



FCC RF Test Report

APPLICANT : iRobot Corporation
EQUIPMENT : Wichita
BRAND NAME : iRobot
MODEL NAME : AXD-Y1
FCC ID : UFEAXD-Y1
STANDARD : FCC Part 15 Subpart C §15.247
CLASSIFICATION : (DTS) Digital Transmission System

The product was received on Mar. 07, 2019 and testing was completed on Apr. 17, 2019. We, Sporton International (Shenzhen) 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.

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

Approved by: Eric Shih / Manager



Sporton International (Shenzhen) Inc.

***1/F, 2/F, Bldg 5, Shiling Industrial Zone, Xinwei Village, Xili, Nanshan, Shenzhen City,
Guangdong Province 518055, China***



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REVISION HISTORY

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR930701-01B	Rev. 01	Initial issue of report	Apr. 30, 2019

SUMMARY OF TEST RESULT

Report Section	FCC Rule	Description	Limit	Result	Remark
3.1	15.247(a)(2)	6dB Bandwidth	$\geq 0.5\text{MHz}$	Pass	-
3.1	-	99% Bandwidth	-	Pass	-
3.2	15.247(b)	Conducted Output Power	$\leq 30\text{dBm}$	Pass	-
3.3	15.247(e)	Power Spectral Density	$\leq 8\text{dBm/3kHz}$	Pass	-
3.4	15.247(d)	Conducted Band Edges	$\leq 30\text{dBc}$	Pass	-
		Conducted Spurious Emission		Pass	-
3.5	15.247(d)	Radiated Band Edges and Radiated Spurious Emission	15.209(a) & 15.247(d)	Pass	Under limit 8.56 dB at 2484.440 MHz
3.6	15.203 & 15.247(b)	Antenna Requirement	N/A	Pass	-

Note: The module is powered by the host. When the host will be charged, it will go through the host battery and enter the module power supply, so the conduction test item can be ignored.



1 General Description

1.1 Applicant

iRobot Corporation

8 Crosby Drive, Bedford, Massachusetts 01730, United States

1.2 Manufacturer

Huizhou BYD Electronic Co.,Ltd.

Xiangshui River,Economic Development Zone,Daya Bay,Huizhou,Guangdong Province,P.R.China

1.3 Product Feature of Equipment Under Test

Product Feature	
Equipment	Wichita
Brand Name	iRobot
Model Name	AXD-Y1
FCC ID	UFEAXD-Y1
EUT supports Radios application	WLAN 2.4GHz 802.11b/g/n HT20 WLAN 5GHz 802.11a/n HT20/HT40 WLAN 5GHz 802.11ac VHT20/VHT40/VHT80 Bluetooth LE/GNSS
HW Version	Wichita B2
SW Version	wichita+2.0.0_rc6+wichita+50
EUT Stage	Production Unit

Remark:

1. The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.
2. The antenna provided to the EUT, please refer to the following table.

Antenna No.	Brand	Model	Gain(dBi)	Antenna Type	Frequency range (GHz to GHz)	Cable Length (mm)
1(External)	Laird	EMN2449A2S-16MHF1	3.15	PCB dipole antenna	2.4-2.4835	160
1(External)	Laird	EMN2449A2S-16MHF1	3.38	PCB dipole antenna	5.15-5.25	160
1(External)	Laird	EMN2449A2S-16MHF1	3.38	PCB dipole antenna	5.25-5.35	160
1(External)	Laird	EMN2449A2S-16MHF1	3.51	PCB dipole antenna	5.47-5.725	160
1(External)	Laird	EMN2449A2S-16MHF1	3.23	PCB dipole antenna	5.725-5.85	160
2(External)	Laird	EMN2449A2S-34MHF1	3.15	PCB dipole antenna	2.4-2.4835	340
2(External)	Laird	EMN2449A2S-34MHF1	3.38	PCB dipole antenna	5.15-5.25	340
2(External)	Laird	EMN2449A2S-34MHF1	3.38	PCB dipole antenna	5.25-5.35	340
2(External)	Laird	EMN2449A2S-34MHF1	3.51	PCB dipole antenna	5.47-5.725	340
2(External)	Laird	EMN2449A2S-34MHF1	3.23	PCB dipole antenna	5.725-5.85	340

1.4 Product Specification of Equipment Under Test

Standards-related Product Specification			
Tx/Rx Channel Frequency Range		2412 MHz ~ 2462 MHz	
Maximum Output Power to antenna		SISO <Ant. 1> 802.11b : 14.40 dBm (0.02754 W) 802.11g : 15.00 dBm (0.03162 W) 802.11n HT20 : 14.10 dBm (0.02570 W) SISO <Ant. 2> 802.11b : 14.20 dBm (0.02630 W) 802.11g : 15.20 dBm (0.03311 W) 802.11n HT20 : 13.90 dBm (0.02455 W) MIMO <Ant. 1 + 2> 802.11n HT20 : 16.41 dBm (0.04375 W)	
99% Occupied Bandwidth		802.11b : 13.19MHz 802.11g : 16.53MHz 802.11n HT20 : 17.68MHz	
Antenna Type / Gain		Ant.1/Ant.2:PCB dipole Antenna type with gain 3.15 dBi	
Antenna Function Description		Ant. 1	Ant. 2
	802.11b/g/n SISO	V	V
	802.11n MIMO	V	
Type of Modulation		802.11b : DSSS (DBPSK / DQPSK / CCK) 802.11g/n : OFDM (BPSK / QPSK / 16QAM / 64QAM)	

Note:

1. For 802.11n HT20 SISO & MIMO mode, the whole testing has assessed only MIMO mode by referring to their higher conducted power.
2. For 802.11b/g SISO mode, the whole testing has assessed 11b of Ant 1 and 11g of Ant 2 mode by referring to their higher conducted power for RSE testing.

1.5 Modification of EUT

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



1.6 Testing Location

Sporton International (Shenzhen) Inc. is accredited to ISO 17025 by National Voluntary Laboratory Accreditation Program (NVLAP code: 600156-0).

Test Site	Sporton International (Shenzhen) Inc.		
Test Site Location	1/F, 2/F, Bldg 5, Shiling Industrial Zone, Xinwei Village, Xili, Nanshan, Shenzhen City, Guangdong Province 518055, China TEL: +86-755-8637-9589 FAX: +86-755-8637-9595		
Test Site No.	Sporton Site No.	FCC designation No.	FCC Test Firm Registration No.
	TH01-SZ	CN5018	337463

Test Site	Sporton International (Shenzhen) Inc.		
Test Site Location	No. 3 Bldg the third floor of south, Shahe River west, Fengzeyuan Warehouse, Nanshan District, Shenzhen City, Guangdong Province 518055, China TEL: +86-755- 3320-2398		
Test Site No.	Sporton Site No.	FCC designation No.	FCC Test Firm Registration No.
	03CH01-SZ	CN5019	577730

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
- ♦ FCC KDB 662911 D01 Multiple Transmitter Output v02r01.
- ♦ ANSI C63.10-2013

Remark: All test items were verified and recorded according to the standards and without any deviation during the test.

2 Test Configuration of Equipment Under Test

- 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: 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 (X plane) were recorded in this report.

2.1 Carrier Frequency and Channel

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)
2400-2483.5 MHz	1	2412	7	2442
	2	2417	8	2447
	3	2422	9	2452
	4	2427	10	2457
	5	2432	11	2462
	6	2437		



2.2 Test Mode

Final test modes are considering the modulation and worse data rates as below table.

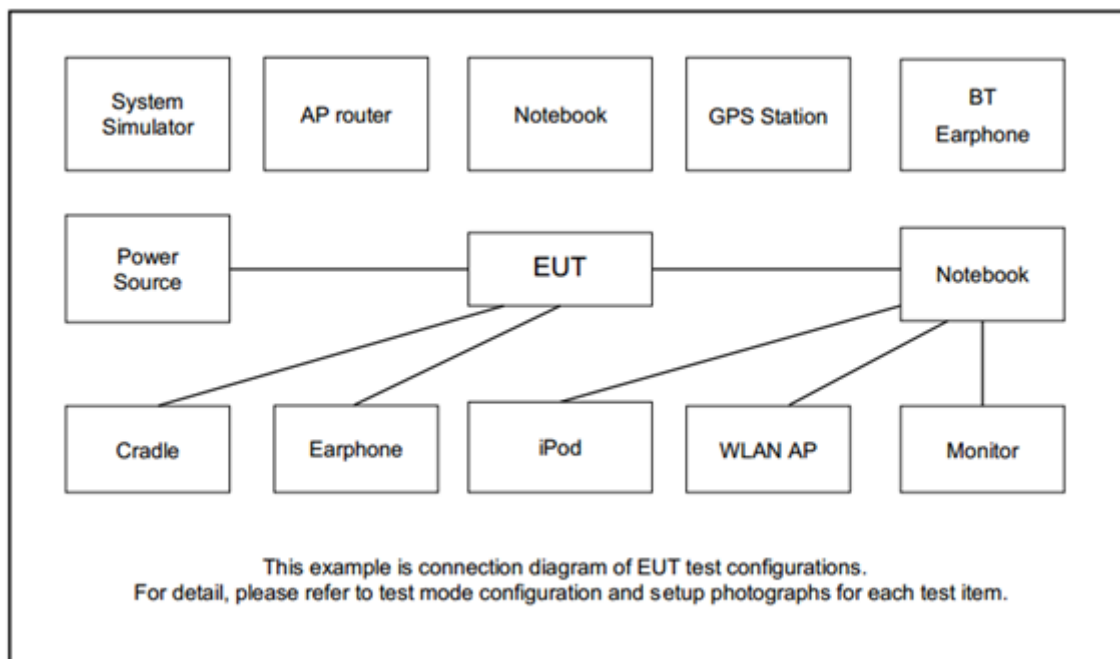
SISO Antenna

Modulation	Data Rate
802.11b	1 Mbps
802.11g	6 Mbps

MIMO Antenna

Modulation	Data Rate
802.11n HT20	MCS0

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.	Battery	N/A	N/A	N/A	N/A	N/A



2.5 EUT Operation Test Setup

For WLAN RF test items, an engineering test program was provided and enabled to make EUT continuous transmit/receive.

