	0.5	PASS
6	2437	17.58	17.58	0.5	PASS
11	2462	17.58	17.58	0.5	PASS

802.11n (HT40)

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
3	2422	36.36	36.36	0.5	PASS
6	2437	36.36	36.36	0.5	PASS
9	2452	36.28	36.28	0.5	PASS

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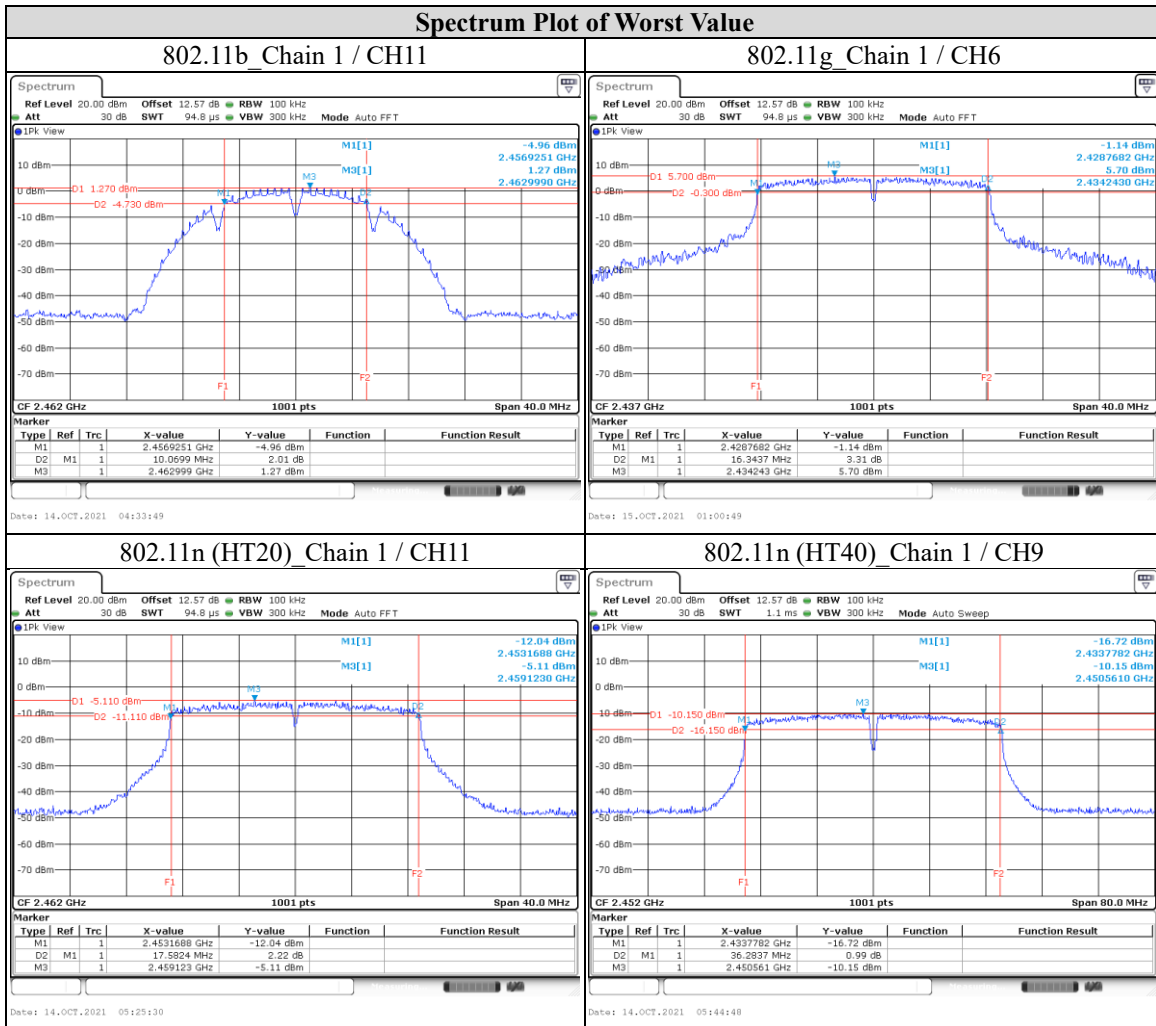
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Doc No: 17-EM-F0876 / 6.0



9.2. Conducted Output Power

Requirements

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

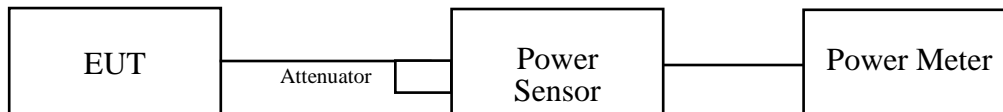
Note:

- Directional Gain = $10 \log[(10^{G1/20} + 10^{G2/20} + \dots + 10^{Gn/20})^2 / N_{ANT}]$ dBi.
Nant: Number of Transmit Antennas
G1, G2,..., Gn: Gain of Individual Antennas
- Per KDB 662911 Method of conducted output power measurement on IEEE 802.11 devices,
Array Gain = 0 dB (i.e., no array gain) for $N_{ANT} \leq 4$;
Array Gain = 0 dB (i.e., no array gain) for channel widths ≥ 40 MHz for any N_{ANT} ;
Array Gain = $5 \log(N_{ANT}/N_{SS})$ dB or 3 dB, whichever is less for 20-MHz channel widths with $N_{ANT} \geq 5$.

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.

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Test Data

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	15.41	14.46	62.661	17.97	30	PASS
2	2417	17.64	16.59	103.753	20.16	30	PASS
6	2437	20.90	19.62	214.783	23.32	30	PASS
10	2457	16.42	15.27	77.446	18.89	30	PASS
11	2462	15.36	14.20	60.674	17.83	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	21.23	21.15	263.027	24.20	30	PASS
2	2417	24.43	23.88	521.195	27.17	30	PASS
6	2437	25.23	24.32	603.949	27.81	30	PASS
10	2457	23.26	22.98	410.204	26.13	30	PASS
11	2462	19.75	20.02	194.984	22.90	30	PASS

802.11n (HT20)

Channel	Frequency (MHz)	Peak Power (dBm)		Total Power (mW)	Total Power (dBm)	Limit (dBm)	Pass / Fail
		Chain 0	Chain 1				
1	2412	18.39	18.75	143.88	21.58	30	PASS
2	2417	23.40	22.69	404.576	26.07	30	PASS
6	2437	25.41	24.58	635.331	28.03	30	PASS
10	2457	21.40	20.99	263.633	24.21	30	PASS
11	2462	17.11	18.09	115.878	20.64	30	PASS

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802.11n (HT40)

Channel	Frequency (MHz)	Peak Power (dBm)		Total Power (mW)	Total Power (dBm)	Limit (dBm)	Pass / Fail
		Chain 0	Chain 1				
3	2422	17.26	17.54	109.901	20.41	30	PASS
6	2437	19.01	19.79	174.985	22.43	30	PASS
9	2452	16.19	16.73	88.716	19.48	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	13.32	12.44	38.994	15.91
2	2417	15.64	14.63	65.615	18.17
6	2437	18.92	17.67	136.458	21.35
10	2457	14.47	13.41	49.888	16.98
11	2462	13.42	12.28	38.905	15.90

802.11g

Channel	Frequency (MHz)	Average Power (dBm)		Total Power (mW)	Total Power (dBm)
		Chain 0	Chain 1		
1	2412	11.58	11.88	29.785	14.74
2	2417	14.79	14.35	57.412	17.59
6	2437	18.75	17.54	131.826	21.20
10	2457	13.71	13.24	44.566	16.49
11	2462	10.37	10.05	20.989	13.22

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802.11n (HT20)

Channel	Frequency (MHz)	Average Power (dBm)		Total Power (mW)	Total Power (dBm)
		Chain 0	Chain 1		
1	2412	10.15	10.27	20.989	13.22
2	2417	14.38	13.89	51.88	17.15
6	2437	18.63	17.41	127.938	21.07
10	2457	12.51	12.09	34.041	15.32
11	2462	9.38	9.50	17.579	12.45

802.11n (HT40)

Channel	Frequency (MHz)	Average Power (dBm)		Total Power (mW)	Total Power (dBm)
		Chain 0	Chain 1		
3	2422	9.09	9.39	16.788	12.25
6	2437	11.19	11.59	27.542	14.40
9	2452	8.17	8.67	13.932	11.44

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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 the 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.

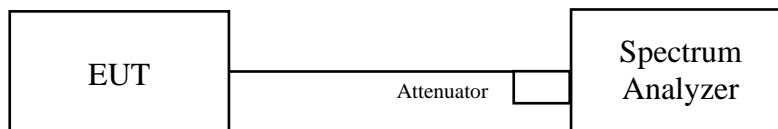
Nant: Number of Transmit Antennas

G1, G2,..., Gn: Gain of Individual Antennas

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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Test Data

802.11b

TX Chain	Channel	Frequency (MHz)	PSD (dBm/3 kHz)	10 log (N=2) dB	Total PSD (dBm/3 kHz)	Limit (dBm/3 kHz)	Pass / Fail
0	1	2412	-18.25	3.01	-15.24	5.99	PASS
	6	2437	-13.29	3.01	-10.28	5.99	PASS
	11	2462	-18.51	3.01	-15.50	5.99	PASS
1	1	2412	-18.99	3.01	-15.98	5.99	PASS
	6	2437	-14.38	3.01	-11.37	5.99	PASS
	11	2462	-19.32	3.01	-16.31	5.99	PASS

NOTE: Directional gain = 8.01 dBi > 6 dBi , so the limit shall be reduced.

802.11g

TX Chain	Channel	Frequency (MHz)	PSD (dBm/3 kHz)	10 log (N=2) dB	Total PSD (dBm/3 kHz)	Limit (dBm/3 kHz)	Pass / Fail
0	1	2412	-18.22	3.01	-15.21	5.99	PASS
	6	2437	-11.26	3.01	-8.25	5.99	PASS
	11	2462	-19.06	3.01	-16.05	5.99	PASS
1	1	2412	-18.12	3.01	-15.11	5.99	PASS
	6	2437	-13.16	3.01	-10.15	5.99	PASS
	11	2462	-19.62	3.01	-16.61	5.99	PASS

NOTE: Directional gain = 8.01 dBi > 6 dBi , so the limit shall be reduced.

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802.11n (HT20)

TX Chain	Channel	Frequency (MHz)	PSD (dBm/3 kHz)	10 log (N=2) dB	Total PSD (dBm/3 kHz)	Limit (dBm/3 kHz)	Pass / Fail
0	1	2412	-18.56	3.01	-15.55	5.99	PASS
	6	2437	-10.43	3.01	-7.42	5.99	PASS
	11	2462	-18.92	3.01	-15.91	5.99	PASS
1	1	2412	-18.21	3.01	-15.20	5.99	PASS
	6	2437	-11.30	3.01	-8.29	5.99	PASS
	11	2462	-18.76	3.01	-15.75	5.99	PASS

NOTE: Directional gain = 8.01 dBi > 6 dBi , so the limit shall be reduced.

802.11n (HT40)

TX Chain	Channel	Frequency (MHz)	PSD (dBm/3 kHz)	10 log (N=2) dB	Total PSD (dBm/3 kHz)	Limit (dBm/3 kHz)	Pass / Fail
0	3	2422	-20.67	3.01	-17.66	5.99	PASS
	6	2437	-18.57	3.01	-15.56	5.99	PASS
	9	2452	-21.55	3.01	-18.54	5.99	PASS
1	3	2422	-20.68	3.01	-17.67	5.99	PASS
	6	2437	-18.59	3.01	-15.58	5.99	PASS
	9	2452	-21.58	3.01	-18.57	5.99	PASS

NOTE: Directional gain = 8.01 dBi > 6 dBi , so the limit shall be reduced.

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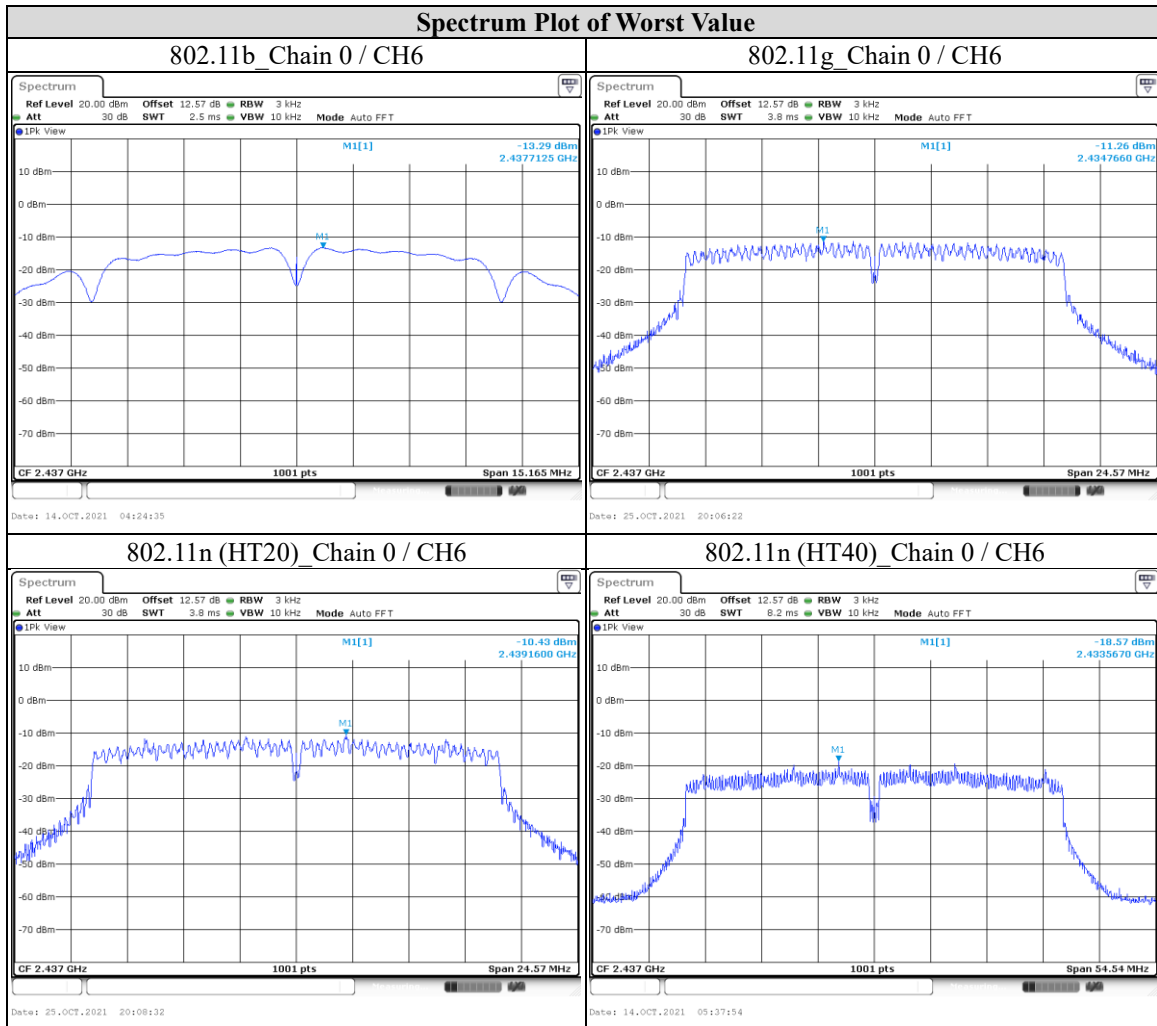
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9.4. Conducted Out of Band Emission

