

TEST REPORT

of

FCC Part 15 Subpart C §15.247

FCC ID: TQ8-DA350TYGU

Equipment Under Test : DISPLAY CAR SYSTEM

Model Name : DA350TYGU

Variant Model Name(s) : Refer to the page 3

Applicant : Hyundai Mobis Co., Ltd.

Manufacturer : Hyundai Mobis Co., Ltd.

Date of Receipt : 2021.12.09

Date of Test(s) : 2021.12.13 ~ 2022.01.07

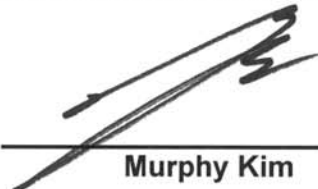
Date of Issue : 2022.01.07

In the configuration tested, the EUT complied with the standards specified above. This test report does not assure KOLAS accreditation.

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- 2) The SGS Korea is not responsible for the sampling, the results of this test report apply to the sample as received.
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Tested by:


Murphy Kim

Technical
Manager:


Jinhyoung Cho

SGS Korea Co., Ltd. Gunpo Laboratory

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1. General Information

1.1. Testing Laboratory

SGS Korea Co., Ltd. (Gunpo Laboratory)

- 10-2, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807
- 4, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807
- Designation number: KR0150

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1.2. Details of Applicant

Applicant : Hyundai Mobis Co., Ltd.

Address : 203, Teheran-ro, Gangnam-gu, Seoul, South Korea, 135-977

Contact Person : Seung-hoon, Choe

Phone No. : +82 31 260 0098

1.3. Details of Manufacturer

Company : Same as applicant

Address : Same as applicant

1.4. Description of EUT

Kind of Product	DISPLAY CAR SYSTEM
Model Name	DA350TYGU
Variant Model Name	DA360TYGU
Serial Number	Conducted Sample: C-001 Radiated Sample: R-001
Power Supply	DC 14.4 V
Frequency Range	2 412 MHz ~ 2 462 MHz (11b/g/n_HT20)
Modulation Technique	DSSS, OFDM
Number of Channels	11 channels (11b/g/n_HT20)
Antenna Type	Pattern antenna
Antenna Gain ※	-0.01 dB i
H/W Version	1.0
S/W Version	1.0

1.5. Test Equipment List

Equipment	Manufacturer	Model	S/N	Cal. Date	Cal. Interval	Cal. Due
Signal Generator	R&S	SMR40	100272	Jun. 16, 2021	Annual	Jun. 16, 2022
Signal Generator	R&S	SMBV100A	255834	May 31, 2021	Annual	May 31, 2022
Spectrum Analyzer	R&S	FSV30	103210	Dec. 08, 2021	Annual	Dec. 08, 2022
Spectrum Analyzer	Agilent	N9020A	MY53421758	Aug. 27, 2021	Annual	Aug. 27, 2022
Attenuator	AEROFLEX / INMET	26A-10dB	3	Mar. 24, 2021	Annual	Mar. 24, 2022
High Pass Filter	Wainwright Instrument GmbH	WHKX3.0/18G-6SS	21	Jun. 04, 2021	Annual	Jun. 04, 2022
High Pass Filter	Wainwright Instrument GmbH	WHNX7.5/26.5G-6SS	11	Aug. 11, 2021	Annual	Aug. 11, 2022
Low Pass Filter	Mini-Circuits	NLP-1200+	V 8979400903-2	Feb. 08, 2021	Annual	Feb. 08, 2022
Power Sensor	R&S	NRP-Z81	100669	May 07, 2021	Annual	May 07, 2022
DC Power Supply	R&S	HMP2020	020089489	May 14, 2021	Annual	May 14, 2022
Preamplifier	H.P.	8447F	2944A03909	Aug. 06, 2021	Annual	Aug. 06, 2022
Signal Conditioning Unit	R&S	SCU-18	10117	Jun. 09, 2021	Annual	Jun. 09, 2022
Pre Amplifier	TESTEK	TK-PA1840H	130016	Jan. 07, 2021	Annual	Jan. 07, 2022
Loop Antenna	Schwarzbeck Mess-Elektronik	FMZB 1519	1519-039	Aug. 23, 2021	Biennial	Aug. 23, 2023
Bilog Antenna	Schwarzbeck Mess-Elektronik	VULB 9163	01126	Dec. 22, 2020	Annual	Dec. 22, 2021
Horn Antenna	R&S	HF906	100326	Feb. 04, 2021	Annual	Feb. 04, 2022
Horn Antenna	Schwarzbeck Mess-Elektronik	BBHA 9170	9170-540	Nov. 30, 2021	Annual	Nov. 30, 2022
EMI Test Receiver	R&S	ESU26	100109	Feb. 19, 2021	Annual	Feb. 19, 2022
Turn Table	Innco systems GmbH	DS 1200 S	N/A	N.C.R.	N/A	N.C.R.
Controller	Innco systems GmbH	CONTROLLER CO3000-4P	CO3000/963/383 30516/L	N.C.R.	N/A	N.C.R.
Antenna Mast	Innco systems GmbH	MA4640-XP-ET	MA4640/536/383 30516/L	N.C.R.	N/A	N.C.R.
Anechoic Chamber	SY Corporation	L x W x H (9.6 m x 6.4 m x 6.6 m)	N/A	N.C.R.	N/A	N.C.R.
Coaxial Cable	RFONE	MWX221-NMSNMS (4 m)	J1023142	Sep. 14, 2021	Semi-Annual	Mar. 14, 2022
Coaxial Cable	RFONE	PL520-NMNM-10M (10 m)	20200324001	Sep. 14, 2021	Semi-Annual	Mar. 14, 2022
Coaxial Cable	RFONE	PL360P-292M292M-1.5 M-A	20200324002	Aug. 18, 2021	Semi-Annual	Feb. 18, 2022