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 5.00 dB and 10.00 dB attenuator.

$$\begin{aligned}\text{Offset(dB)} &= \text{RF cable loss(dB)} + \text{attenuator factor(dB)} \\ &= 5.00 + 10.00 = 15.00 \text{ (dB)}\end{aligned}$$

3 Test Result

3.1 6dB and 99% Bandwidth Measurement

3.1.1 Limit of 6dB and 99% Bandwidth

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

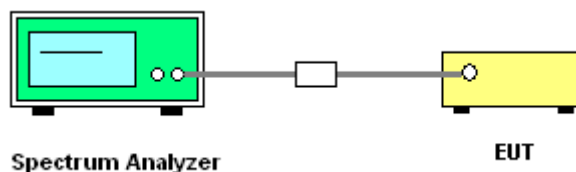
3.1.2 Measuring Instruments

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

3.1.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 11.8
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. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. Set the Video bandwidth (VBW) = 300 kHz. In order to make an accurate measurement. The 6 dB bandwidth must be greater than 500 kHz.
5. For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) = 300KHz and set the Video bandwidth (VBW) = 1MHz.
6. Measure and record the results in the test report.

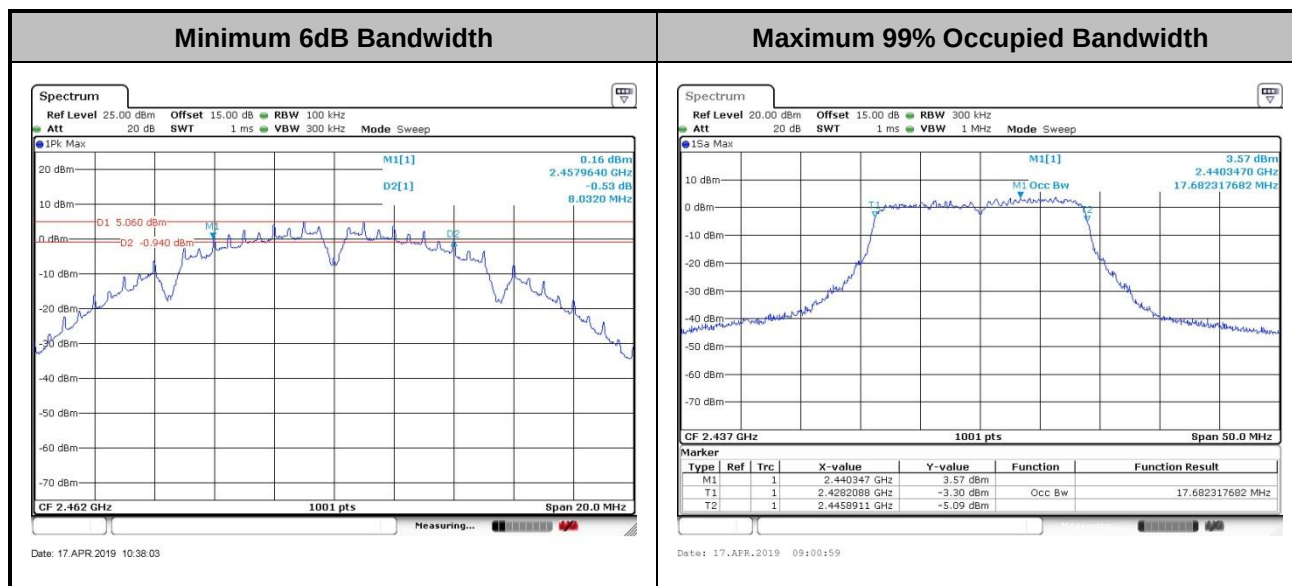
3.1.4 Test Setup





3.1.5 Test Result of 6dB and 99% Occupied Bandwidth

Please refer to Appendix A.



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

3.2 Output Power Measurement

3.2.1 Limit of Output Power

For systems using digital modulation in the 2400-2483.5MHz, the limit for output power is 30dBm. If transmitting antenna with directional gain greater than 6dBi is used, the output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the antenna exceeds 6 dBi. In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

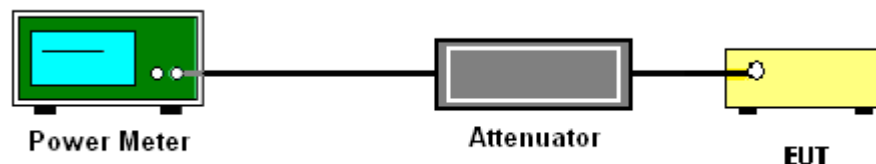
3.2.2 Measuring Instruments

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

3.2.3 Test Procedures

1. The testing follows the Measurement Procedure of ANSI C63.10-2013 clause 11.9.2.3.2 Method AVGPM-G.
2. The RF output of EUT was connected to the power meter 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. Measure the conducted output power and record the results in the test report.
5. For MIMO mode, calculation method follows FCC KDB 662911 D01 Multiple Transmitter Output v02r01.

3.2.4 Test Setup



3.2.5 Test Result of Average output Power

Please refer to Appendix A.

3.3 Power Spectral Density Measurement

3.3.1 Limit of Power Spectral Density

The peak power spectral density shall not be greater than 8dBm in any 3kHz band at any time interval of continuous transmission.

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 Measurement Procedure of ANSI C63.10-2013 clause 11.10.2 Method PKPSD.
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. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 3 kHz. Video bandwidth VBW = 10 kHz In order to make an accurate measurement, set the span to 1.5 times DTS Channel Bandwidth. (6dB BW)
5. Detector = peak, Sweep time = auto couple, Trace mode = max hold, Allow trace to fully stabilize. Use the peak marker function to determine the maximum power level.
6. Measure and record the results in the test report.
7. For MIMO mode, calculation method follows FCC KDB 662911 D01 Multiple Transmitter Output v02r01.

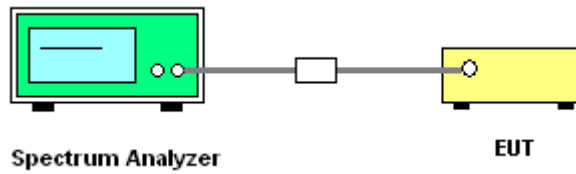
If measurements performed using method (2) plus $10 \log(N)$ exceeds the emission limit, the test should choose method (1) before declaring that the device fails the emission limit.

Method (1): Measure and sum the spectra across the outputs.

The total final Power Spectral Density is from a device with 2 transmitter outputs. The spectrum measurements of the individual outputs are all performed with the same span and number of points, the spectrum value in the first spectral bin of output 1 is summed with that in the first spectral bin of output 2 to obtain the value for the first frequency bin of the summed spectrum.

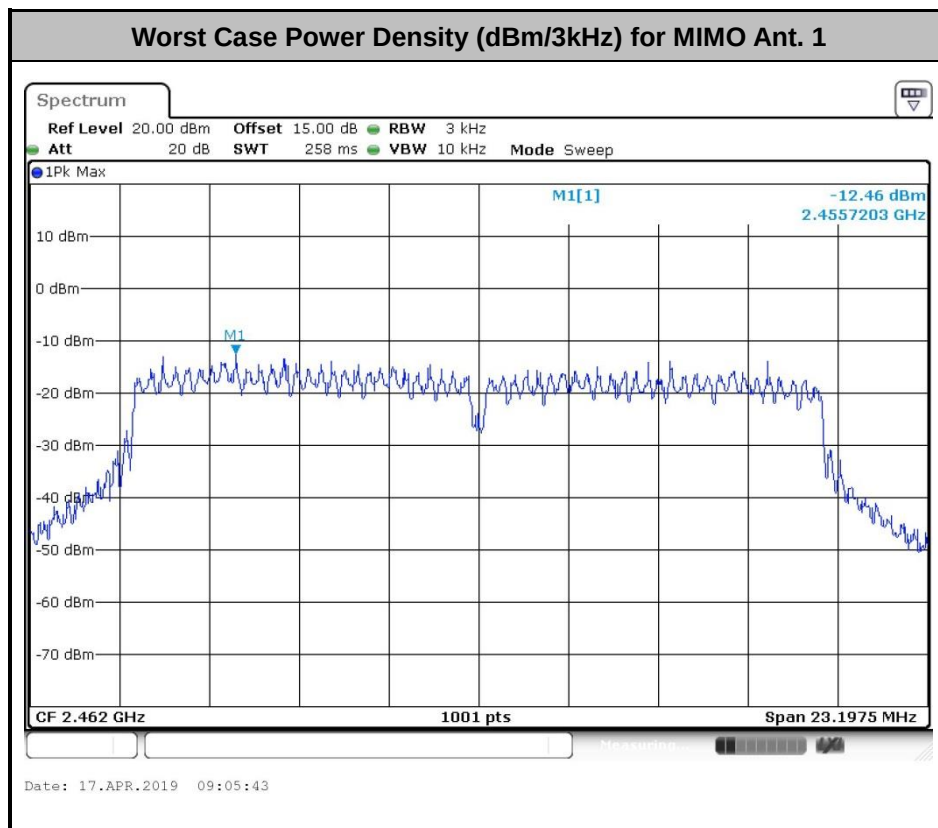
Method (2): Measure and add $10 \log(N)$ dB, where N is the number of outputs. (N=2)

3.3.4 Test Setup



3.3.5 Test Result of Power Spectral Density

Please refer to Appendix A.