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

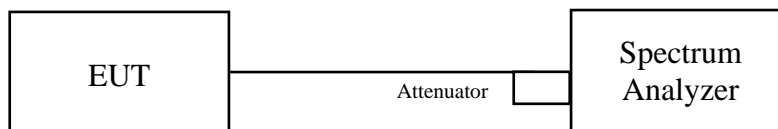
Measurement Procedure REF

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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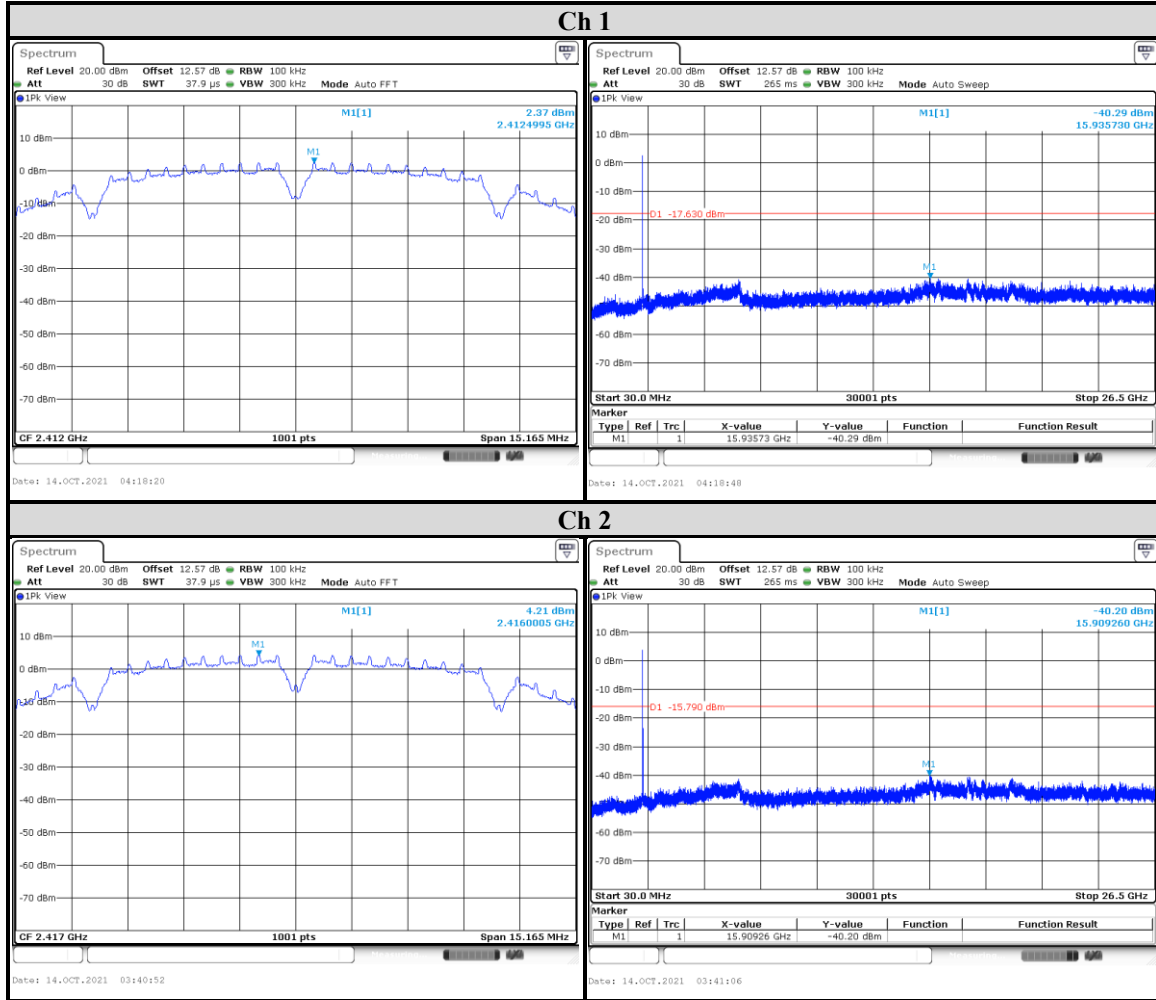


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Test Data

802.11b

Chain 0



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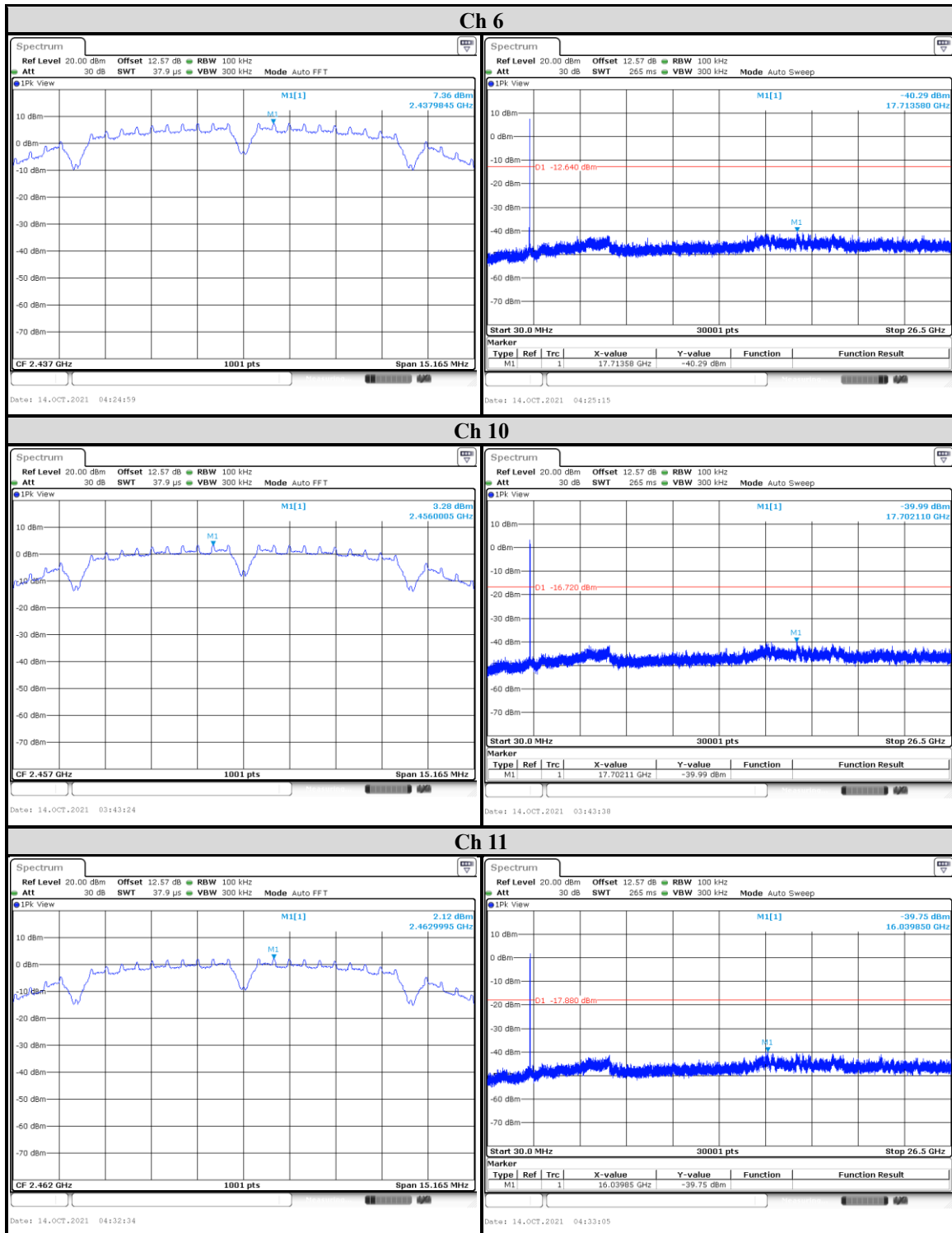
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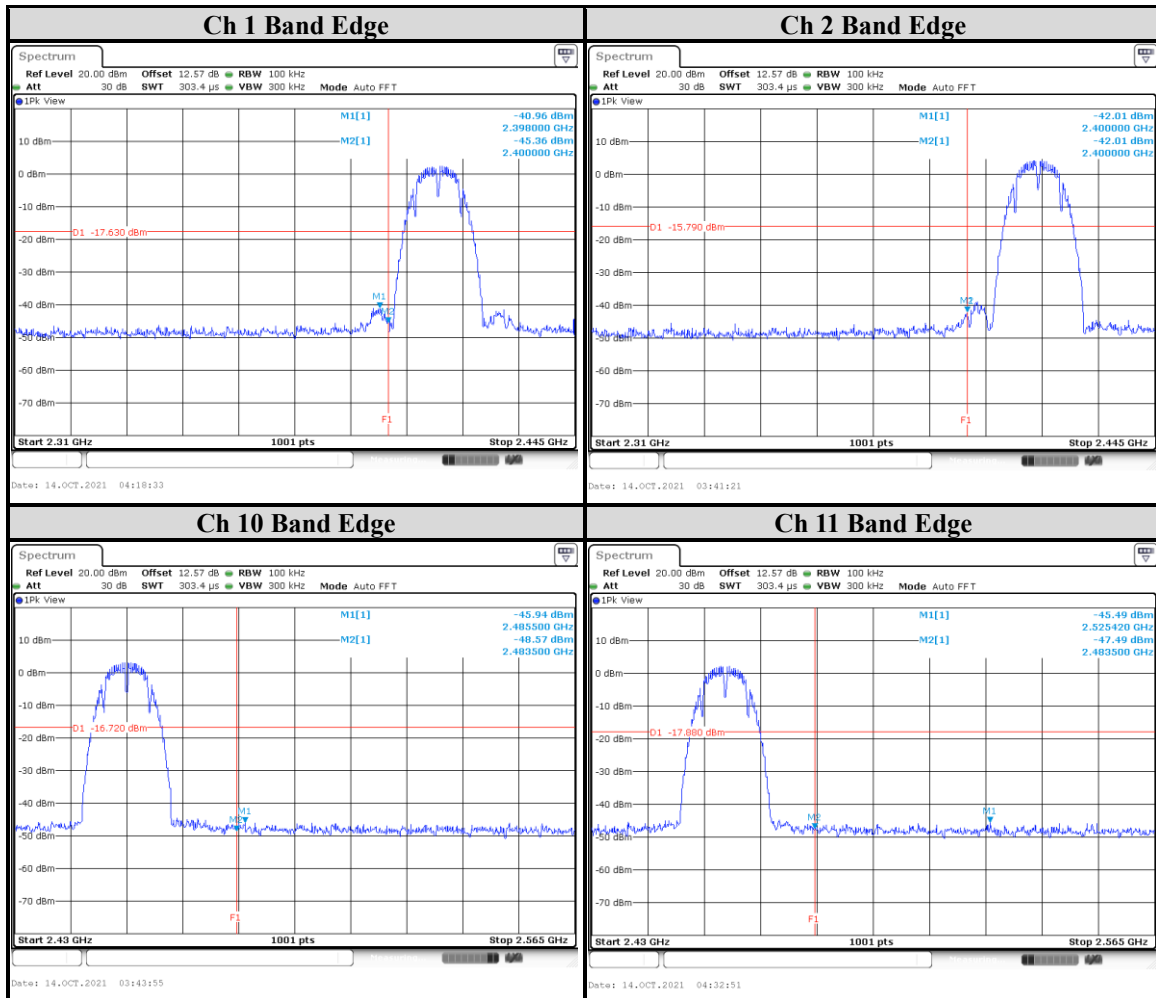
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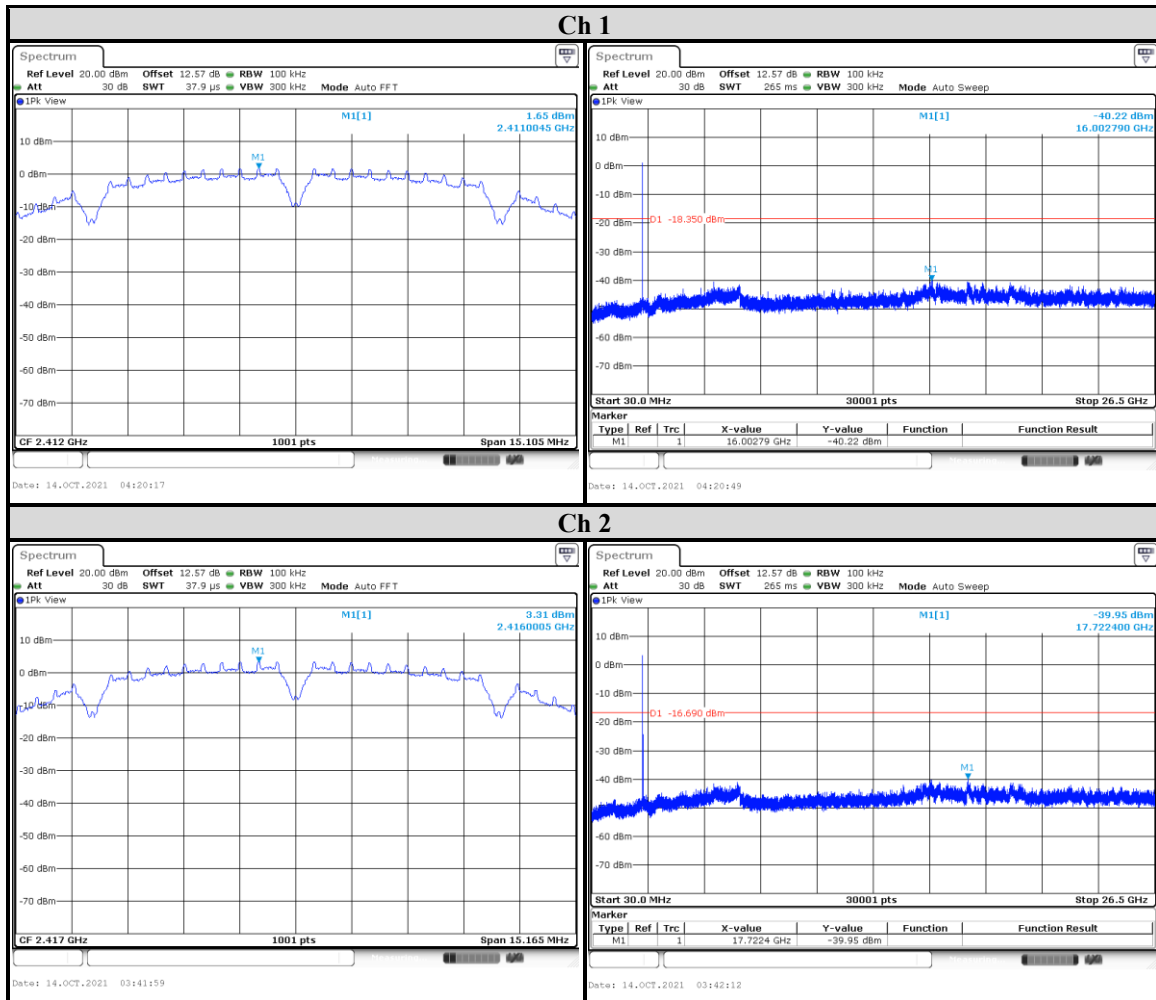
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Chain 1