Note;

For equipment listed above that has a calibration date or calibration due date that falls within the test date range, care was taken to ensure that this equipment was used after the calibration date and before the calibration due date

1.6. Summary of Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARD: FCC Part15 Subpart C		
Section	Test Item(s)	Result
15.205(a) 15.209 15.247(d)	Transmitter Radiated Spurious Emissions and Conducted Spurious Emission	Complied
15.247(a)(2)	6 dB Bandwidth	Complied
15.247(b)(3)	Maximum Peak Conducted Output Power	Complied
15.247(e)	Power Spectral Density	Complied
15.207	AC Power Line Conducted Emission	N/A ¹⁾

Note;

- 1) The AC power line test was not performed because the EUT use battery power for operation and which do not operate from the AC power lines.

1.7. Test Procedure(s)

The measurement procedures described in the American National Standard of Procedure for Compliance Testing of unlicensed Wireless Devices (ANSI C63.10-2013) and the guidance provided in KDB 558074 D01 15.247 Meas Guidance v05r02 were used in the measurement of the DUT.

1.8. Sample Calculation

Where relevant, the following sample calculation is provided:

1.8.1. Conducted Test

Offset value (dB) = Attenuator (dB) + Cable loss (dB)

1.8.2. Radiation Test

Field strength level (dB μ V/m) = Measured level (dB μ V) + Antenna factor (dB) + Cable loss (dB) - Amplifier gain (dB) + Duty factor (dB)

1.9. Information of software for test

- Operating software of EUT has integrated test interface. No additional software was used.

1.10. Worst-Case Configuration and Test Mode

802.11b mode:

We found out the test mode with the highest power level after we analyze all the data rates. 1 Mbps data rate among 1 Mbps, 2 Mbps, 5.5 Mbps and 11 Mbps is chosen as worst case.

802.11g mode:

We found out the test mode with the highest power level after we analyze all the data rates. 6 Mbps data rate among 6 Mbps, 9 Mbps, 12 Mbps, 18 Mbps, 24 Mbps, 36 Mbps, 48 Mbps and 54 Mbps is chosen as worst case.

802.11n_HT20 mode:

We found out the test mode with the highest power level after we analyze all the data rates. MCS0 data rate among MCS0, MCS1, MCS2, MCS3, MCS4, MCS5, MCS6 and MCS7 is chosen as worst case.

Radiated emission below 1GHz and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

Radiated emission above 1GHz was performed with the EUT set to transmit Low/Middle/High Channels.

Conducted tests were performed with the EUT set to transmit Low/Middle/High channels with highest output power.

1.11. Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

Parameter	Uncertainty	
RF Output Power	± 0.36 dB	
Occupied Bandwidth	± 13.12 kHz	
Power Spectral Density	± 0.63 dB	
Conducted Spurious Emission	± 0.63 dB	
Radiated Emission, 9 kHz to 30 MHz	H	± 3.66 dB
	V	± 3.66 dB
Radiated Emission, below 1 GHz	H	± 4.90 dB
	V	± 4.82 dB
Radiated Emission, above 1 GHz	H	± 3.62 dB
	V	± 3.64 dB

All measurement uncertainty values are shown with a coverage factor $k = 2$ to indicate a 95 % level of confidence.

1.12. Test Report Revision

Revision	Report Number	Date of Issue	Description
0	F690501-RF-RTL002858	2022.01.07	Initial

1.13. Description of Variant Model

Model	Model Name	AMP	BT	Wi-Fi	FM Fre. Range	FM Ch.Space	AM Fre. Range	AM Ch. Space
Basic Model	DA350TYGU	Internal	O	O	87.5~107.9 MHz	200 kHz	530 ~ 1 701 kHz	9 kHz
Variant Model	DA360TYGU	External	O	O	87.5~107.9 MHz	200 kHz	530 ~ 1 701 kHz	9 kHz

Note;

All the test was performed with basic model.

1.14. Duty Cycle of EUT

Regarding to KDB 558074 D01 15.247 Meas Guidance v05r02, 6, the maximum duty cycles of all modes were investigated and set the spectrum analyzer as below;

Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value. Set detector = peak or average. The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T and the number of sweep points across duration T exceeds 100.