3.4 Conducted Band Edges and Spurious Emission Measurement

3.4.1 Limit of Conducted Band Edges and Spurious Emission Measurement

In any 100 kHz bandwidth outside of the authorized frequency band, the emissions which fall in the non-restricted bands shall be attenuated at least 20 dB / 30dB relative to the maximum PSD level in 100 kHz by RF conducted measurement.

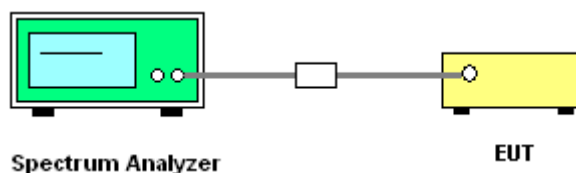
3.4.2 Measuring Instruments

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 11.13
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. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB per 15.247(d).
5. Measure and record the results in the test report.
6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

3.4.4 Test Setup



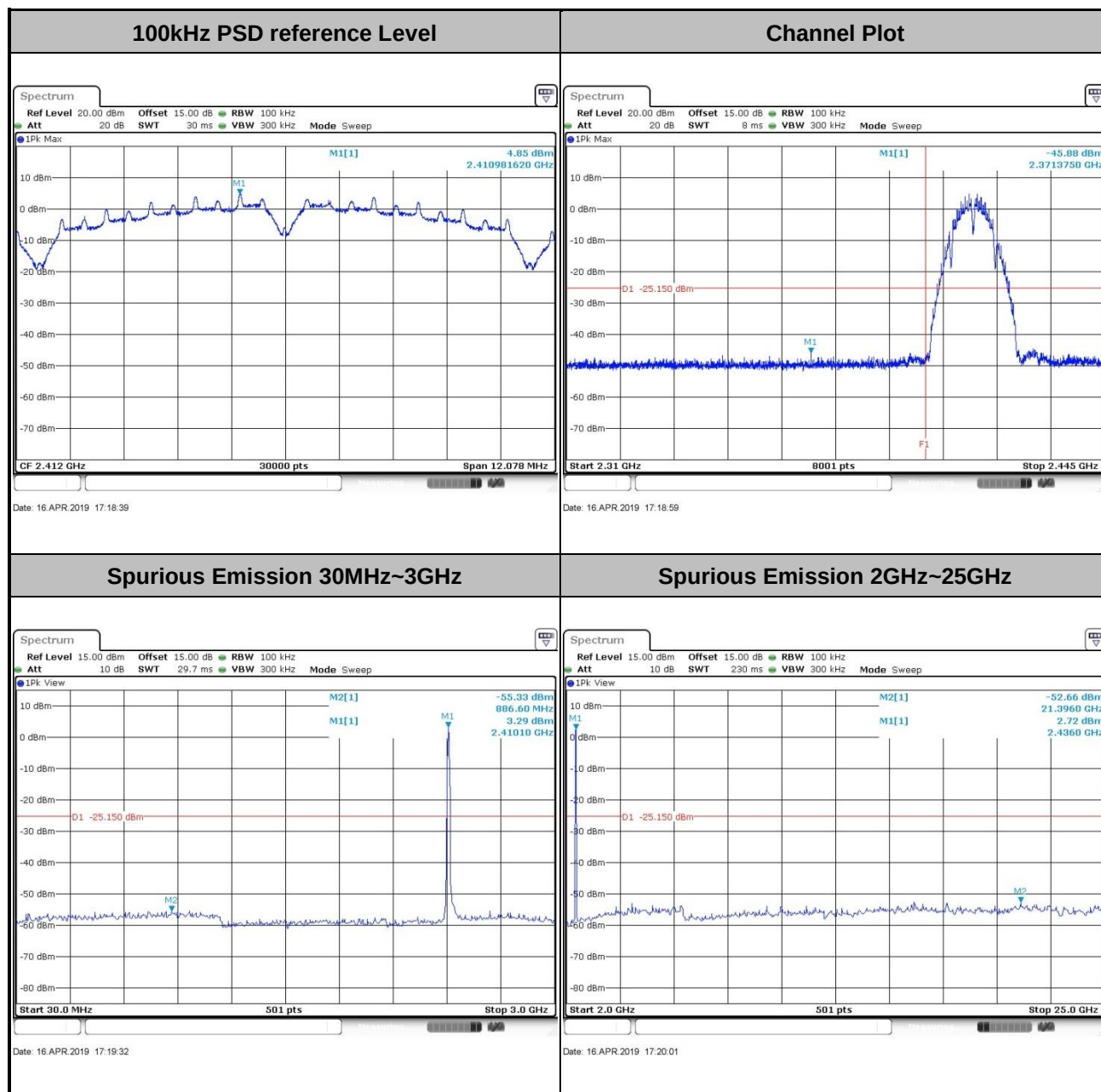


3.4.5 Test Result of Conducted Band Edges and Spurious Emission

Test Engineer :	Zhang jiang	Temperature :	24~26°C
		Relative Humidity :	50~53%

Number of TX = 1 Ant. 1 (Measured)

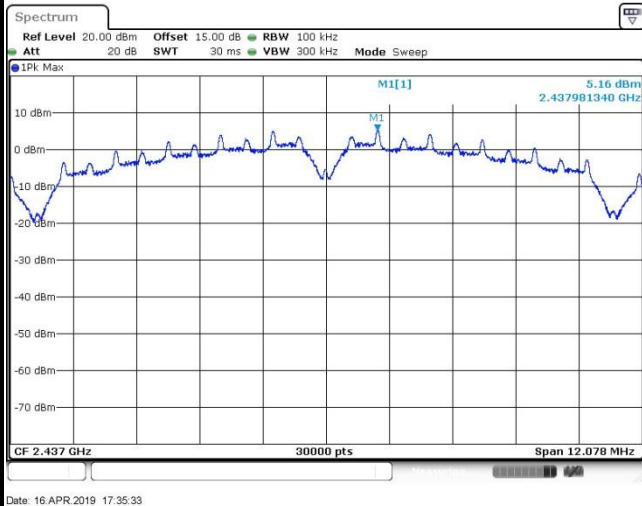
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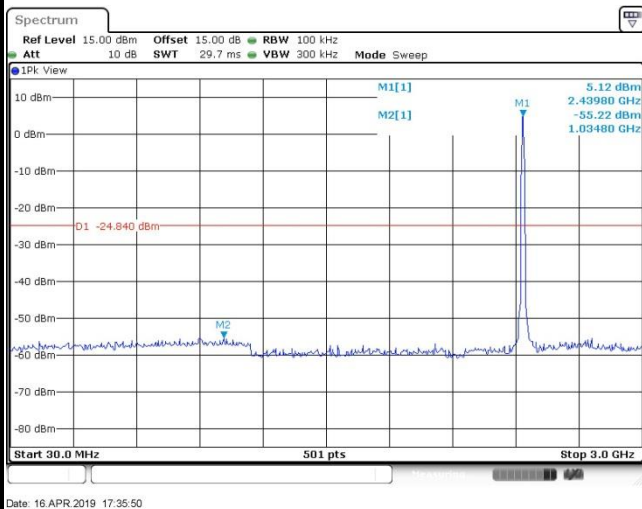
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100kHz PSD reference Level