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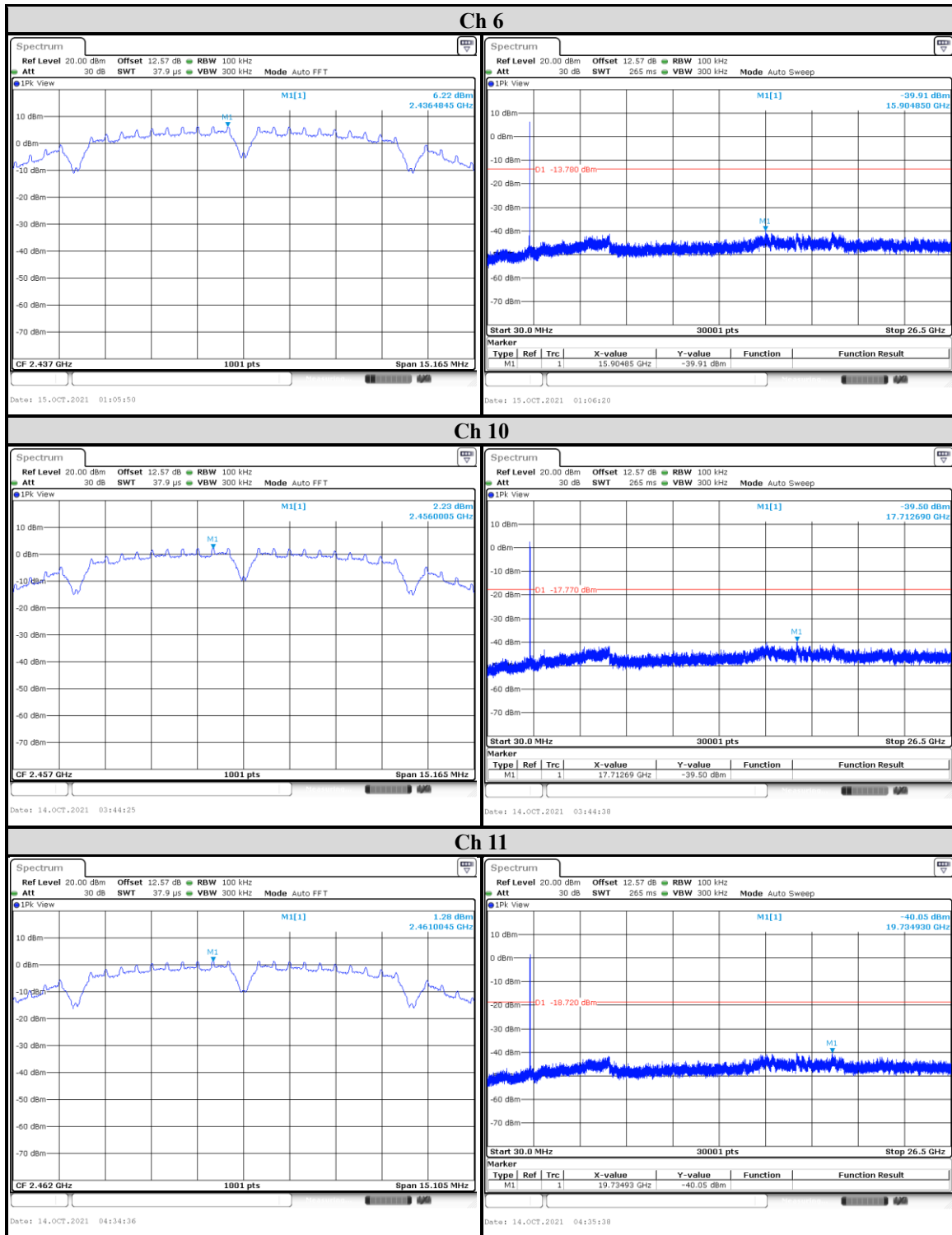
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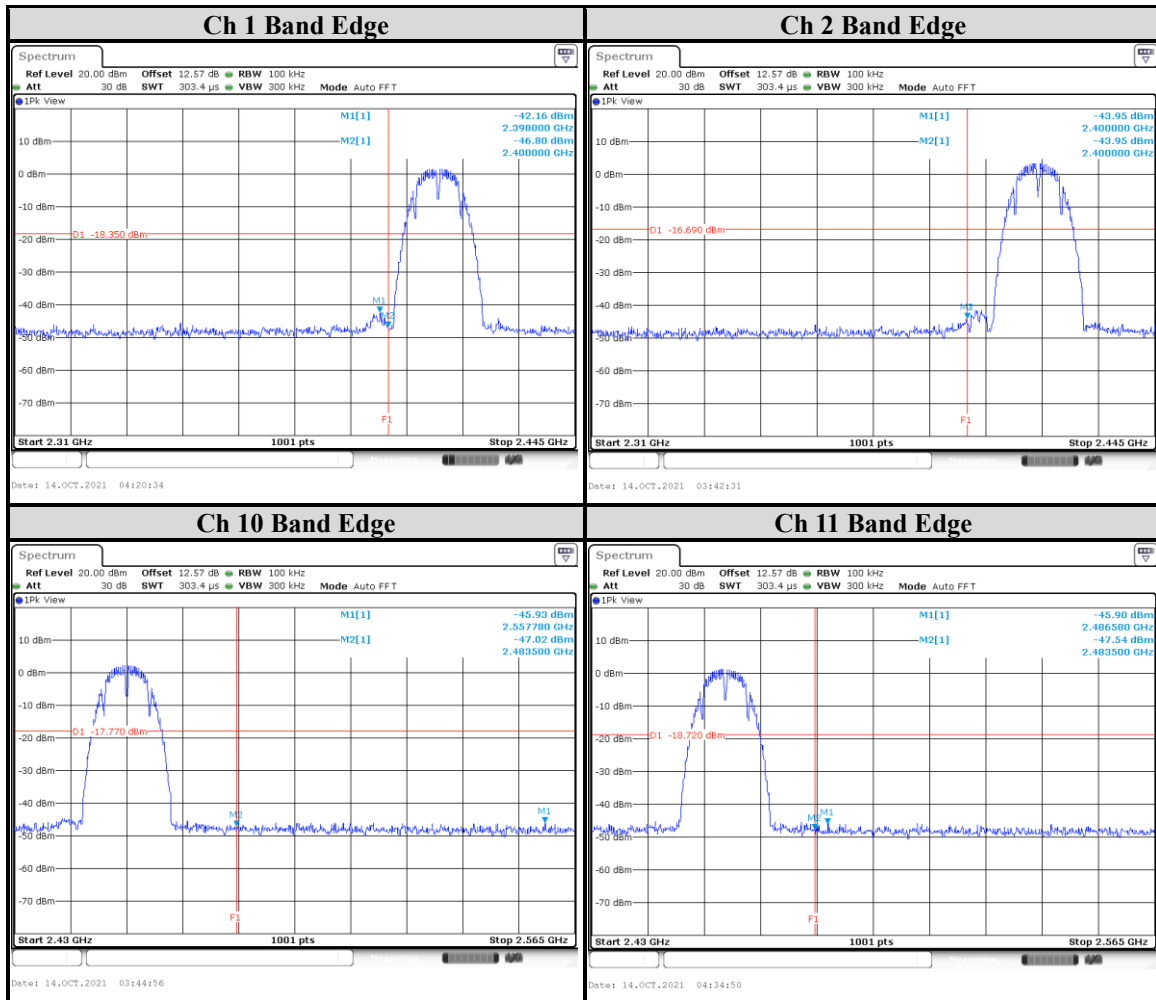
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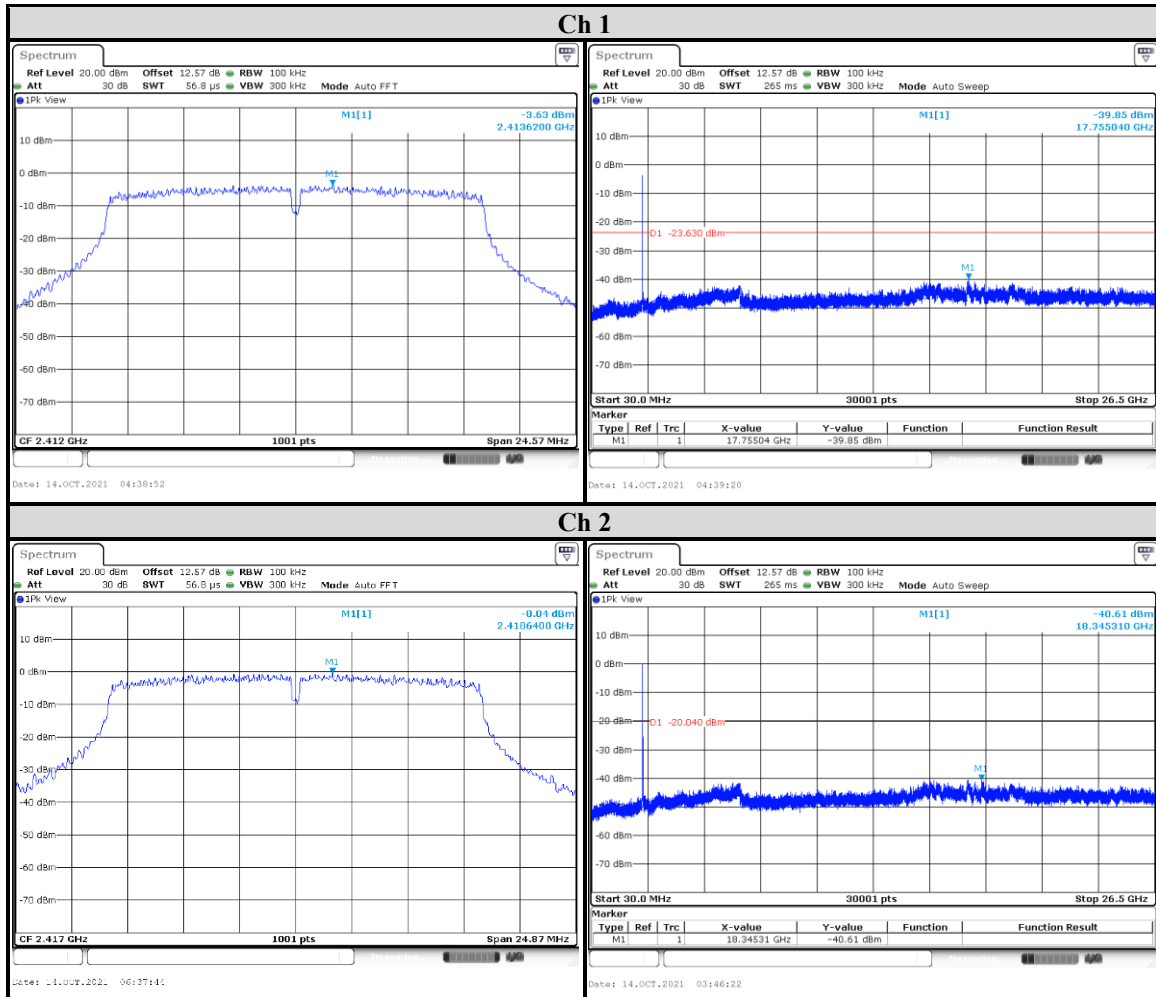
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802.11g
Chain 0