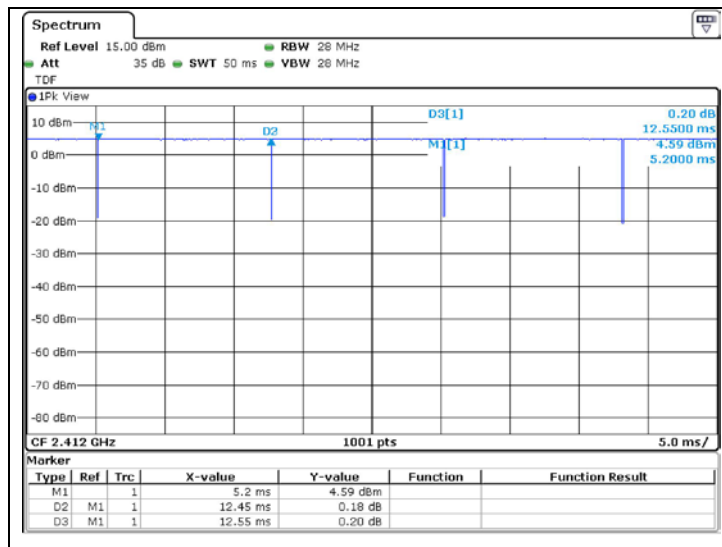
Mode	Data Rate (Mbps)	Duty Cycle (%)	Correction Factor (dB)
11b	1	99.20	0
11g	6	88.84	0.51
11n_HT20	MCS0	93.83	0.28

Remark;

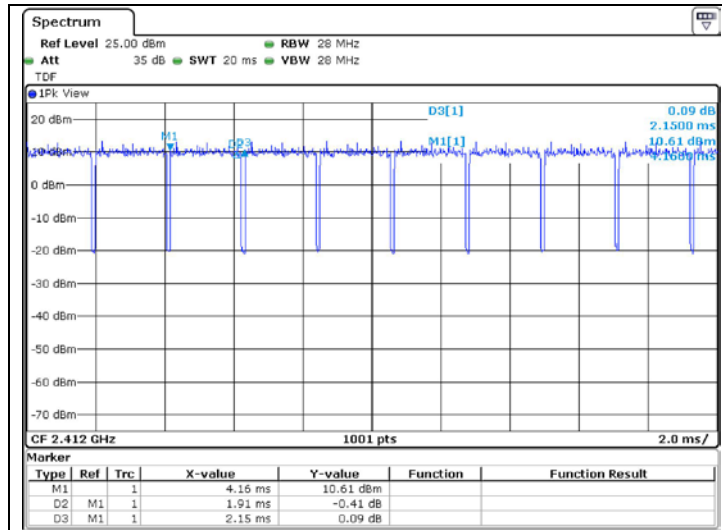
- As measured duty cycles of EUT, all of mode and data rate keeps constant period and are converted to log scale (power averaging) to compensate correction factor to result of average test items.
- Duty Cycle (%) = (Tx on time / Tx on + off time) x 100
- Correction Factor (dB) = 10 log (1 / Duty Cycle)