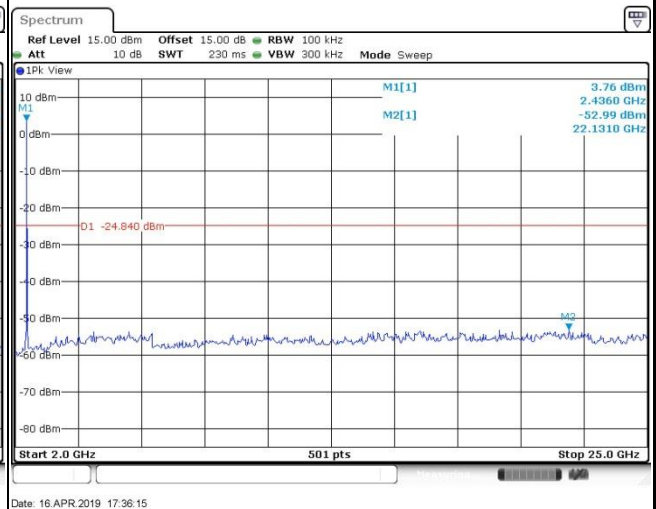


Channel Plot

Spurious Emission 30MHz~3GHz

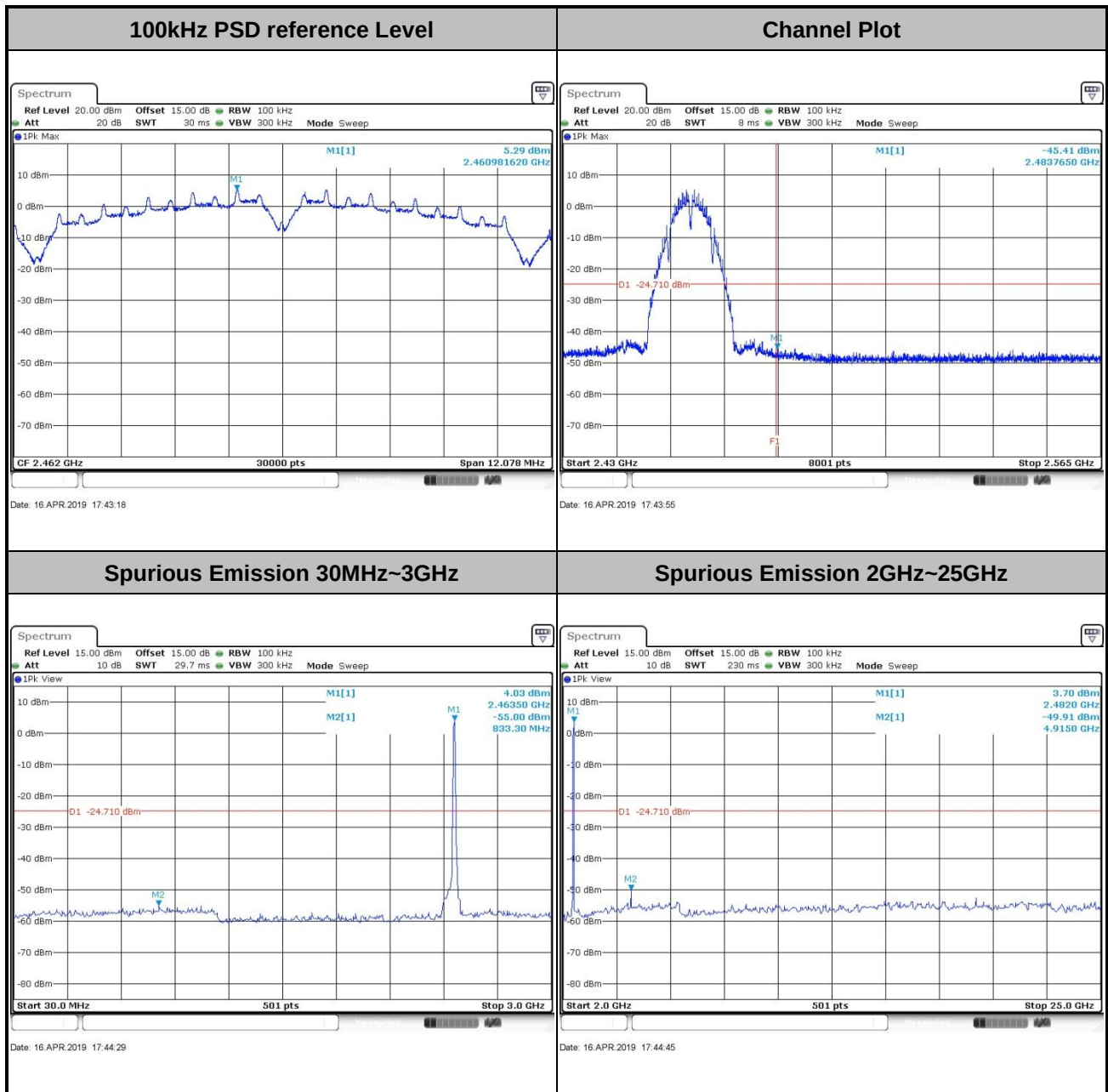


Spurious Emission 2GHz~25GHz





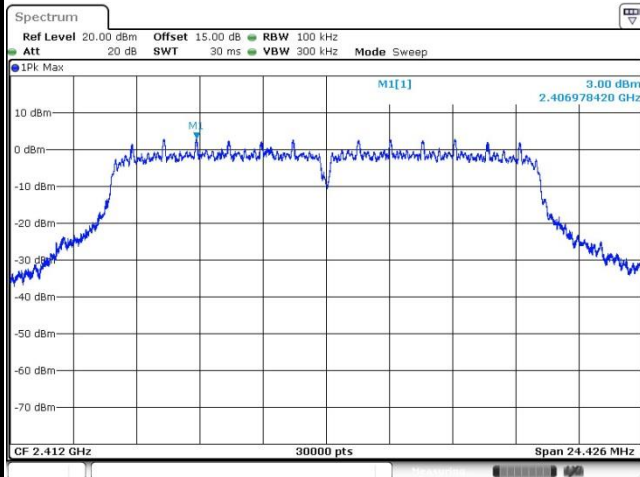
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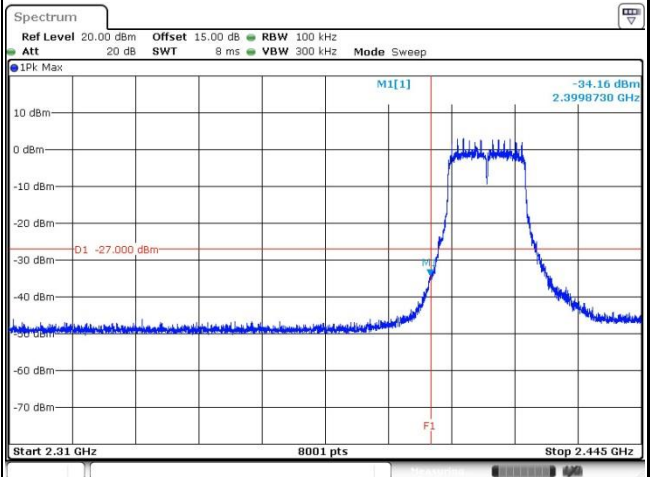
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100kHz PSD reference Level