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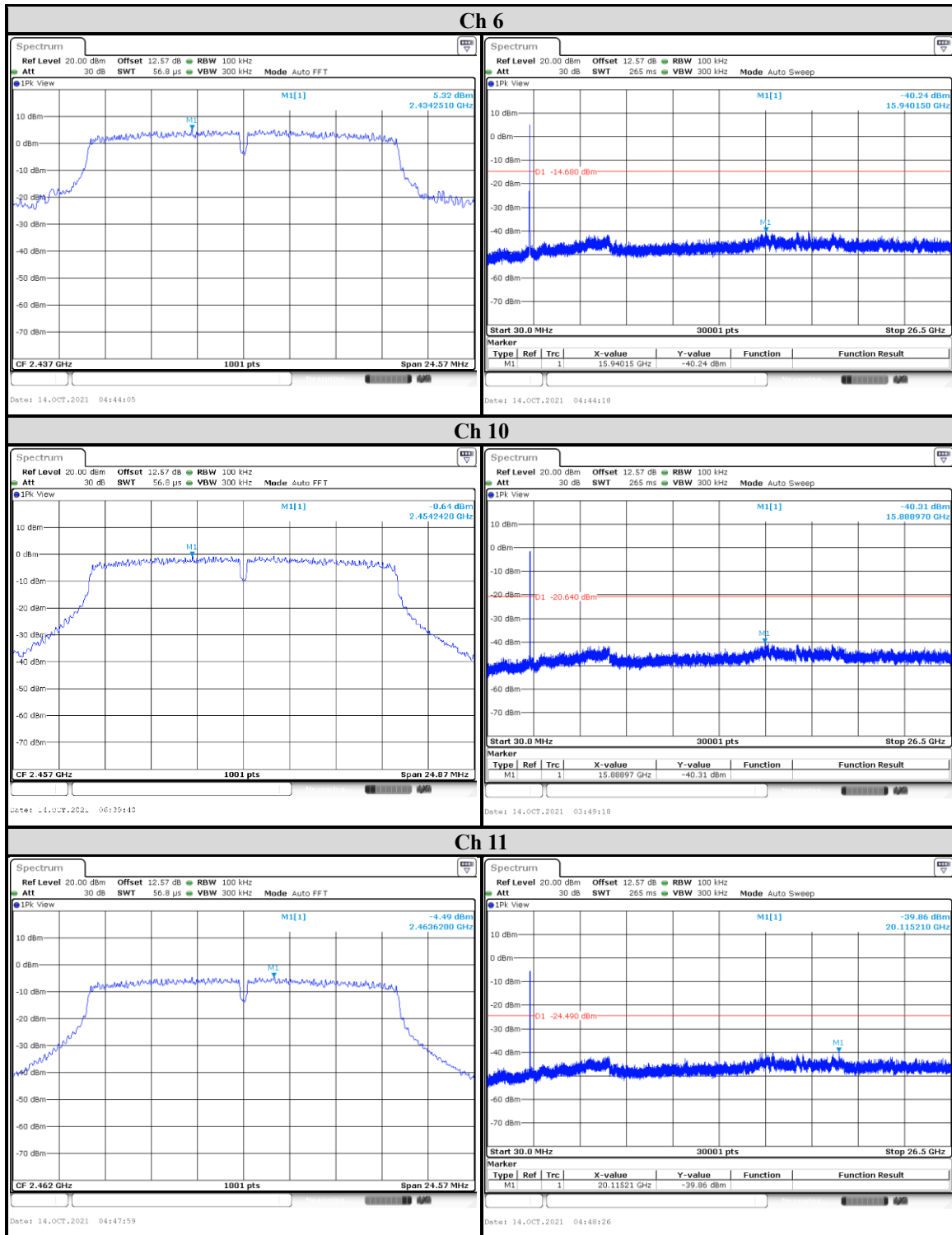
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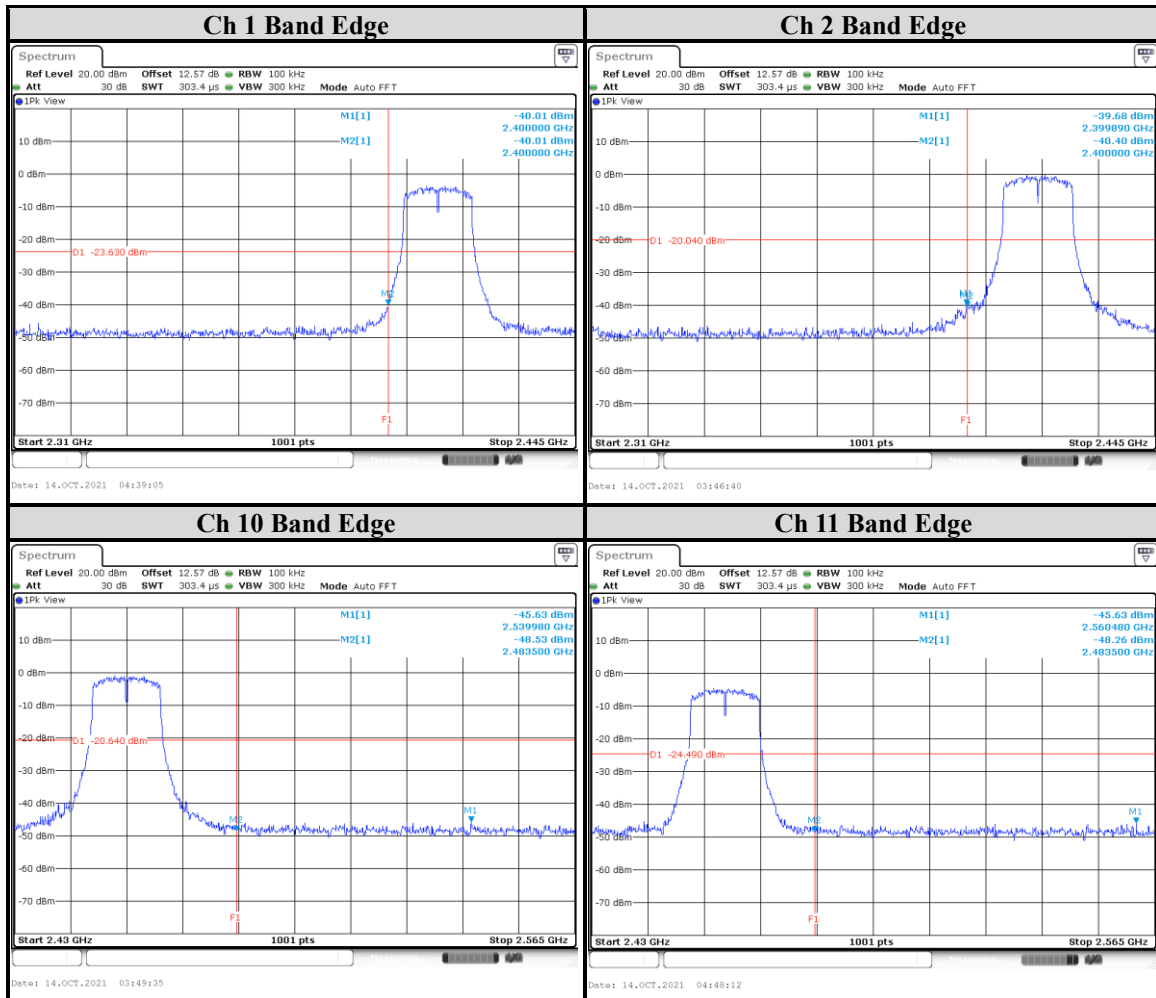
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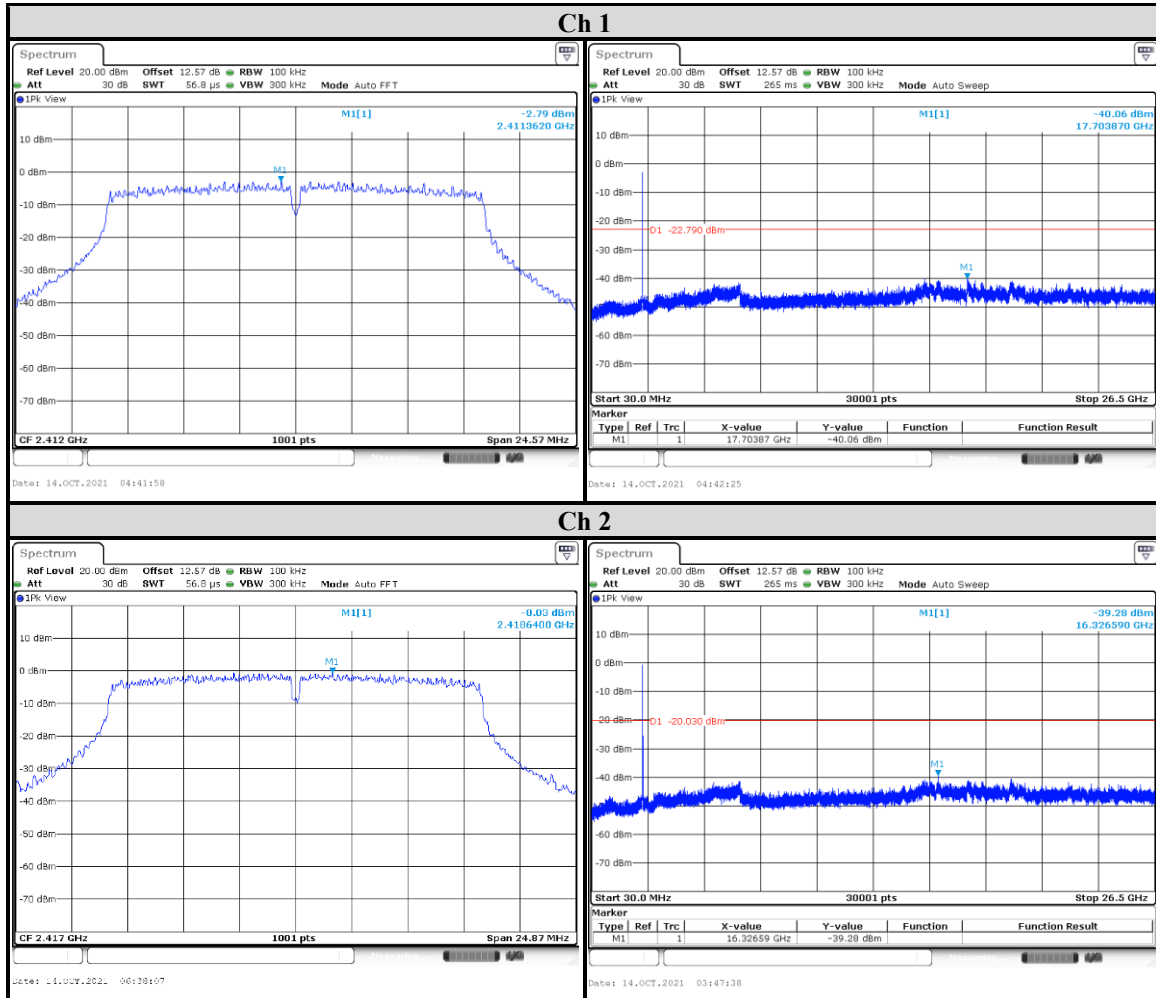
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Chain 1



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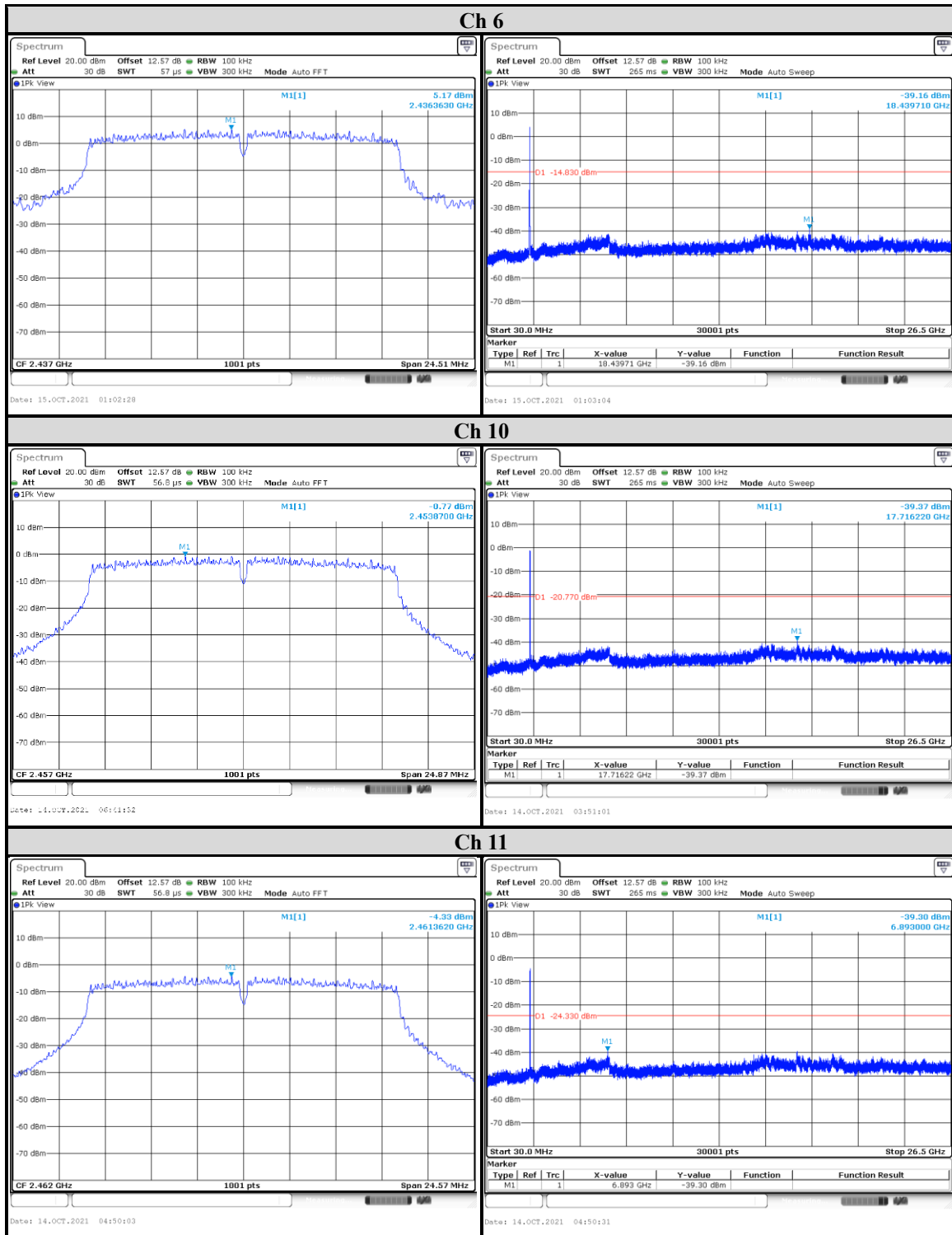
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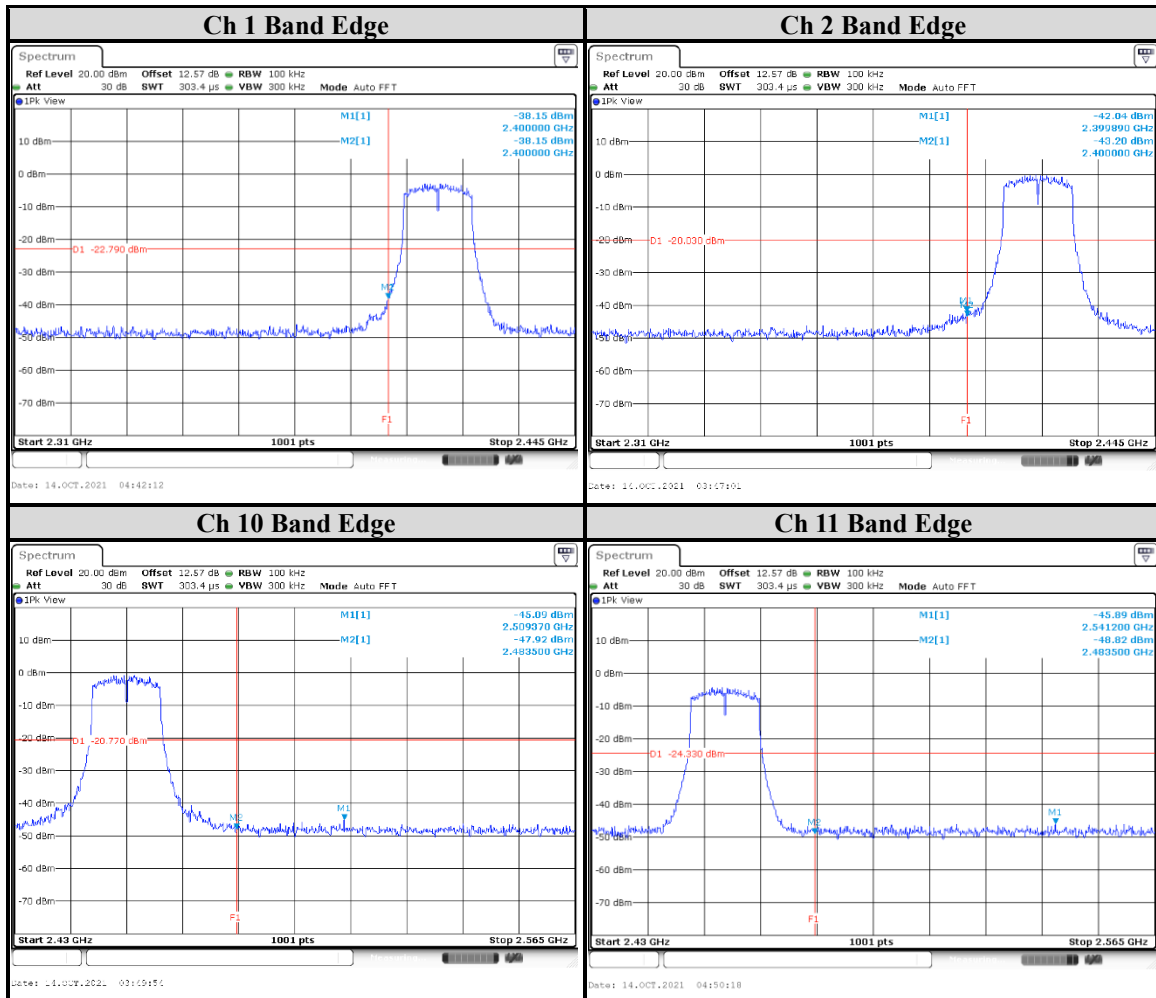
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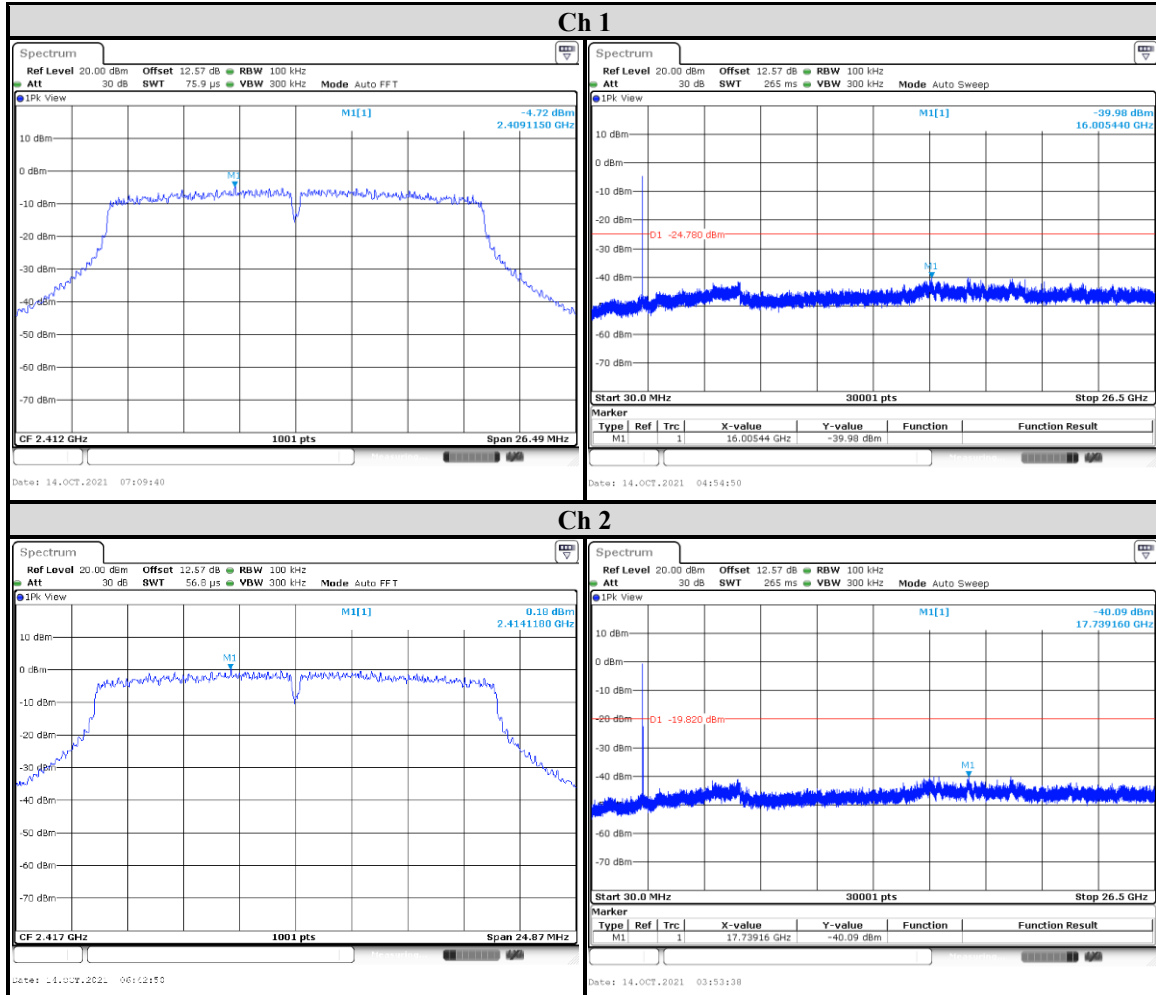
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802.11n (HT20)