- Test plots

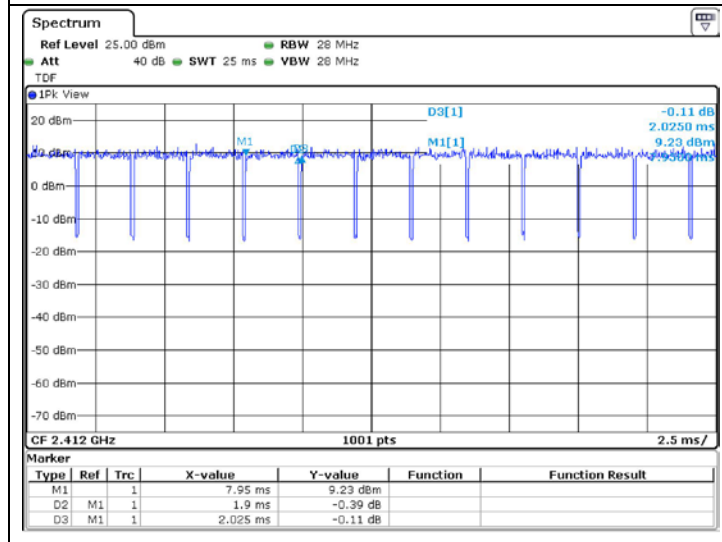
802.11b



802.11g



802.11n_HT20

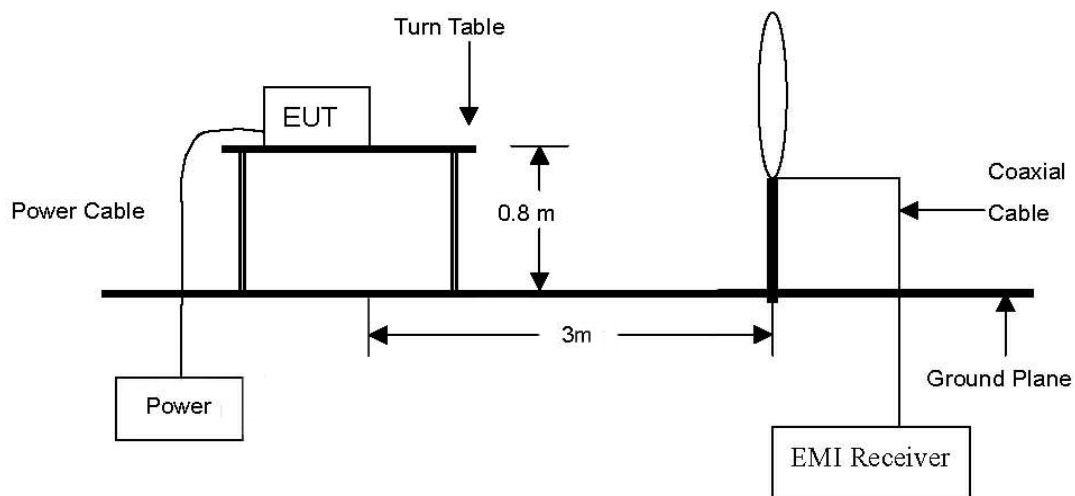


2. Transmitter Radiated Spurious Emissions and Conducted Spurious Emission

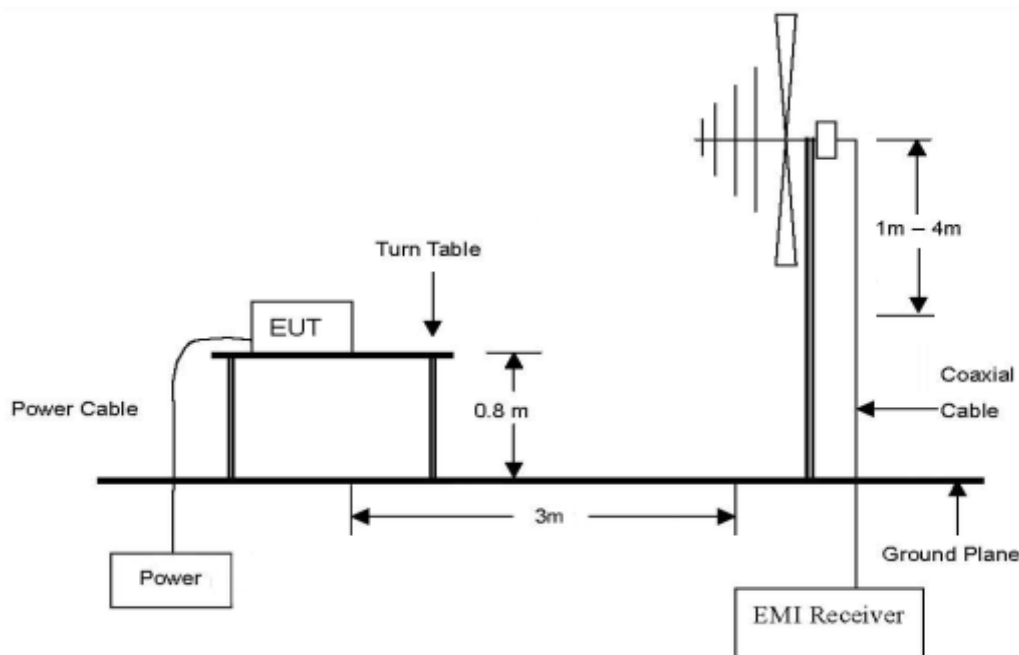
2.1. Test Setup

2.1.1. Transmitter Radiated Spurious Emissions

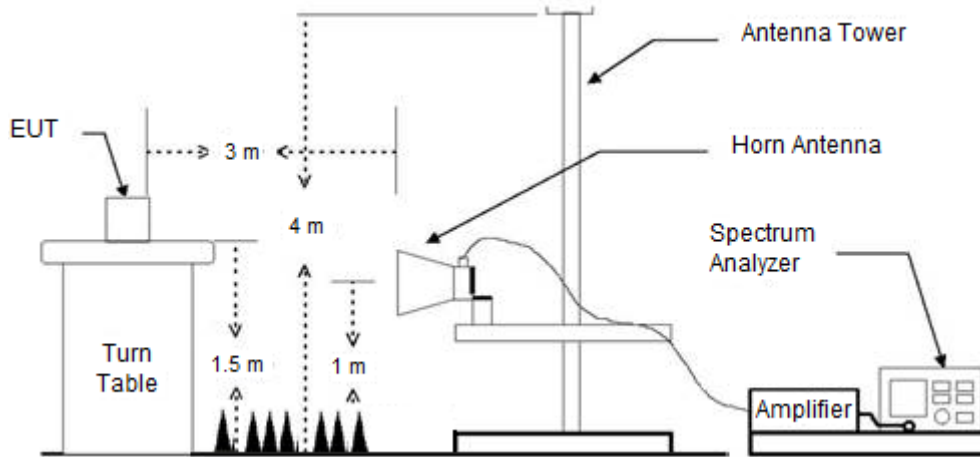
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 30 MHz emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 30 MHz to 1 GHz emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission. The spurious emissions were investigated from 1 GHz to the 10th harmonic of the highest fundamental frequency or 40 GHz, whichever is lower.