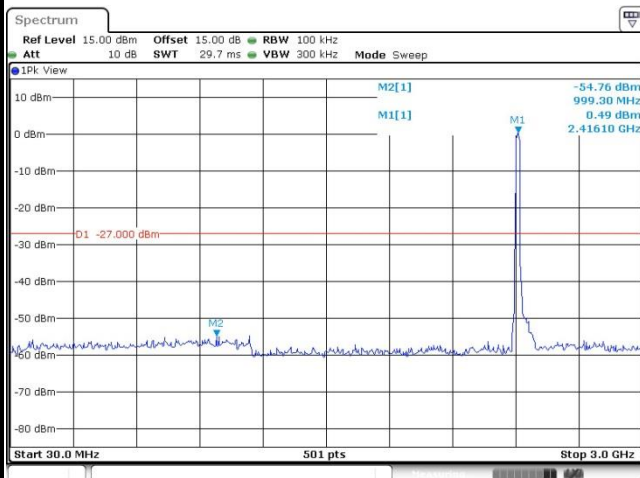
Date: 16 APR 2019 18:07:22

Channel Plot



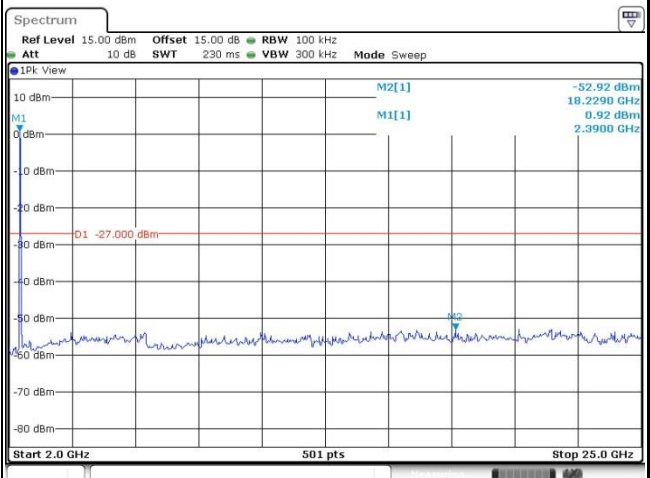
Date: 16 APR 2019 18:08:41

Spurious Emission 30MHz~3GHz



Date: 16 APR 2019 18:09:12

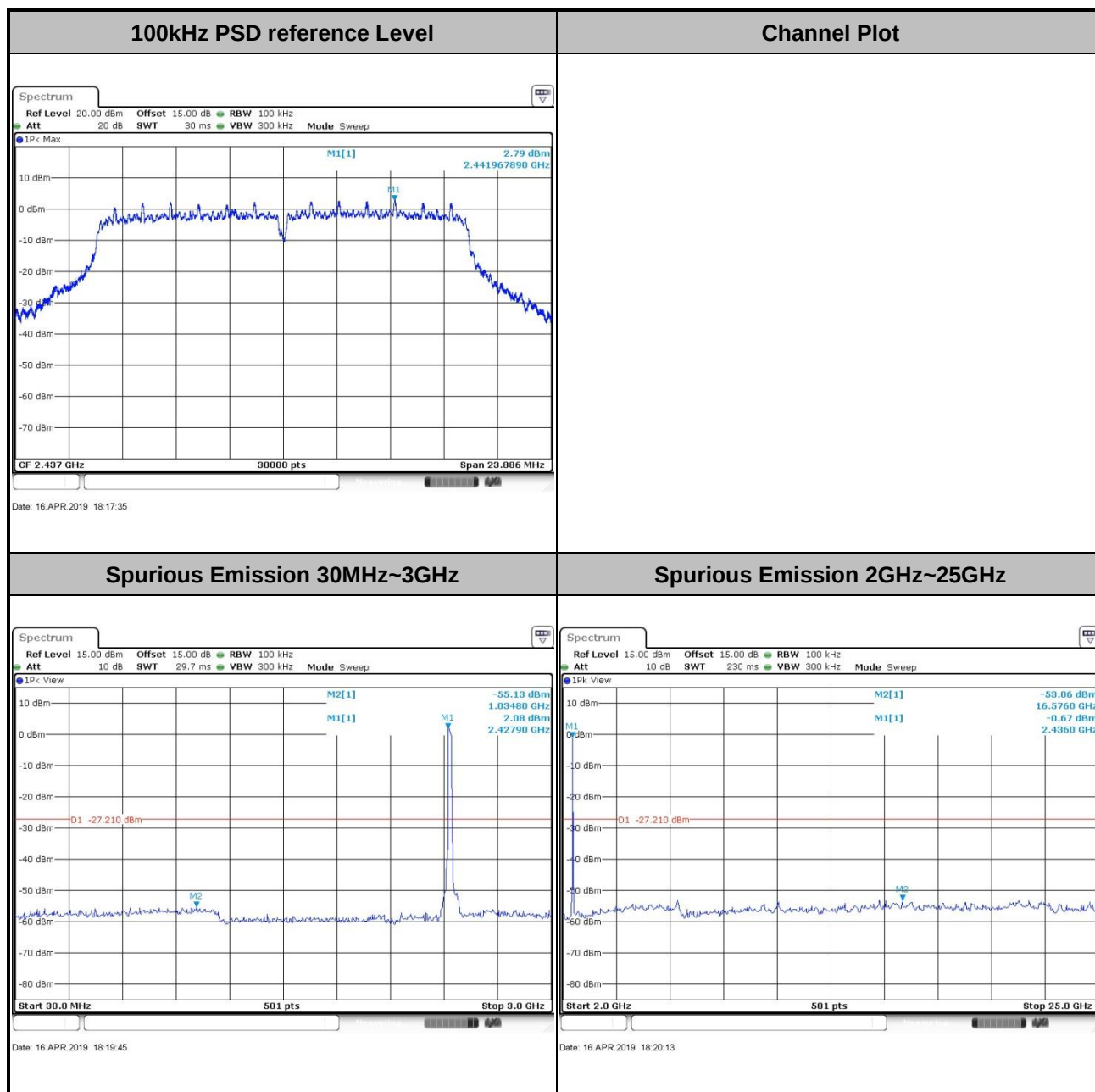
Spurious Emission 2GHz~25GHz



Date: 16 APR 2019 18:09:35

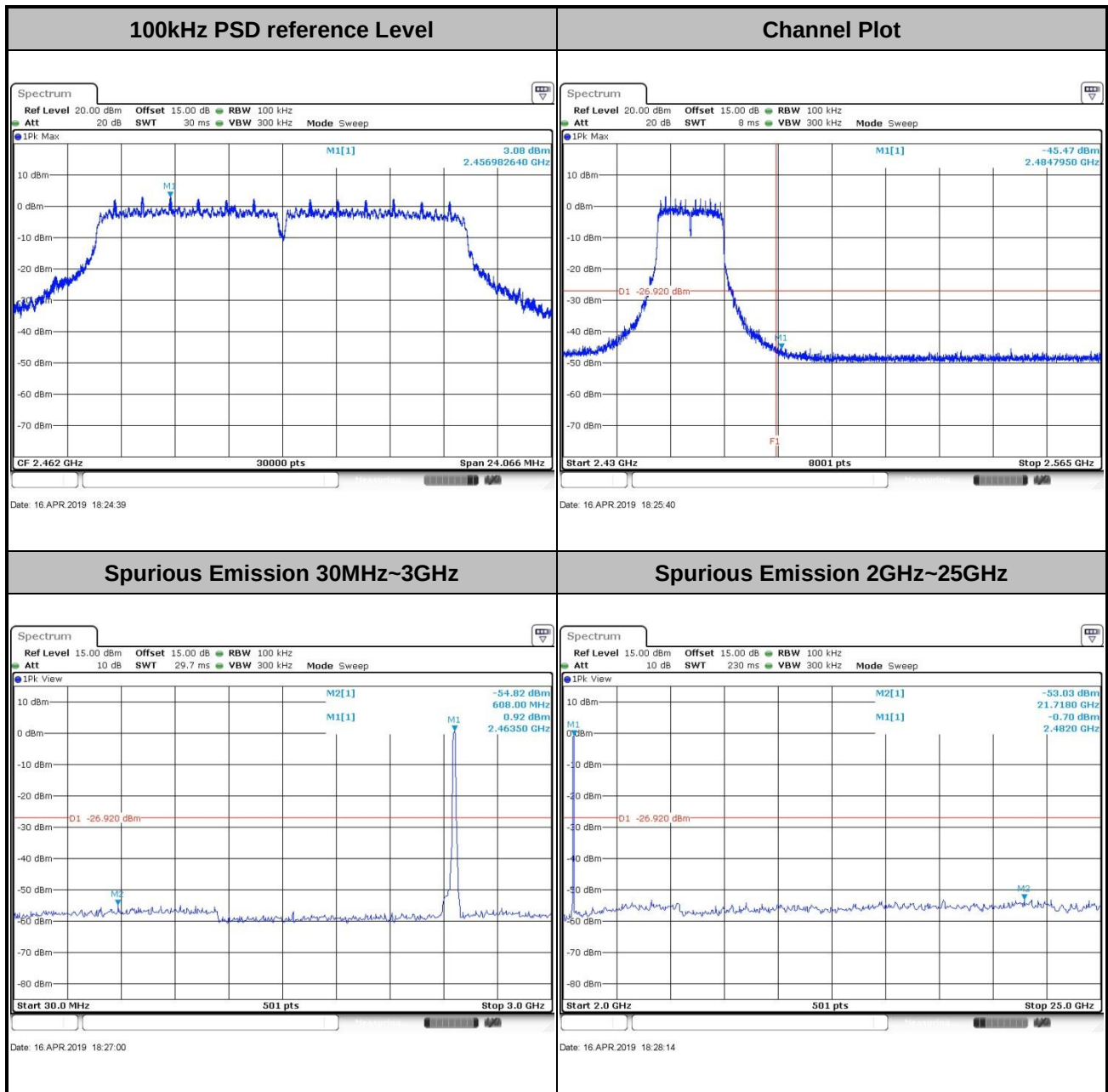


Test Mode :	802.11g	Test Channel :	06
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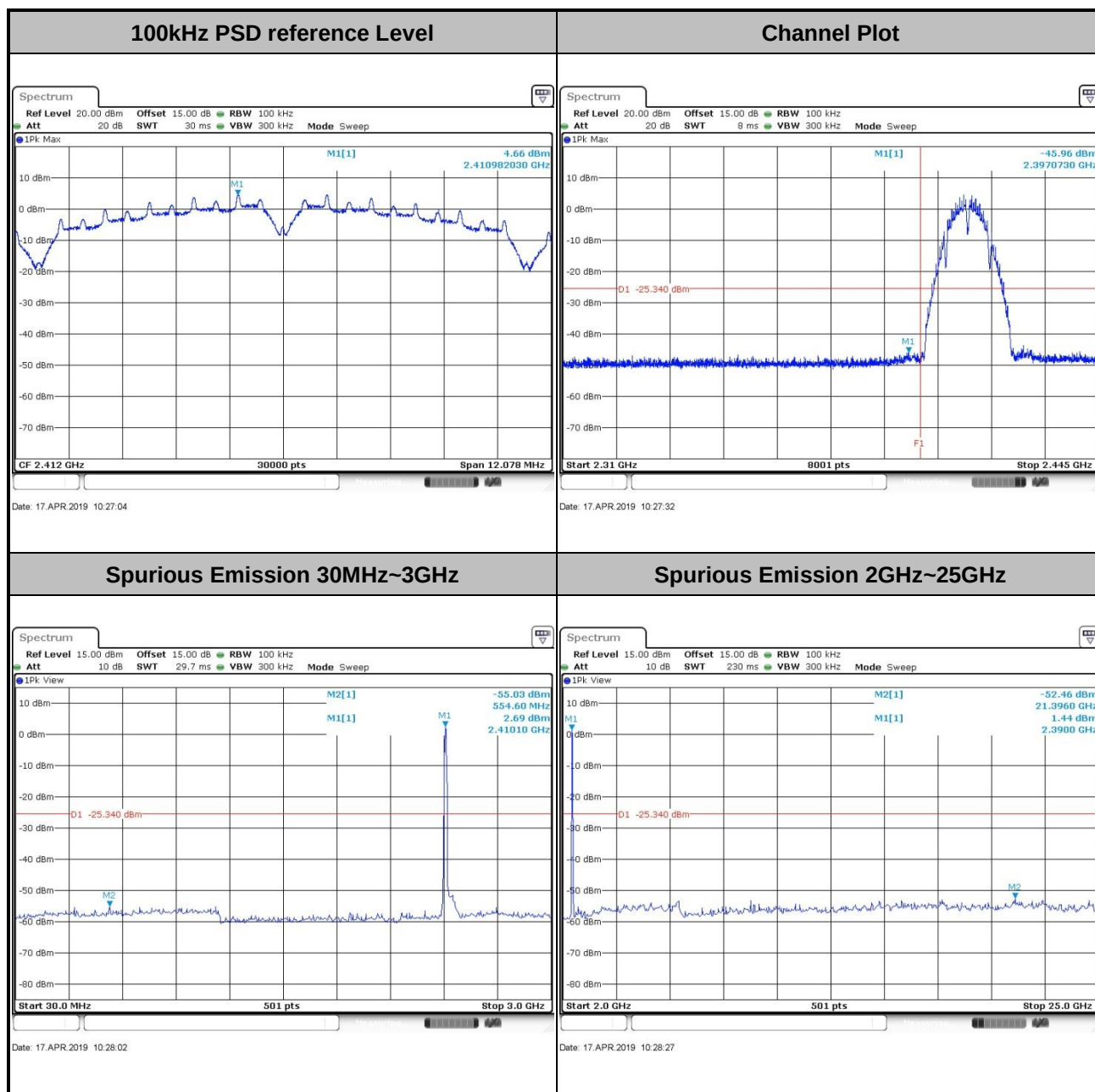
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Number of TX = 1 Ant. 2 (Measured)