Chain 0



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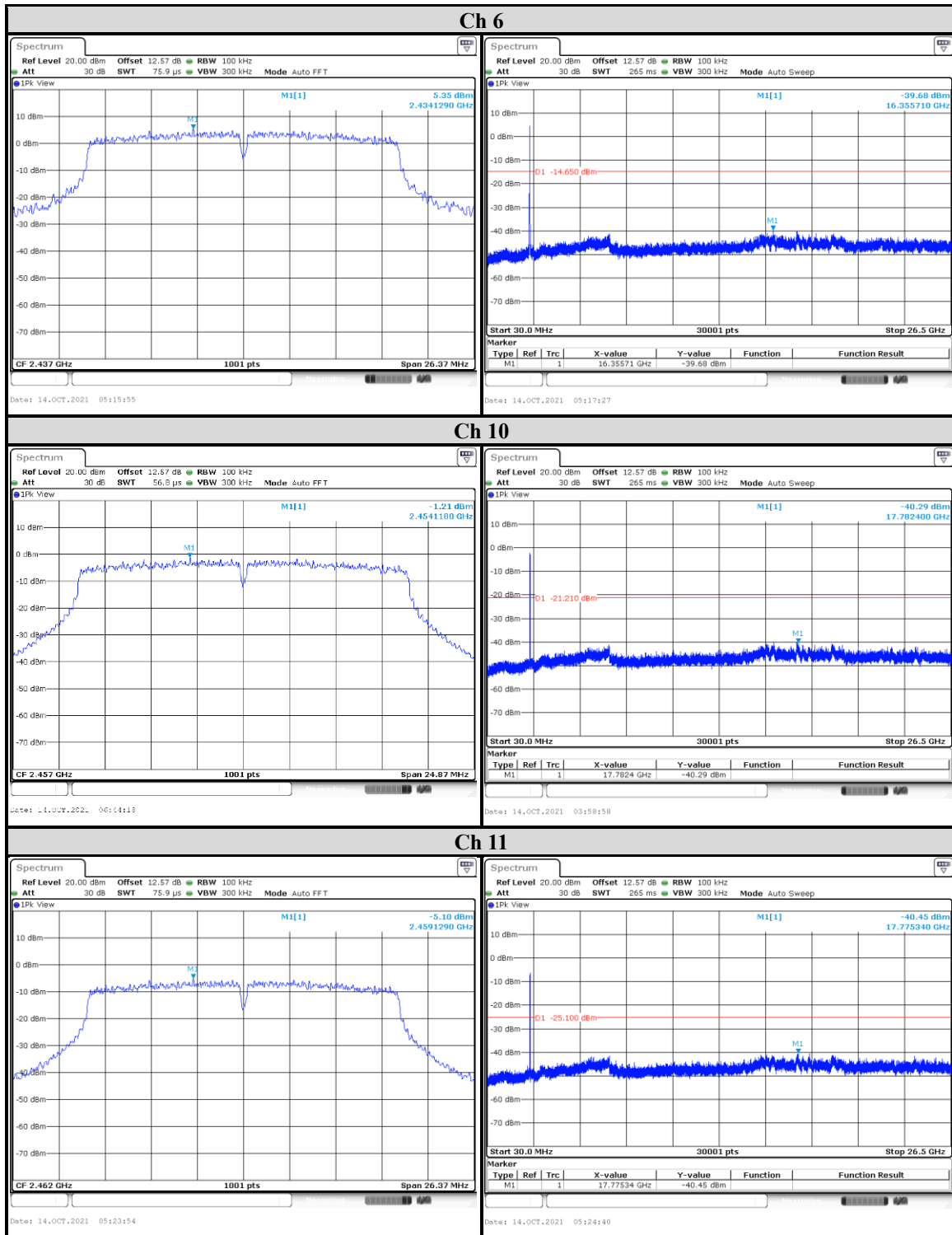
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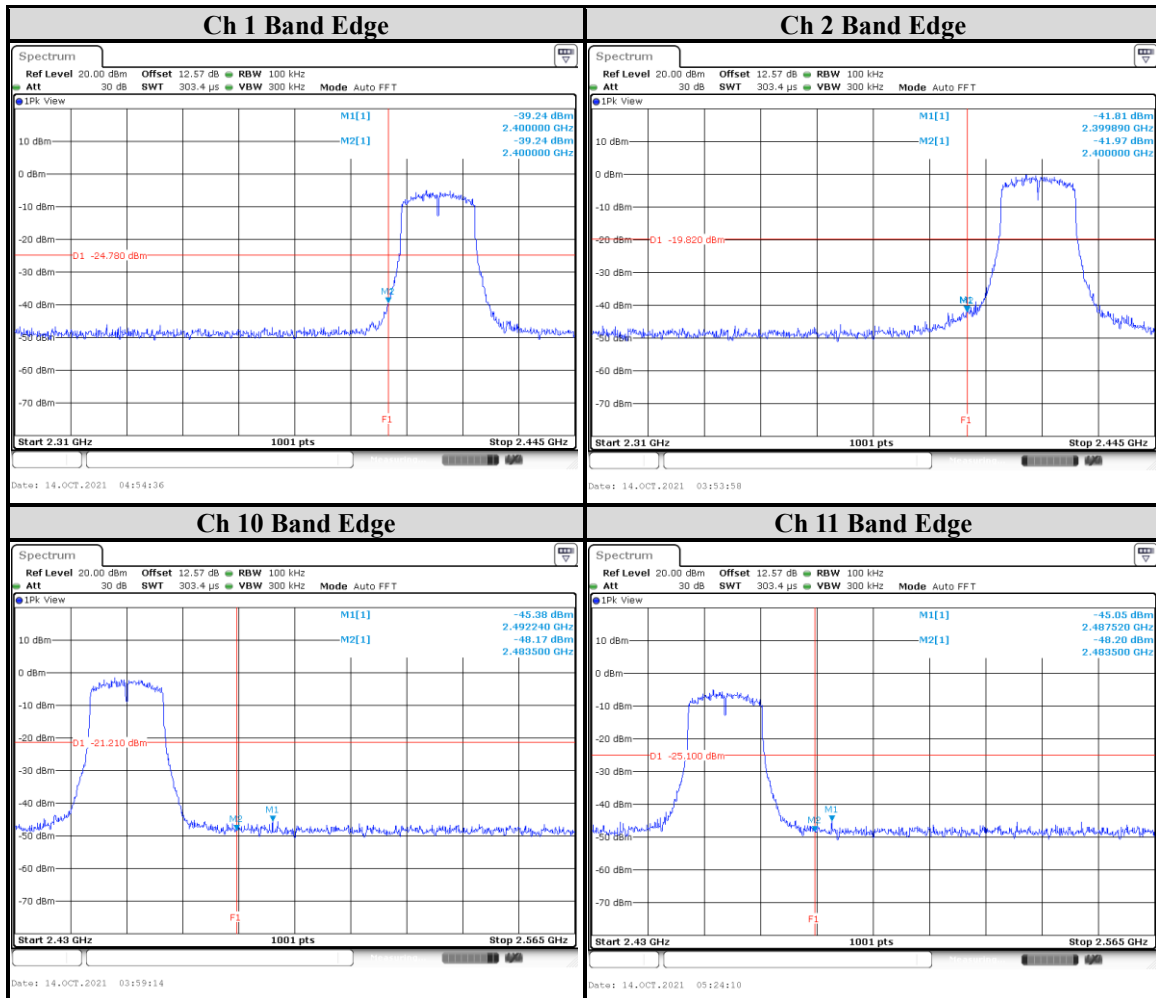
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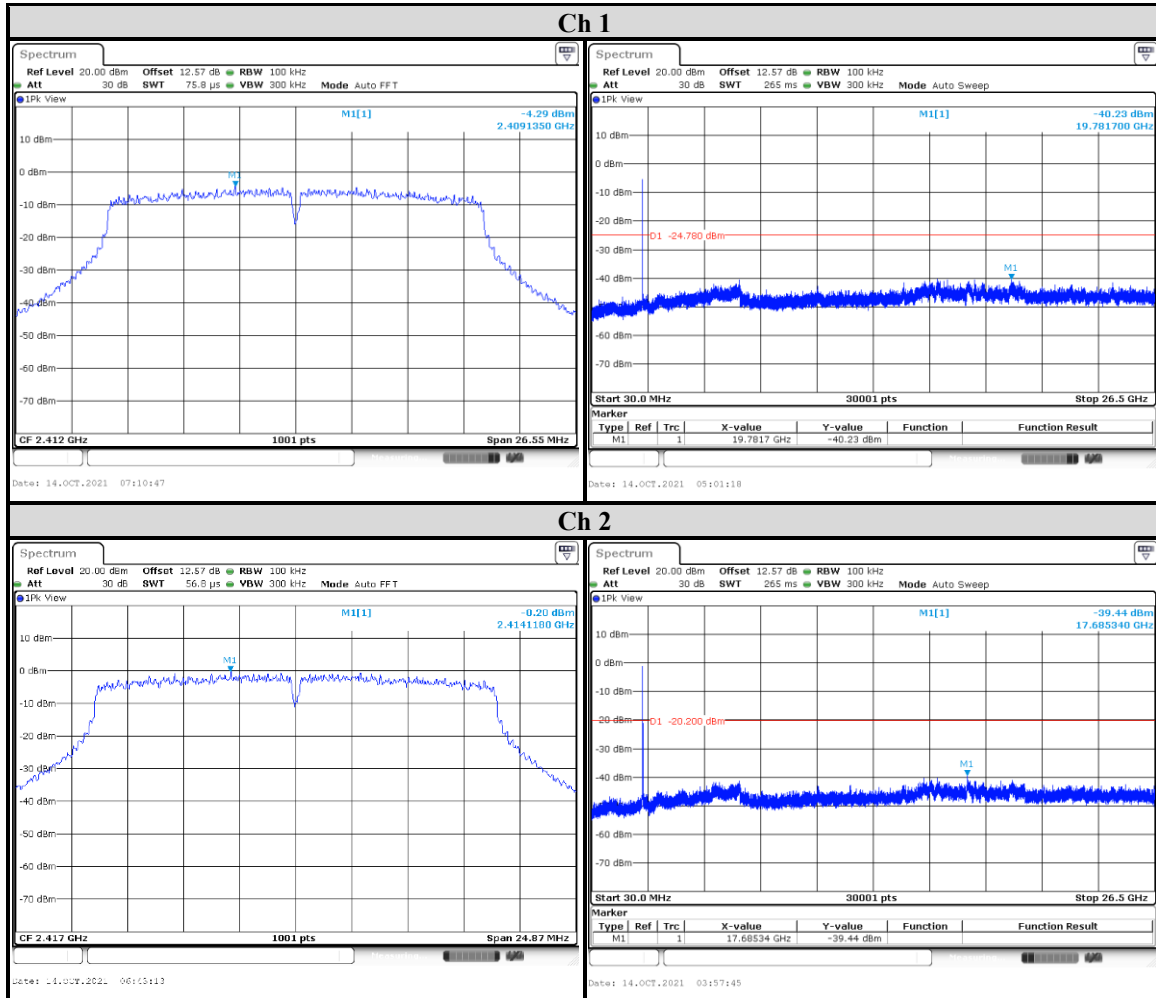
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Chain 1