2.1.2. Conducted Spurious Emission



2.2. Limit

According to §15.247(d), 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. In addition, radiated emission which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

According to §15.209(a), except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (μV/m)	Measurement Distance (Meters)
0.009-0.490	2 400/F(kHz)	300
0.490-1.705	24 000/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

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

2.3. Test Procedures

Radiated emissions from the EUT were measured according to the dictates in section 11.11 & 11.12 of ANSI C63.10-2013.

2.3.1. Test Procedures for emission below 30 MHz

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement.
3. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading.
4. The test-receiver system was set to average or quasi peak detect function and Specified Bandwidth with Maximum Hold Mode.

2.3.2. Test Procedures for emission from above 30 MHz

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site below 1 GHz and 1.5 meters above the ground at a 3 meter anechoic chamber test site above 1 GHz. The table was rotated 360 degrees to determine the position of the highest radiation.
2. During performing radiated emission below 1 GHz, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 GHz, the EUT was set 3 meter away from the interference-receiving antenna.
3. The antenna is a bi-log antenna, a horn antenna and its height 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.
4. 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 table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. For measurements below 1 GHz resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.
6. For measurements Above 1 GHz resolution bandwidth is set to 1 MHz, the video bandwidth is set to 3 MHz for peak measurements and as applicable for average measurements.

1. Unwanted Emissions into Non-Restricted Frequency Bands

- The Reference Level Measurement refer to section 11.11.2

Set analyzer center frequency to DTS channel center frequency, SPAN ≥ 1.5 times the DTS bandwidth, the RBW = 100 kHz and VBW $\geq 3 \times$ RBW, Detector = Peak, Sweep time = Auto couple, Trace = Max hold.

- Unwanted Emissions Level Measurement refer to section 11.11.3

Set the center frequency and span to encompass frequency range to be measured, the RBW = 100 kHz and VBW $\geq 3 \times$ RBW, Detector = Peak, Sweep time = Auto couple, Trace = Max hold.

2. Unwanted Emissions into Restricted Frequency Bands

- Peak Power measurement procedure refer to section 11.12.2.4

Set RBW = as specified in Table 9, VBW $\geq 3 \times$ RBW, Detector = Peak, Sweep time = auto, Trace = Max hold.

Table 9 – RBW as a function of frequency

Frequency	RBW
9 kHz to 150 kHz	200 Hz to 300 Hz
0.15 MHz to 30 MHz	9 kHz to 10 kHz
30 MHz to 1 000 MHz	100 kHz to 120 kHz
> 1 000 MHz	1 MHz

If the peak – detected amplitude can be shown to comply with the average limit, then it is not necessary to perform a separate average measurement.

- Average Power measurements procedure refer to section 11.12.2.5.2

The EUT shall be configured to operate at the maximum achievable duty cycle.

Measure the duty cycle D of the transmitter output signal as described in section 11.6.

Set RBW = 1 MHz, VBW $\geq 3 \times$ RBW, Detector = RMS, if span / (# of points in sweep) \leq (RBW/2).

Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied then the detector mode shall be set to peak.

Averaging type = power (i.e., RMS).

As an alternative the detector and averaging type may be set for linear voltage averaging.

Some instruments require linear display mode in order to use linear voltage averaging. Log or dB averaging shall not be used. Sweep time = auto, Perform a trace average of at least 100 traces.

A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:

- 1) If power averaging (rms) mode was used in step f), then the applicable correction factor is $[10 \log(1 / D)]$, where D is the duty cycle.
- 2) If a specific emission is demonstrated to be continuous ($D \geq 98 \%$) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission.

3. Definition of DUT Axis.

The test orthogonal plan of EUT was investigated with three axis described in the test setup photo.

The Z-axis was worst-case, all radiated testing of EUT was performed with **Z-axis**.

2.3.3. Test Procedures for Conducted Spurious Emissions

All data rates and modes were investigated for conducted spurious emissions.

Per the guidance of ANSI C63.10-2013, section 11.11.1 & 11.11.2 & 11.11.3, the reference level for out of band emissions is established from the plots of this section since the band edge emissions are measured with a RBW of 100 kHz. This reference level is then used as the limit in subsequent plots for out of band spurious emissions shown in section 2.4.3. The limit for out of band spurious emission at the band edge is 20 dB below the fundamental emission level measured in a 100 kHz bandwidth.

1. Conducted Emissions at Band Edge

- The Measurement refer to section 11.11.3

Set the center frequency and span to encompass frequency range to be measured, the RBW = 100 kHz and VBW $\geq 3 \times$ RBW, Detector = Peak, Sweep time = Auto couple, Trace mode = Max hold, The trace was allowed to stabilize.