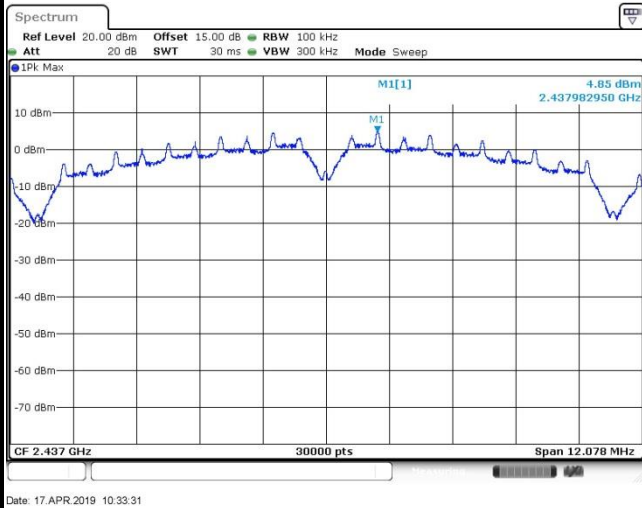
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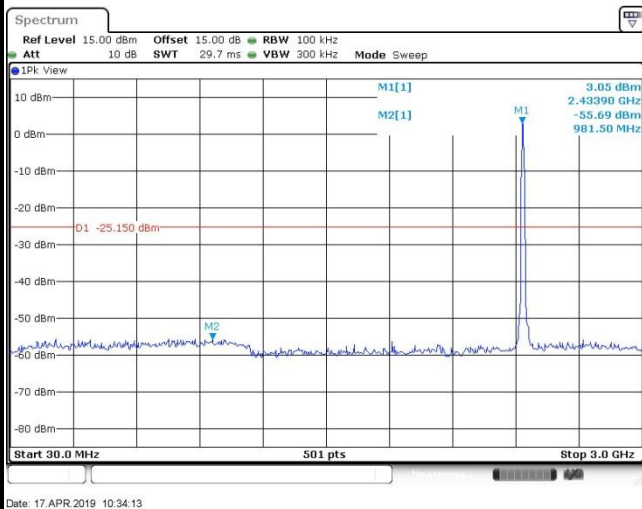
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100kHz PSD reference Level