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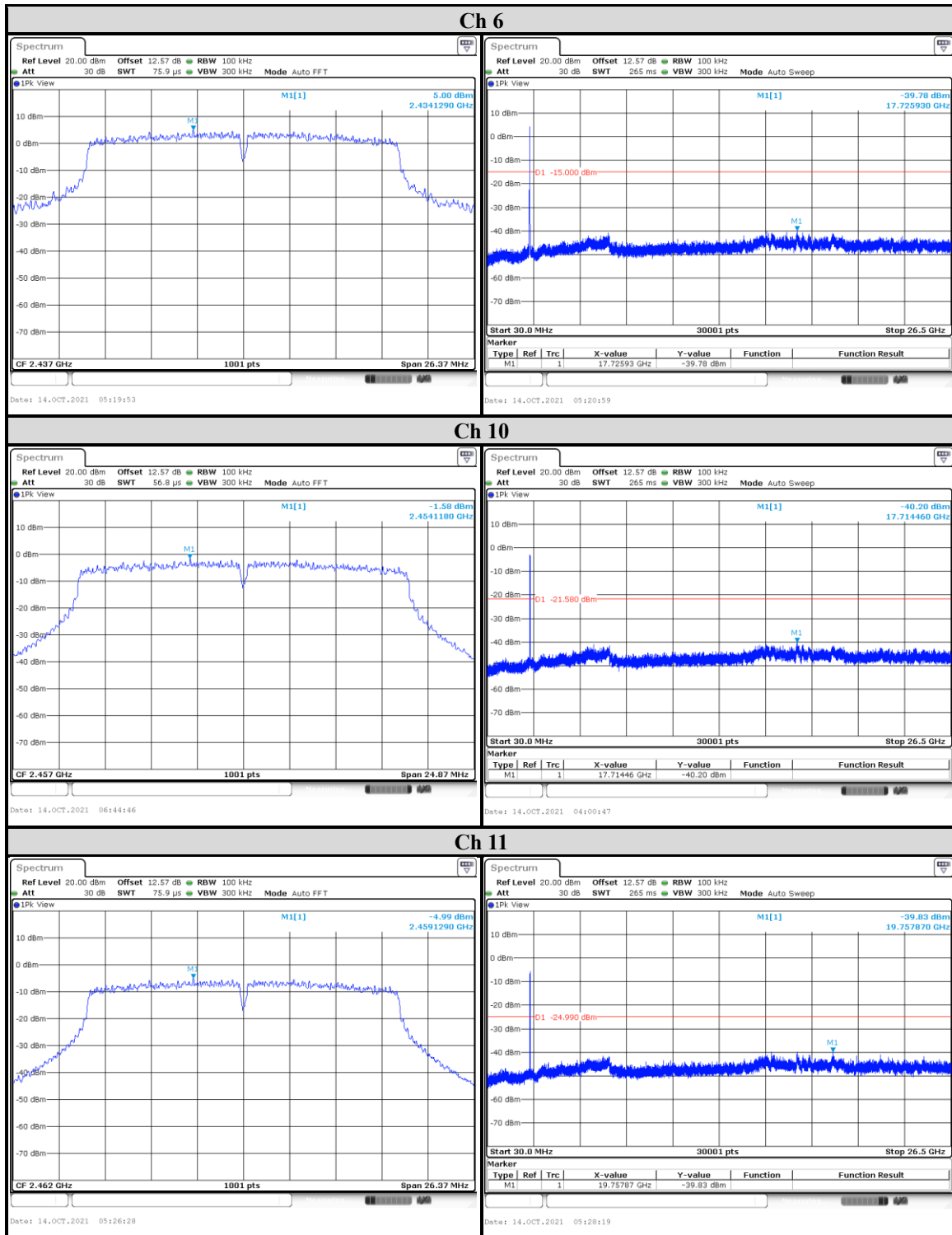
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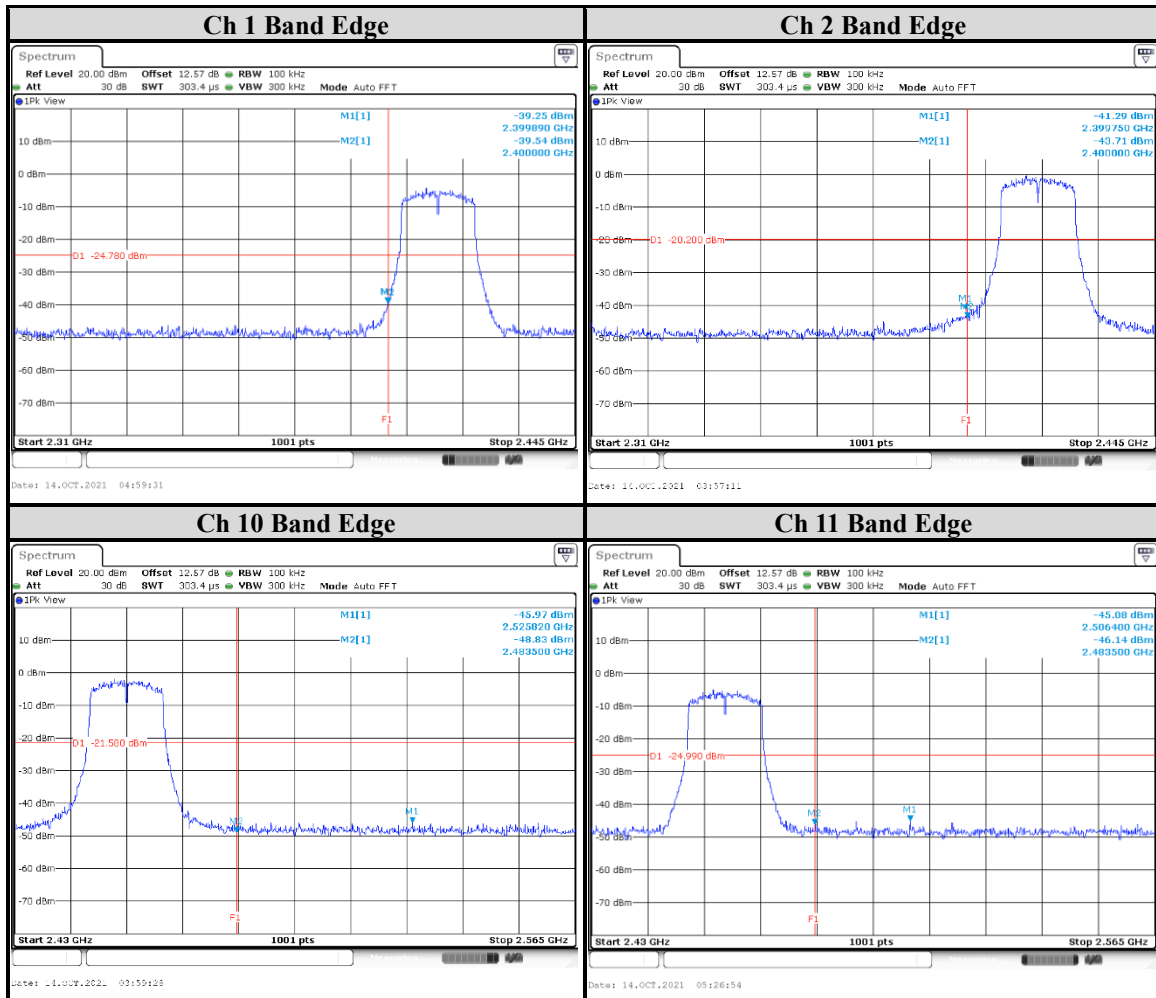
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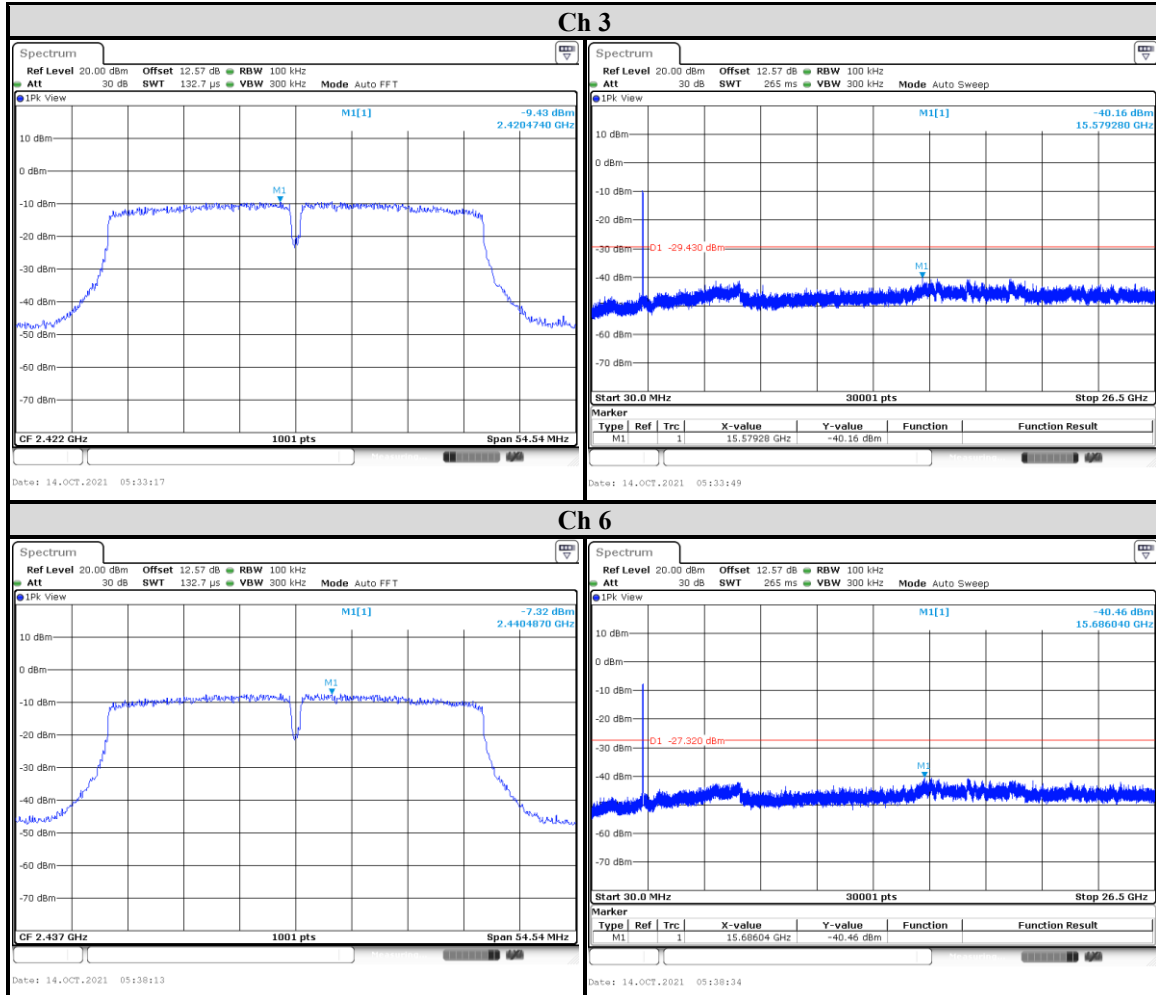
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802.11n (HT40)