2. Conducted Spurious Emissions

- The Measurement refer to section 11.11.3

Start frequency was set to 9 kHz and stop frequency was set to 25 GHz (separated into two plots per channel), RBW = 1 MHz, VBW $\geq 3 \times$ RBW, Detector = Peak, Sweep time = Auto couple, Trace = Max hold, The trace was allowed to stabilize.

3. TDF function

- For plots showing conducted spurious emissions from 9 kHz to 25 GHz, all path loss of wide frequency range was investigated and compensated to spectrum analyzer as TDF function.
So, the reading values shown in plots were final result.

2.4. Test Results

Ambient temperature : (23 ± 1) °C
 Relative humidity : 47 % R.H.

2.4.1. Radiated Spurious Emission below 1 000 MHz

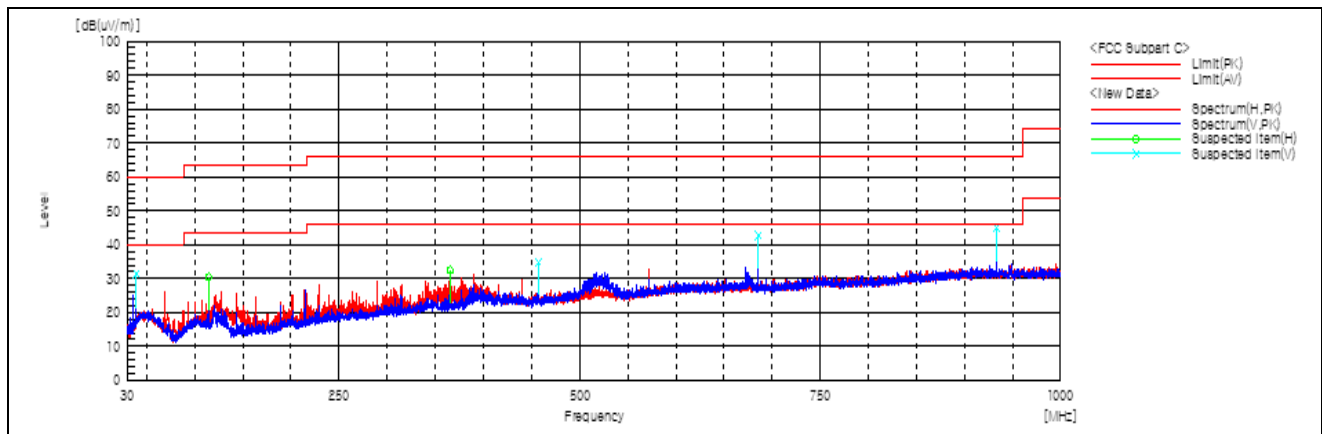
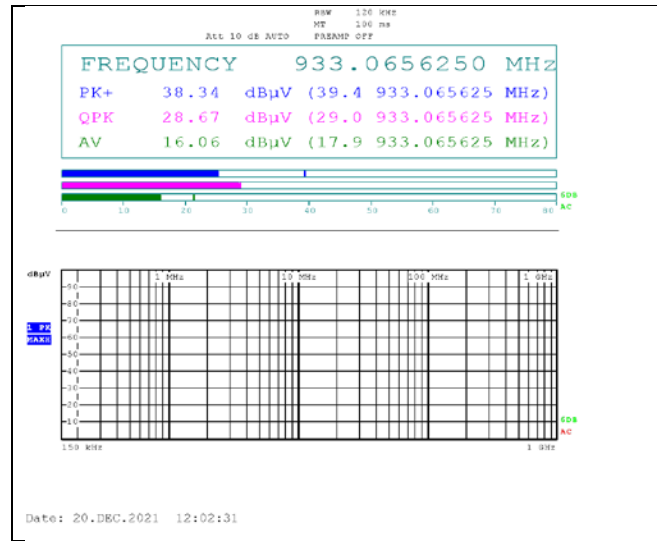
The frequency spectrum from 9 kHz to 1 000 MHz was investigated. All reading values are peak values.

Radiated Emissions			Ant.	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP + CL (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
39.09	40.50	Peak	V	17.95	-27.17	31.28	40.00	8.72
114.27	40.30	Peak	H	16.57	-26.43	30.44	43.50	13.06
365.14	36.80	Peak	H	20.41	-24.75	32.46	46.00	13.54
457.16	38.20	Peak	V	21.94	-25.15	34.99	46.00	11.01
685.72	42.70	Peak	V	25.20	-24.94	42.96	46.00	3.04
933.07	29.00	Quasi Peak	V	28.04	-23.70	33.34	46.00	12.66

Remark;

- Spurious emissions for all channels were investigated and almost the same below 1 GHz.
- Reported spurious emissions are in **11n HT20 / MCS0 / Middle channel** as worst case among other modes.
- Radiated spurious emission measurement as below.
 (Actual = Reading + AF + AMP + CL)
- According to §15.31(o), emission levels are not report much lower than the limits by over 20 dB.

- Test plots



2.4.2. Radiated Spurious Emission above 1 000 MHz

The frequency spectrum above 1 000 MHz was investigated. All reading values are peak and average values.