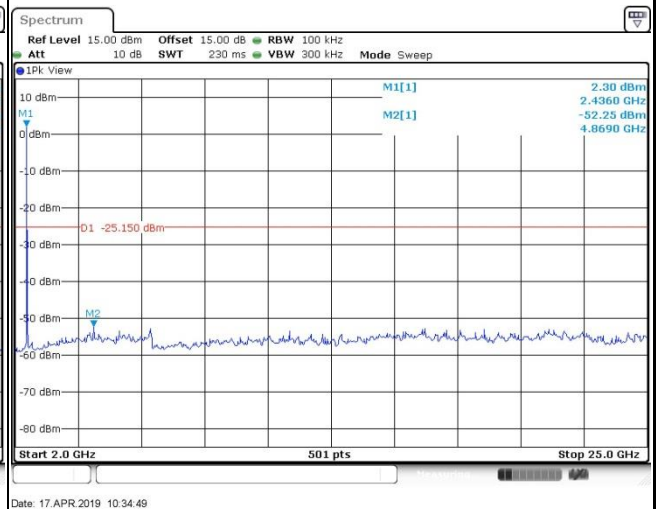


Channel Plot

Spurious Emission 30MHz~3GHz

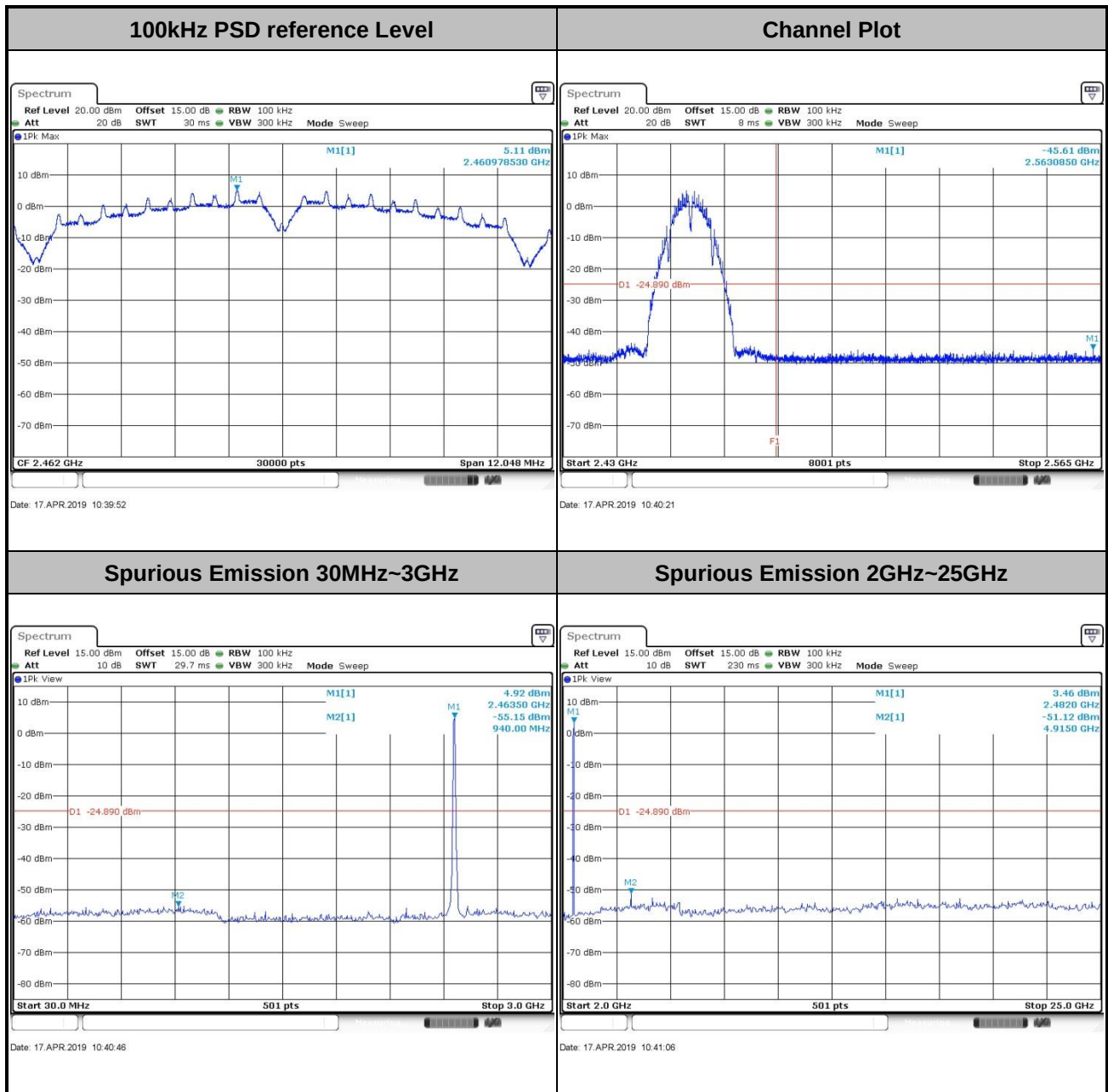


Spurious Emission 2GHz~25GHz



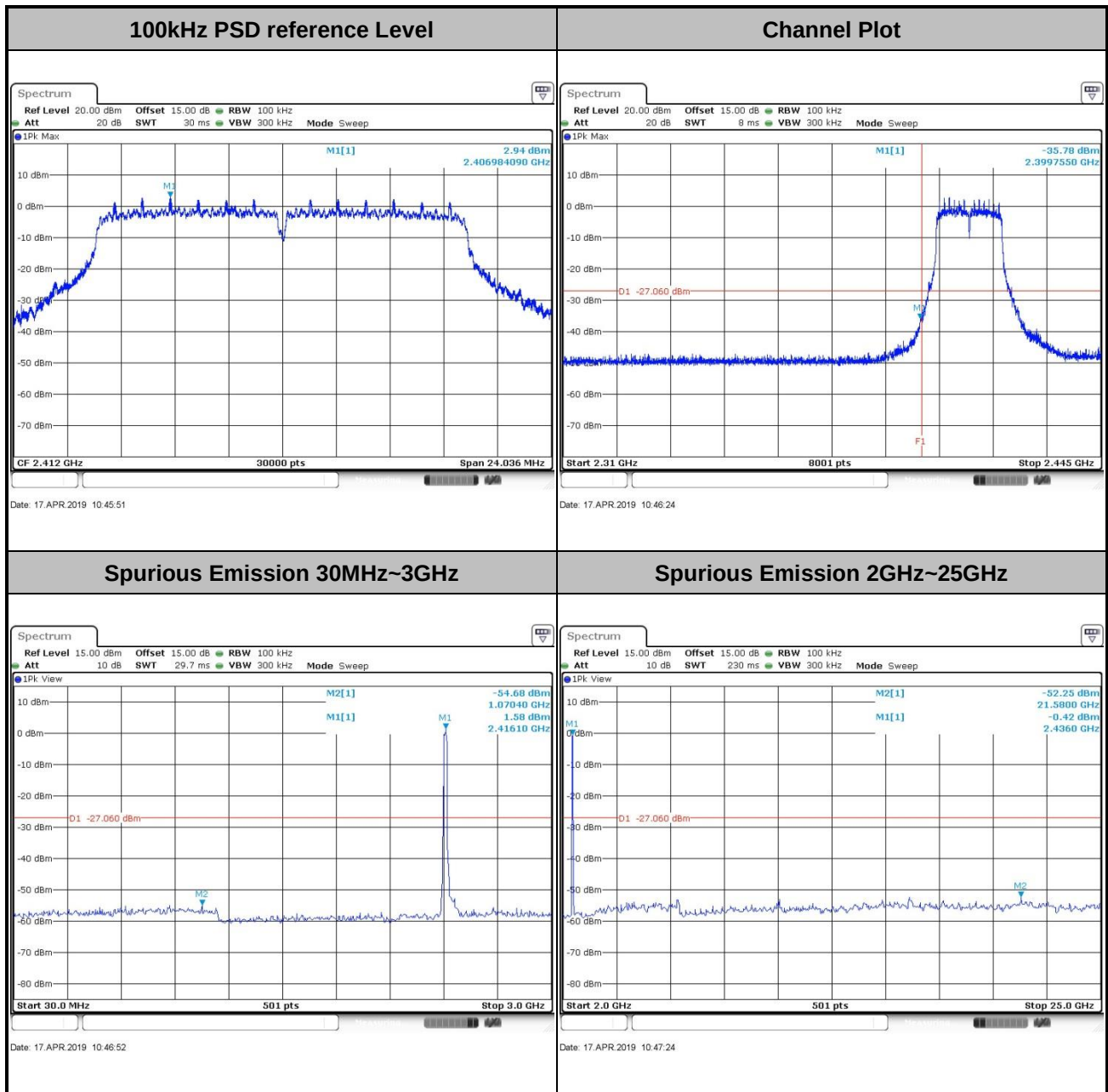


Test Mode :	802.11b	Test Channel :	11
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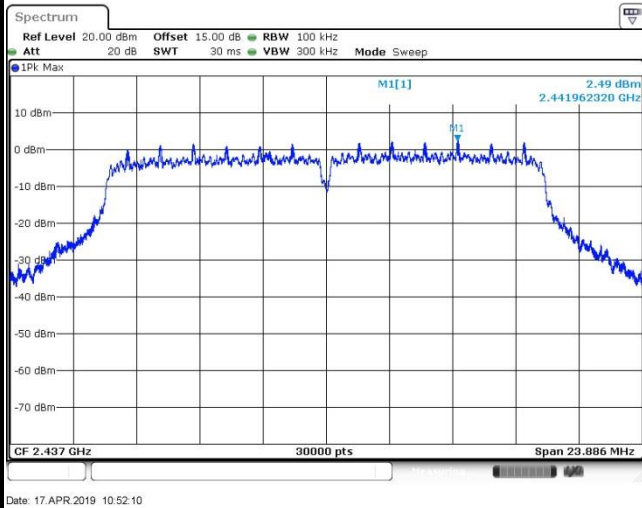
Test Mode :	802.11g	Test Channel :	01
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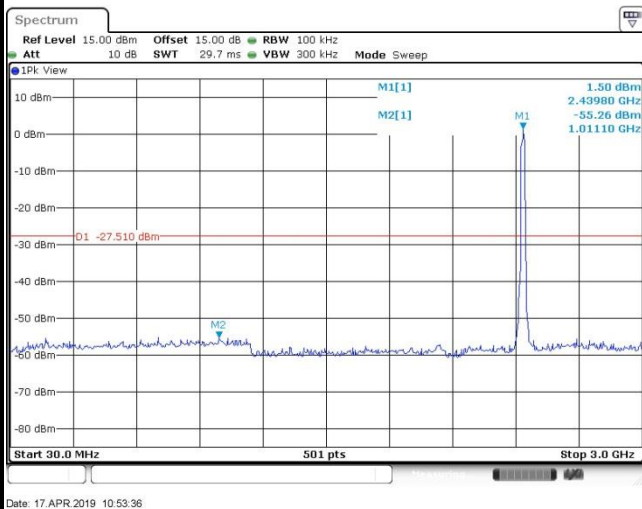
Test Mode :	802.11g	Test Channel :	06
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100kHz PSD reference Level