Chain 0



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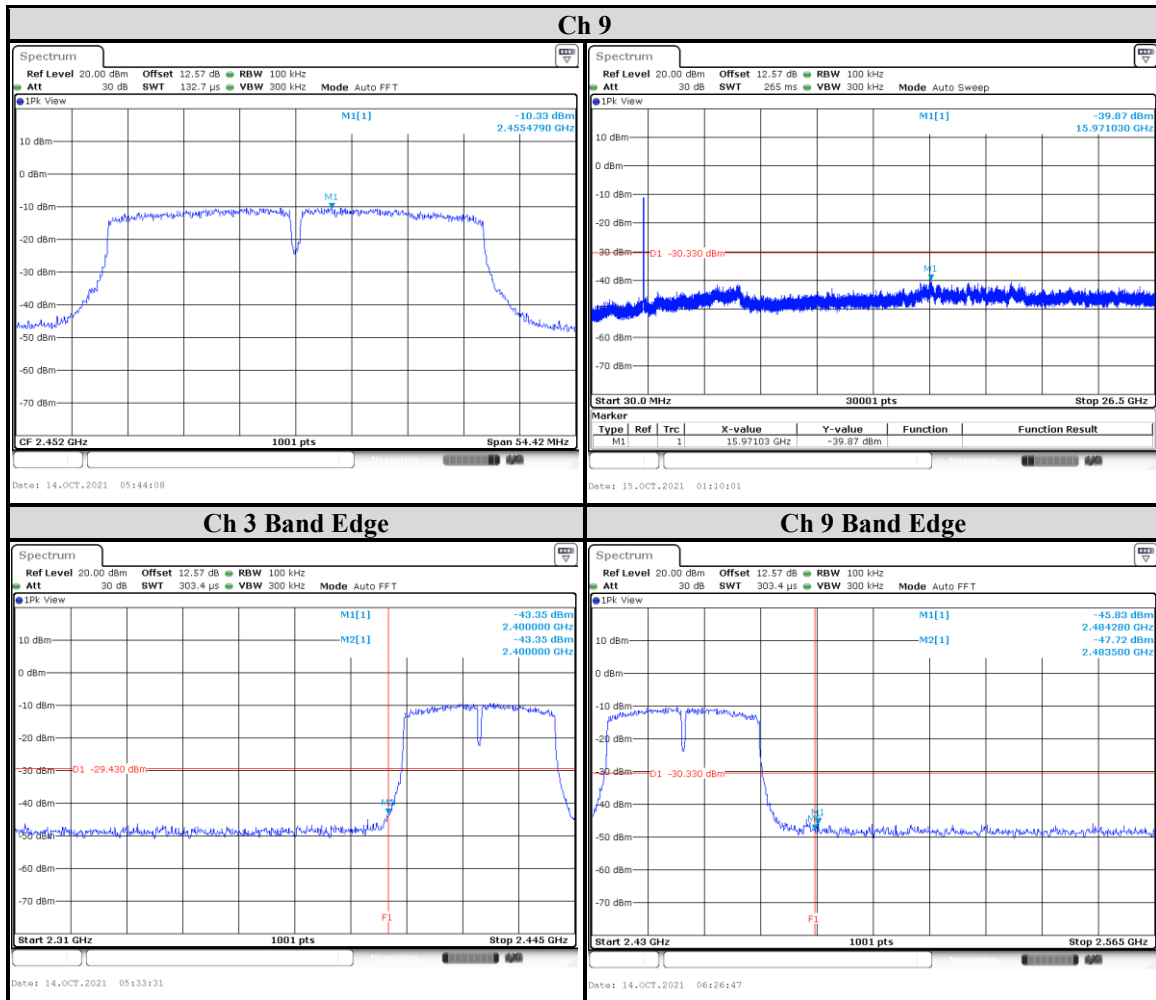
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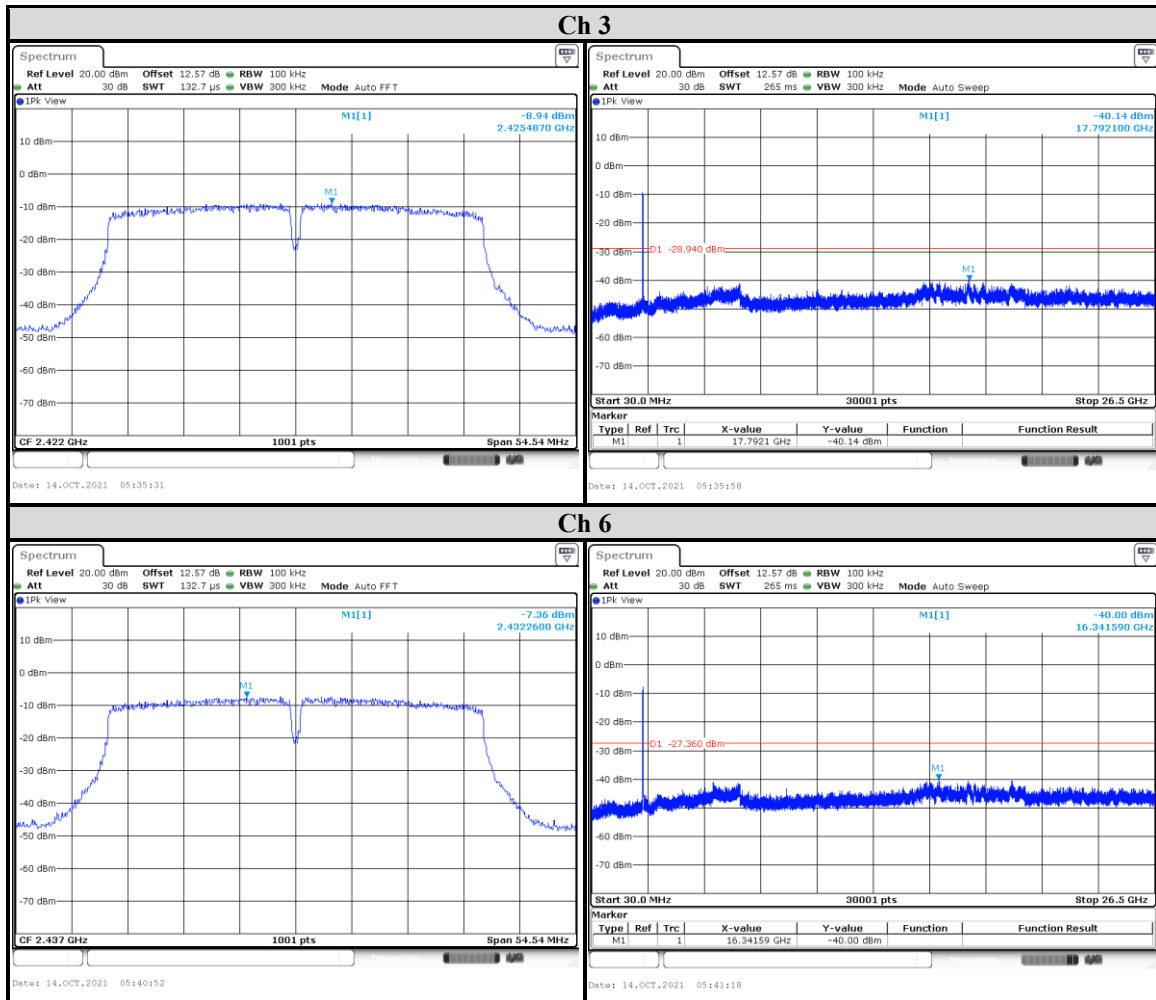
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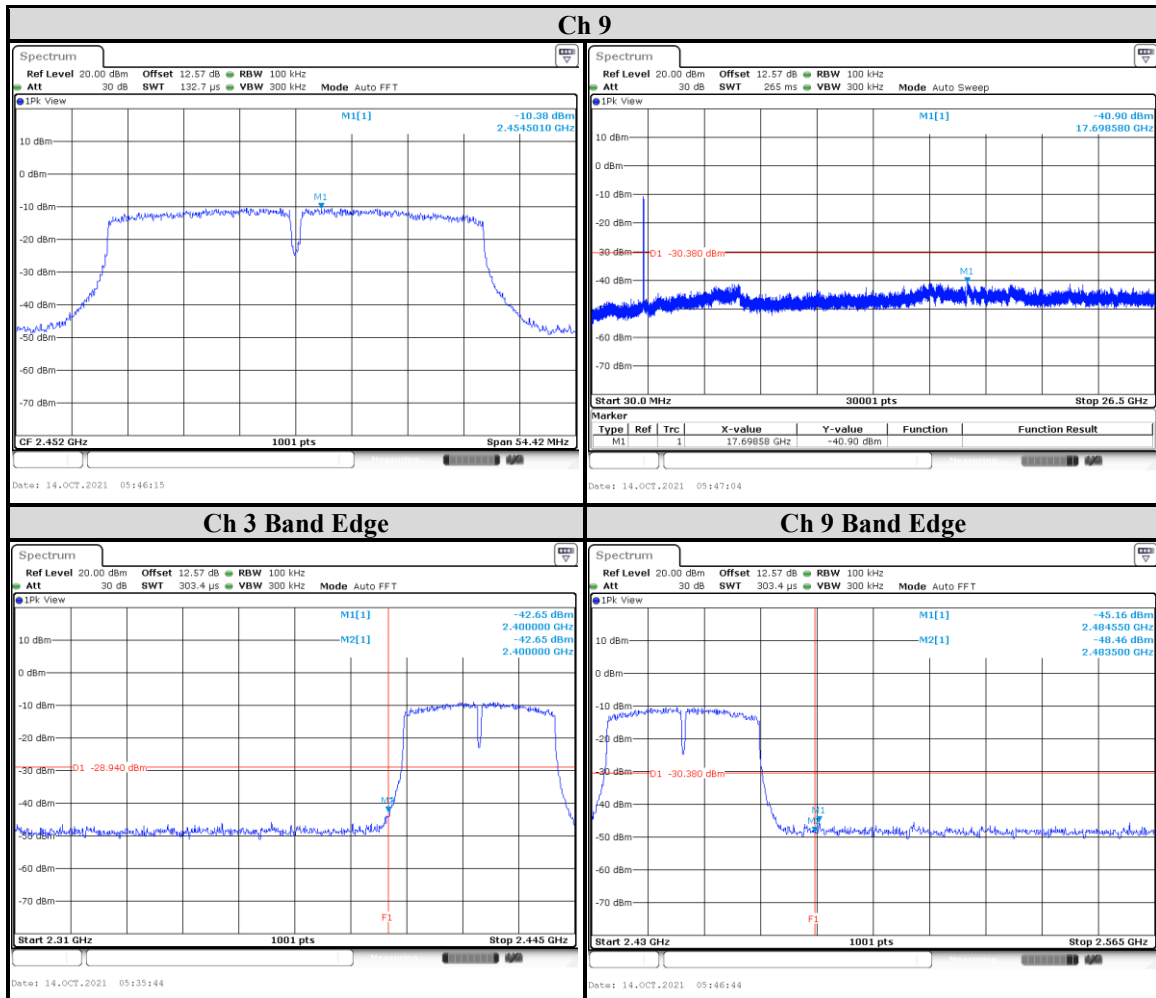
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9.5. Radiated Spurious Emission

Requirements

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table. Other emissions shall be at least 20dB below the highest level of the desired power:

Frequency(MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

NOTE:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

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Test Procedures

[For 9 kHz ~ 30 MHz]

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. For measurement below 30MHz, the initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured. If the emission level of the EUT measured by the peak detector is lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9kHz at frequency below 30MHz.

[For above 30 MHz]

- a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. For measurement below 1GHz, the initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured. If the emission level of the EUT measured by the peak detector is lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.
- f. The test-receiver system was set to peak and average detects function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

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Note:

- The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
- The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
- The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is $\geq 1/T$ (Duty cycle $< 98\%$) or 10Hz (Duty cycle $\geq 98\%$) for Average detection (AV) at frequency above 1GHz.

Configuration	Average	
	RBW	VBW
802.11b	1MHz	10Hz
802.11g		10Hz
802.11n (HT20)		10Hz
802.11n (HT40)		10Hz

Note: Refer to section 6.6 for duty cycle.

- All modes of operation were investigated (includes all external accessories) and the worst-case emissions are reported, the other emission levels were low against the limit.
- Test data of Result value (dBuV/m) = Reading value (dBuV/m) + Correction Factor (dB/m).
- Test data of Margin(dB) = Result value (dBuV/m) - Limit value (dBuV/m).
- Test data of Correction Factor (dB/m) = Antenna Factor (dBuV/m) + Cable Loss (dB) - Preamp Factor (dB).
- Test data of Notation "@" = Fundamental Frequency
- Test data of Notation "*" = The peak result under 20 dB above and complies with AVG limit, AVG result is deemed to comply with AVG limit.

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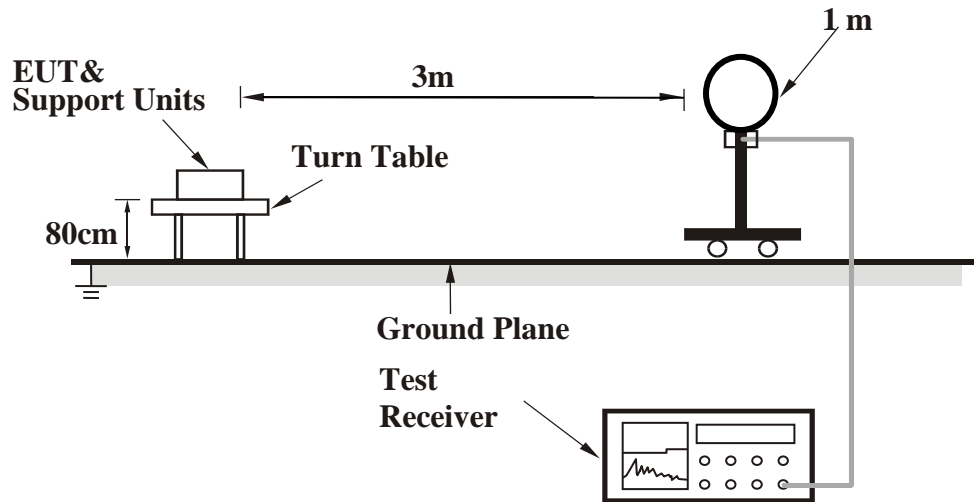
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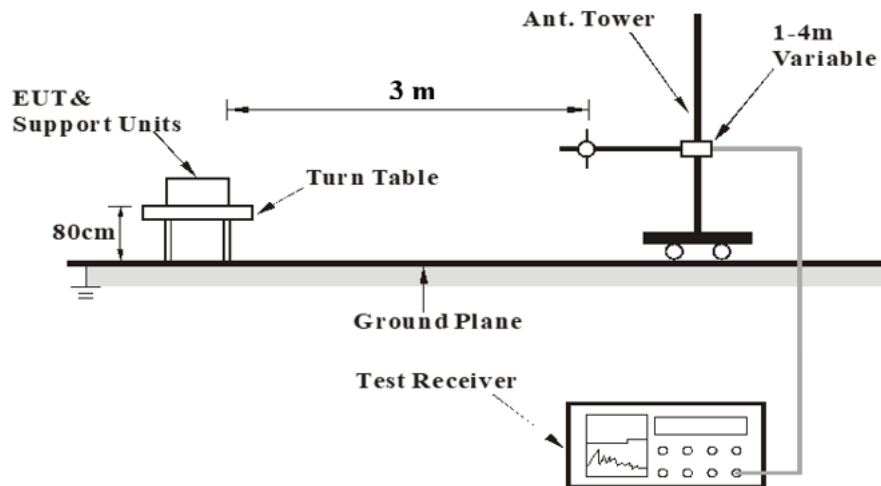
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Test Setup

<Frequency Range 9 kHz ~ 30 MHz>



<Frequency Range 30 MHz ~ 1 GHz >



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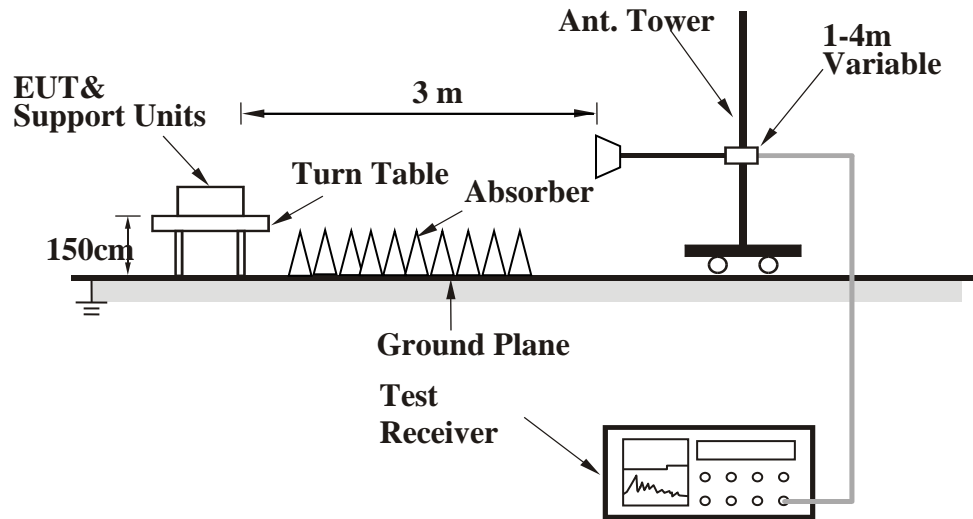
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<Frequency Range above 1 GHz>



For the actual test configuration, please refer to the Setup Configurations.