DSSS: 802.11b

Low Channel (2 412 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	DF (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
*2 310.00	14.02	Peak	H	28.00	7.55	-	49.57	74.00	24.43
*2 310.00	3.18	Average	H	28.00	7.55	-	38.73	54.00	15.27
*2 381.90	15.80	Peak	H	28.13	7.53	-	51.46	74.00	22.54
*2 384.37	4.46	Average	H	28.14	7.54	-	40.14	54.00	13.86
*2 390.00	13.92	Peak	H	28.16	7.54	-	49.62	74.00	24.38
*2 390.00	3.89	Average	H	28.16	7.54	-	39.59	54.00	14.41

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
*4 823.50	40.14	Peak	H	32.64	-30.70	-	42.08	74.00	31.92
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

Mid Channel (2 437 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB μ V)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
*4 874.16	40.08	Peak	H	32.94	-30.17	-	42.85	74.00	31.15
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

High Channel (2 462 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB μ V)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	DF (dB)	Actual (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
*2 483.50	14.21	Peak	H	28.33	7.91	-	50.45	74.00	23.55
*2 483.50	3.96	Average	H	28.33	7.91	-	40.20	54.00	13.80
*2 495.08	16.06	Peak	H	28.31	8.03	-	52.40	74.00	21.60
*2 490.18	4.79	Average	H	28.32	7.98	-	41.09	54.00	12.91
*2 500.00	14.91	Peak	H	28.30	8.08	-	51.29	74.00	22.71
*2 500.00	4.32	Average	H	28.30	8.08	-	40.70	54.00	13.30

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB μ V)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
*4 924.14	40.18	Peak	H	33.20	-29.90	-	43.48	74.00	30.52
Above 5 000.00	Not detected	-	-	-	-	-	-	-	-

OFDM: 802.11g

Low Channel (2 412 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	DF (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
*2 310.00	14.28	Peak	H	28.00	7.55	-	49.83	74.00	24.17
*2 310.00	3.31	Average	H	28.00	7.55	0.51	39.37	54.00	14.63
*2 388.92	15.98	Peak	H	28.16	7.54	-	51.68	74.00	22.32
*2 352.91	4.48	Average	H	28.01	7.47	0.51	40.47	54.00	13.53
*2 390.00	14.82	Peak	H	28.16	7.54	-	50.52	74.00	23.48
*2 390.00	3.98	Average	H	28.16	7.54	0.51	40.19	54.00	13.81

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
*4 823.06	42.46	Peak	H	32.64	-30.70	-	44.40	74.00	29.60
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

Mid Channel (2 437 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
*4 871.74	39.76	Peak	H	32.93	-30.18	-	42.51	74.00	31.49
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

High Channel (2 462 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	DF (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
*2 483.50	13.86	Peak	H	28.33	7.91	-	50.10	74.00	23.90
*2 483.50	4.45	Average	H	28.33	7.91	0.51	41.20	54.00	12.80
*2 493.12	15.73	Peak	H	28.31	8.01	-	52.05	74.00	21.95
*2 486.89	4.86	Average	H	28.33	7.95	0.51	41.65	54.00	12.35
*2 500.00	14.02	Peak	H	28.30	8.08	-	50.40	74.00	23.60
*2 500.00	4.19	Average	H	28.30	8.08	0.51	41.08	54.00	12.92

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
*4 922.54	40.31	Peak	H	33.19	-29.96	-	43.54	74.00	30.46
Above 5 000.00	Not detected	-	-	-	-	-	-	-	-

OFDM: 802.11n_HT20

Low Channel (2 412 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	DF (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
*2 310.00	12.89	Peak	H	28.00	7.55	-	48.44	74.00	25.56
*2 310.00	3.65	Average	H	28.00	7.55	0.28	39.48	54.00	14.52
*2 325.87	16.01	Peak	H	28.00	7.58	-	51.59	74.00	22.41
*2 388.53	4.81	Average	H	28.15	7.54	0.28	40.78	54.00	13.22
*2 390.00	13.91	Peak	H	28.16	7.54	-	49.61	74.00	24.39
*2 390.00	4.28	Average	H	28.16	7.54	0.28	40.26	54.00	13.74

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
*4 825.04	41.95	Peak	H	32.65	-30.72	-	43.88	74.00	30.12
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

Mid Channel (2 437 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
*4 873.70	39.96	Peak	H	32.94	-30.17	-	42.73	74.00	31.27
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

High Channel (2 462 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	DF (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
*2 483.50	13.94	Peak	H	28.33	7.91	-	50.18	74.00	23.82
*2 483.50	4.67	Average	H	28.33	7.91	0.28	41.19	54.00	12.81
*2 497.25	17.22	Peak	H	28.31	8.05	-	53.58	74.00	20.42
*2 485.77	4.50	Average	H	28.33	7.93	0.28	41.04	54.00	12.96
*2 500.00	14.08	Peak	H	28.30	8.08	-	50.46	74.00	23.54
*2 500.00	4.04	Average	H	28.30	8.08	0.28	40.70	54.00	13.30