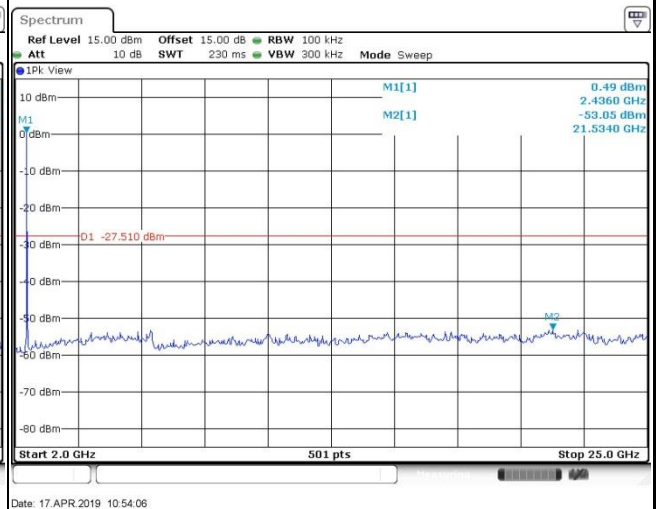


Channel Plot

Spurious Emission 30MHz~3GHz

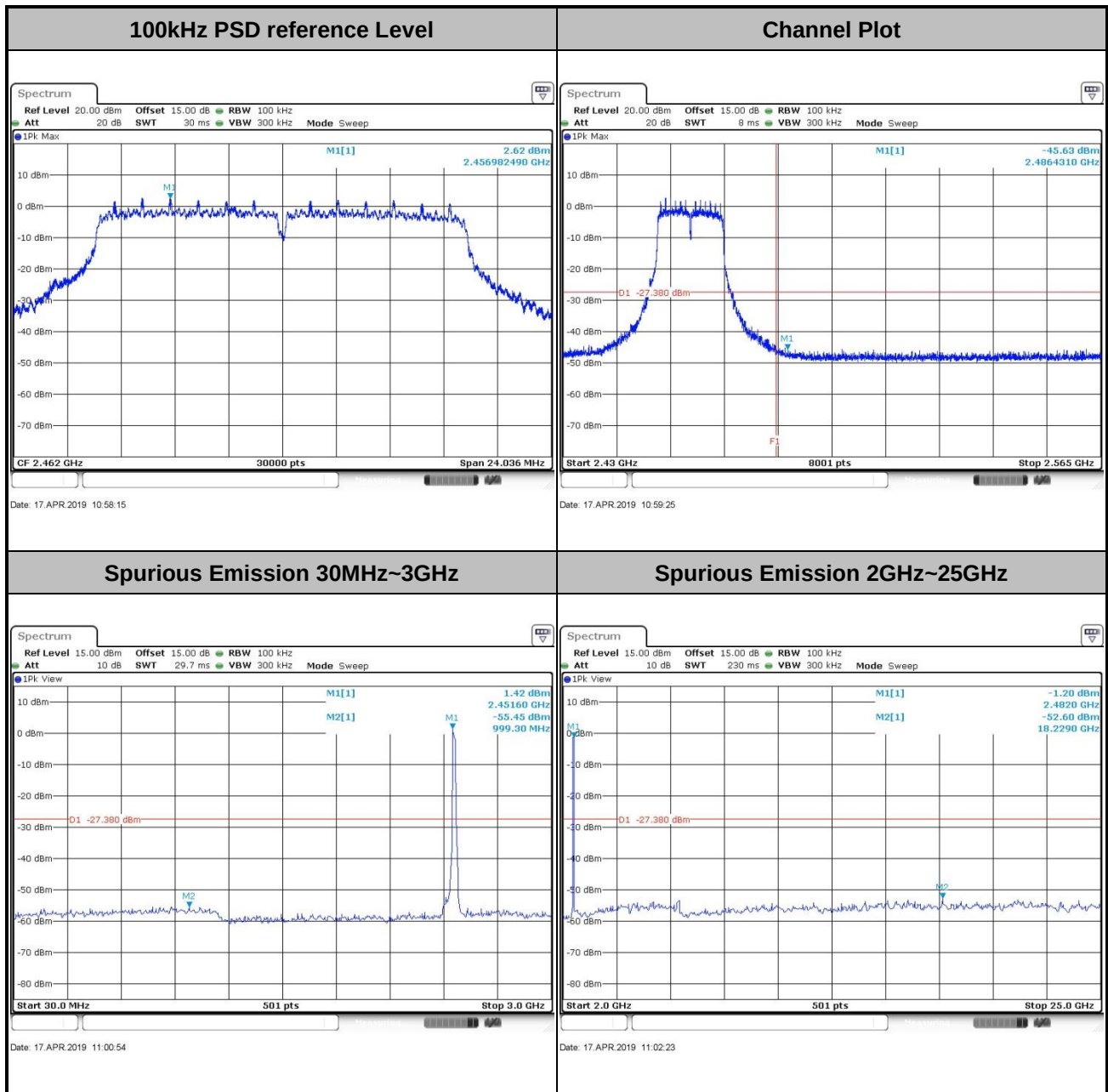


Spurious Emission 2GHz~25GHz



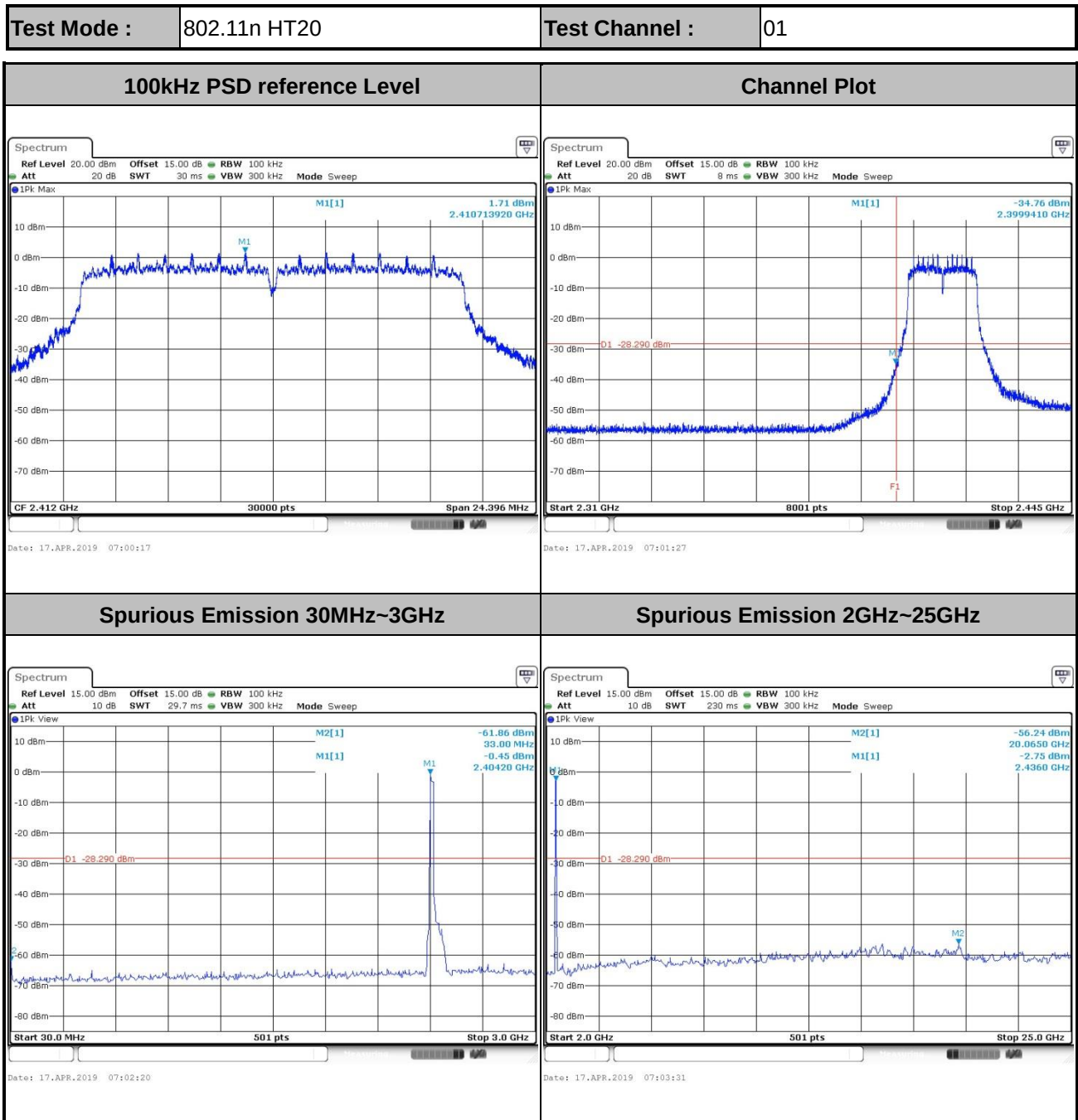


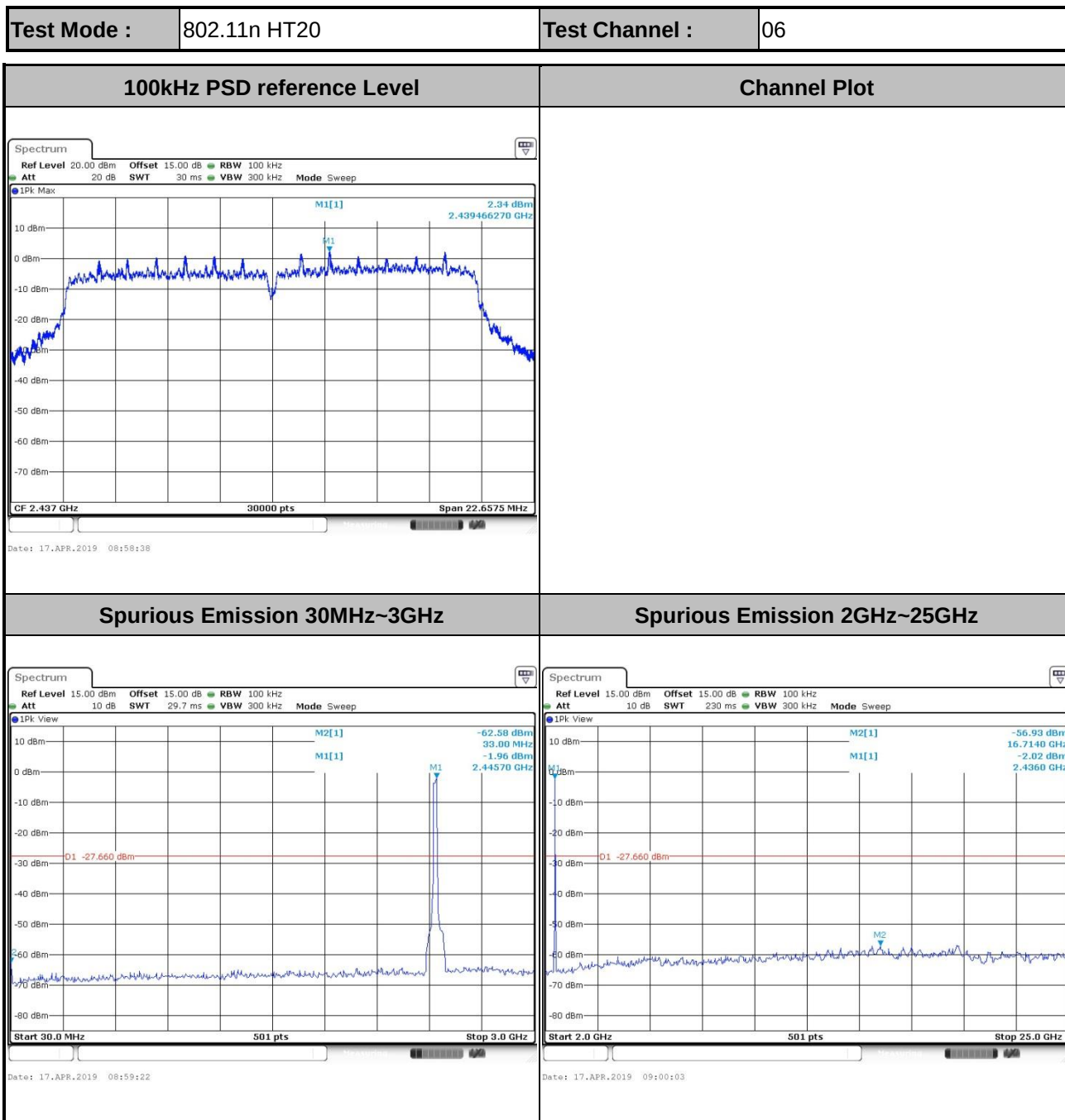
Test Mode :	802.11g	Test Channel :	11
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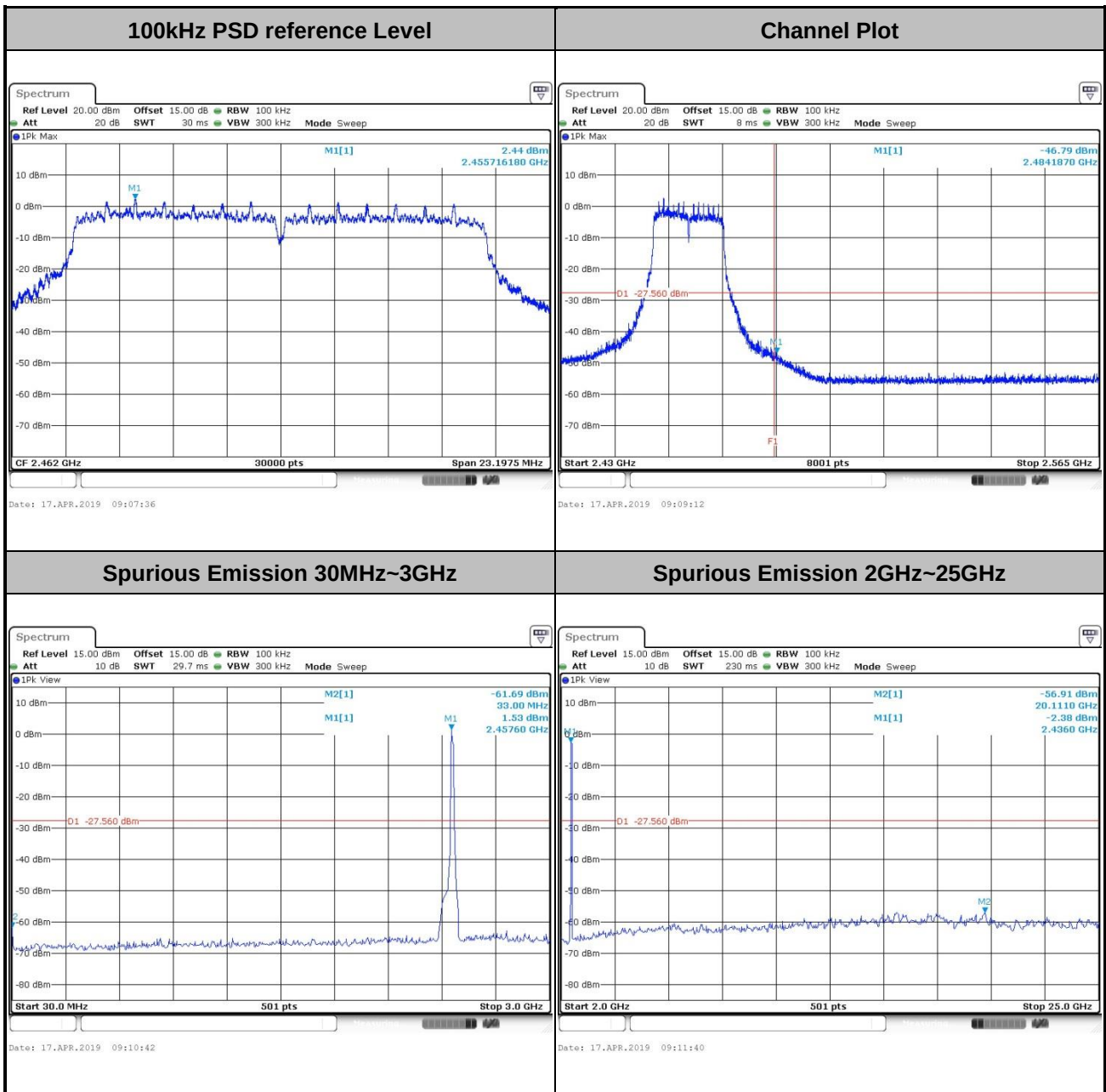
Number of TX = 2 Ant. 1(Measured)







Test Mode :	802.11n HT20	Test Channel :	11
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Number of TX = 2 Ant. 2Measured)