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Test Data

Dipole Antenna

Above 1G

Mode	802.11b	Channel	1
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Polarization	Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
		(MHz)	(dBuV)	(dB/m)	(dBuV/m)	(dBuV/m)	(dB)	
Horizontal		2321.59	41.97	6.15	48.12	74	-25.88	PK
		2332.04	33.49	6.1	39.59	54	-14.41	AVG
	@	2412	94.46	6.13	100.59	N/A	N/A	PK
	@	2412	90.75	6.13	96.88	N/A	N/A	AVG
	*	4824	37.43	2.55	39.98	74	-34.02	PK
Vertical		2386	51.34	6.09	57.43	74	-16.57	PK
		2386.19	46.14	6.09	52.23	54	-1.77	AVG
	@	2412	103.57	6.13	109.7	N/A	N/A	PK
	@	2412	100.34	6.13	106.47	N/A	N/A	AVG
	*	4824	39.8	2.55	42.35	74	-31.65	PK

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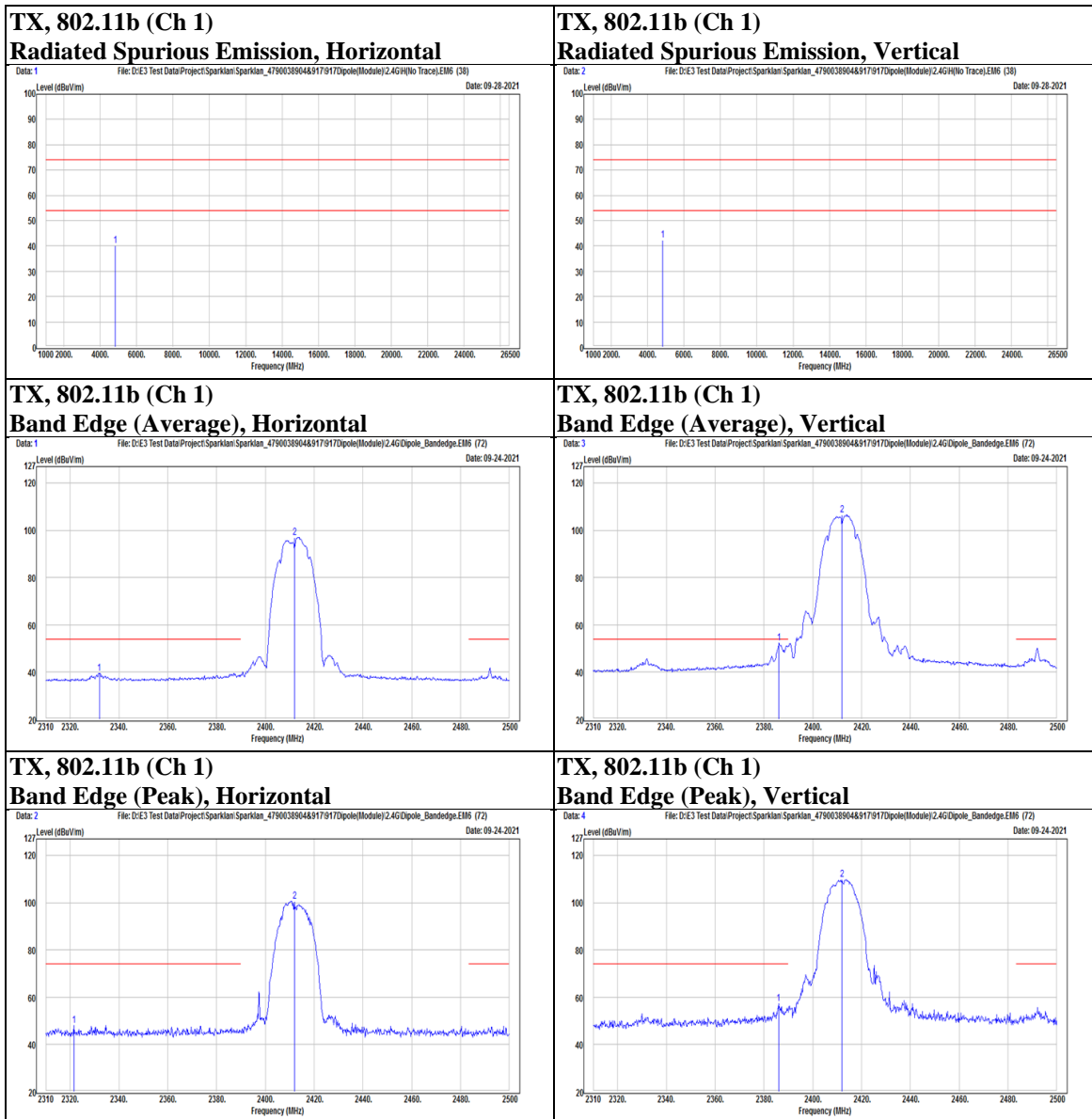
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Mode	802.11b	Channel	2
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Polarization	Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
		(MHz)	(dBuV)	(dB/m)	(dBuV/m)	(dBuV/m)	(dB)	
Horizontal		2332.99	42.72	6.1	48.82	74	-25.18	PK
		2336.98	35.73	6.08	41.81	54	-12.19	AVG
	@	2417	100.73	6.13	106.86	N/A	N/A	PK
	@	2417	94.05	6.13	100.18	N/A	N/A	AVG
	*	4834	35.75	2.61	38.36	74	-35.64	PK
Vertical		2386.95	46.79	6.1	52.89	54	-1.11	AVG
		2387.52	49.85	6.1	55.95	74	-18.05	PK
	@	2417	106.37	6.13	112.5	N/A	N/A	PK
	@	2417	101.81	6.13	107.94	N/A	N/A	AVG
	*	4834	35.19	2.61	37.8	74	-36.2	PK

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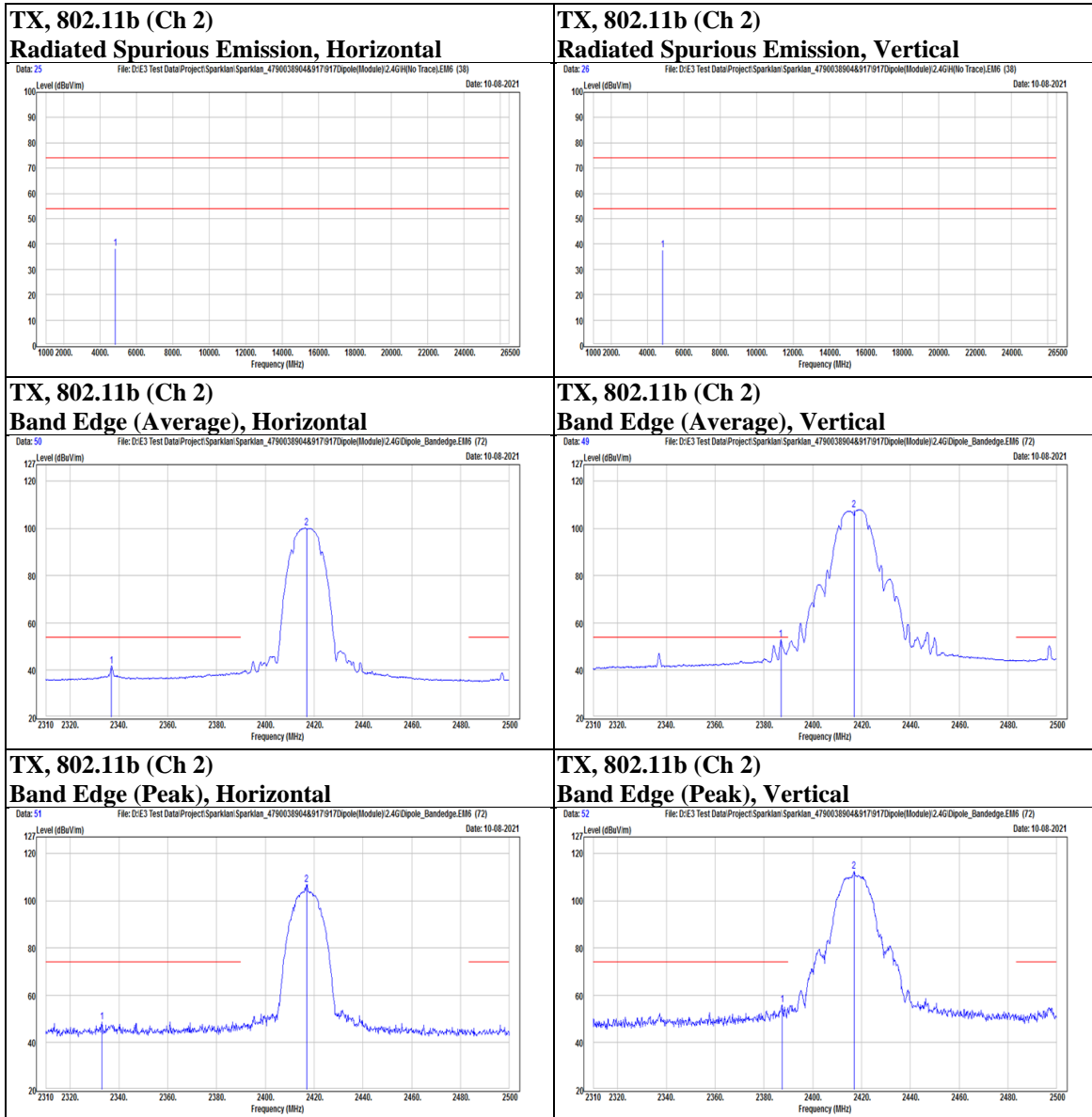
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Mode	802.11b	Channel	6
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Polarization	Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
		(MHz)	(dBuV)	(dB/m)	(dBuV/m)	(dBuV/m)	(dB)	
Horizontal		2353.7	41.32	6.04	47.36	74	-26.64	PK
		2358.45	32.97	6.05	39.02	54	-14.98	AVG
	@	2437	98.67	6.12	104.79	N/A	N/A	PK
	@	2437	96.45	6.12	102.57	N/A	N/A	AVG
		2484.42	32.03	6.1	38.13	54	-15.87	AVG
		2493.35	41.36	6.1	47.46	74	-26.54	PK
	*	4874	38.09	2.66	40.75	74	-33.25	PK
Vertical		2388.85	50.11	6.1	56.21	74	-17.79	PK
		2389.04	45.79	6.1	51.89	54	-2.11	AVG
	@	2437	107.21	6.12	113.33	N/A	N/A	PK
	@	2437	103.75	6.12	109.87	N/A	N/A	AVG
		2484.99	51.91	6.1	58.01	74	-15.99	PK
		2484.99	46.81	6.1	52.91	54	-1.09	AVG
	*	4874	38.61	2.66	41.27	74	-32.73	PK

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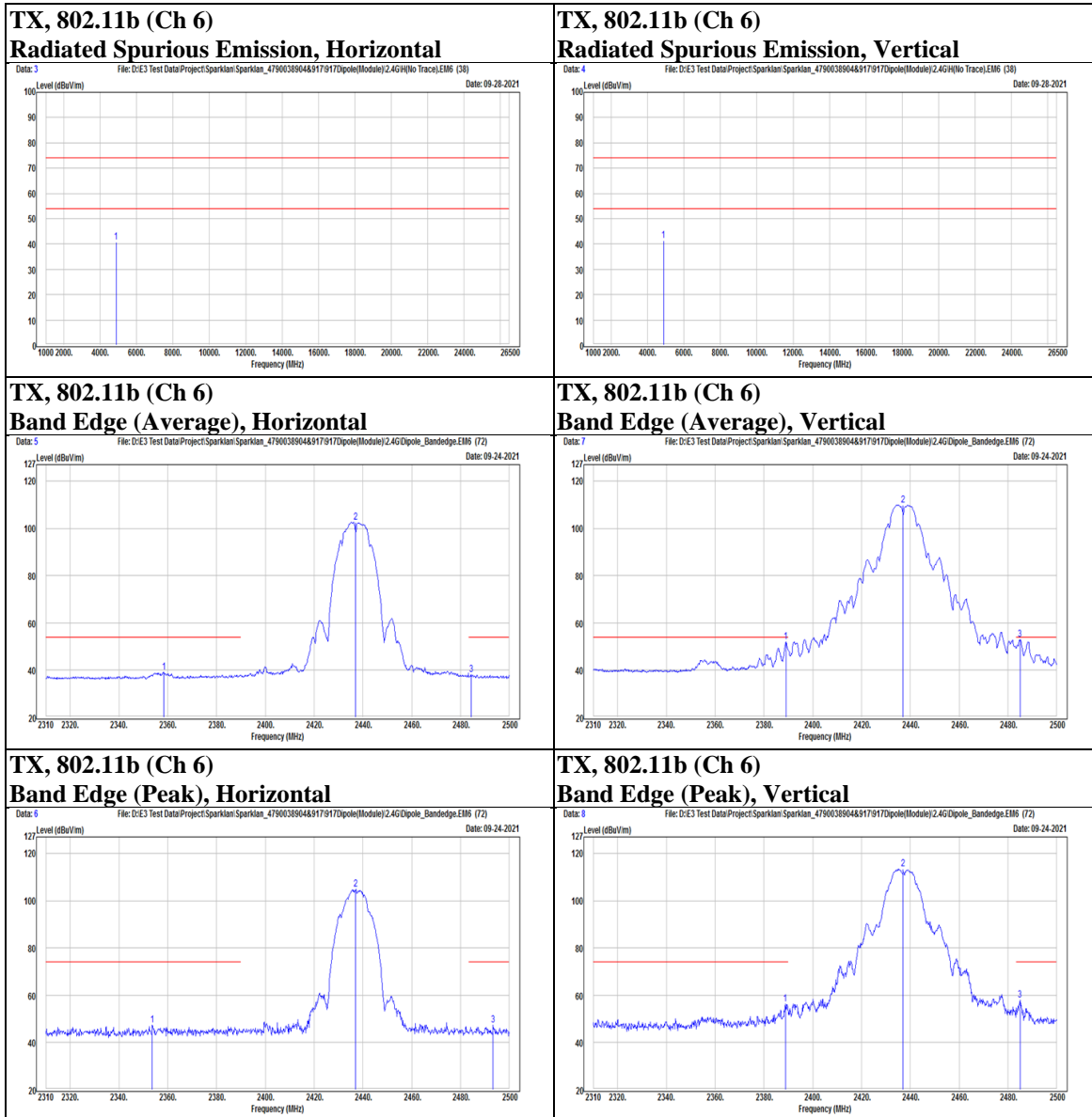
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