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dBμV)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dBμV/m)	Limit (dBμV/m)	Margin (dB)
*4 920.50	40.71	Peak	H	33.18	-30.03	-	43.86	74.00	30.14
Above 5 000.00	Not detected	-	-	-	-	-	-	-	-

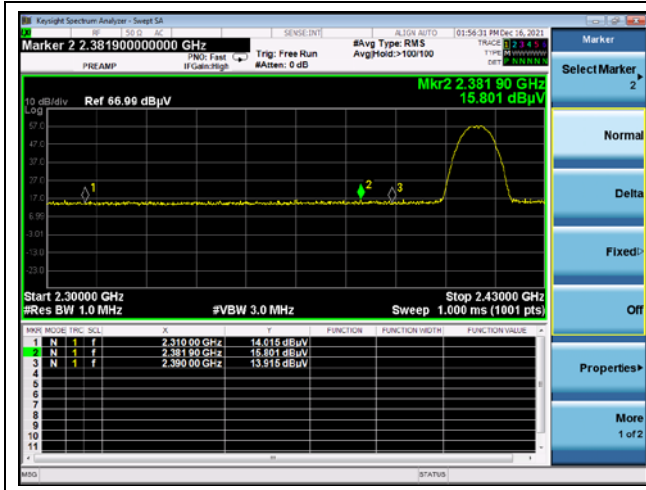
Remarks;

1. "*" means the restricted band.
2. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
3. Radiated emissions measured in frequency above 1 000 MHz were made with an instrument using peak/average detector mode.
4. Actual = Reading + AF + CL + (DF) or Reading + AF + AMP + CL + (DF).
5. According to § 15.31(o), emission levels are not reported much lower than the limits by over 20 dB.
6. The maximized peak measured value complies with the average limit, to perform an average measurement is unnecessary.

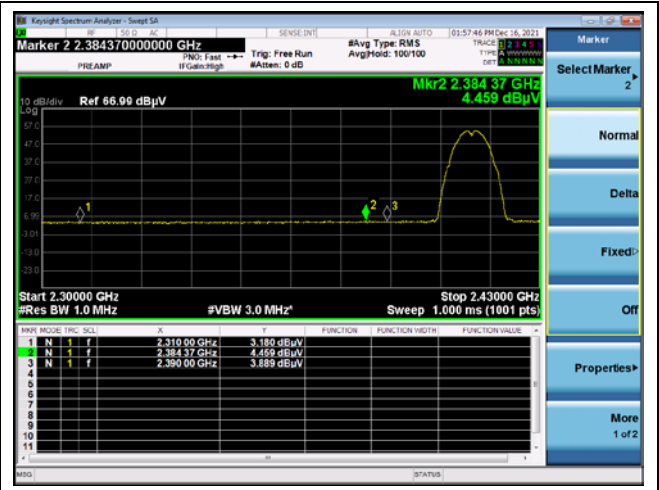
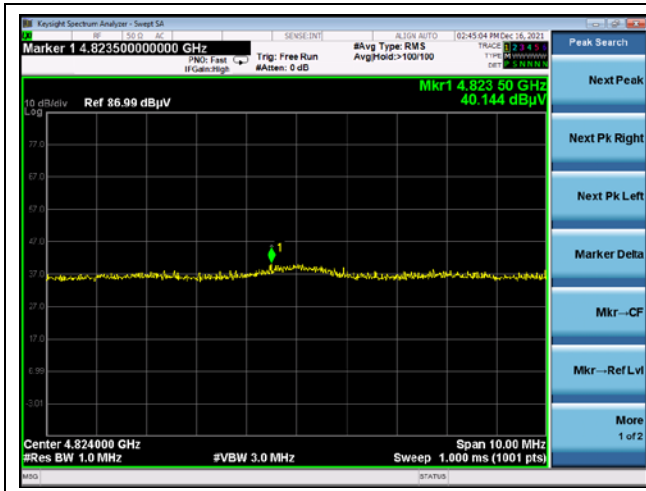
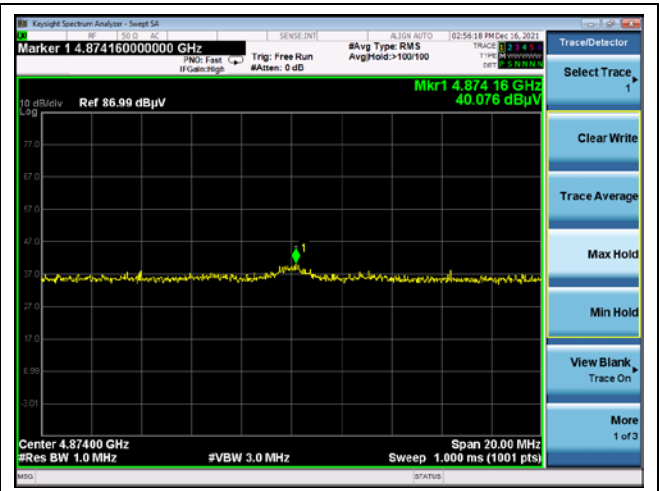
- Test plots

DSSS: 802.11b

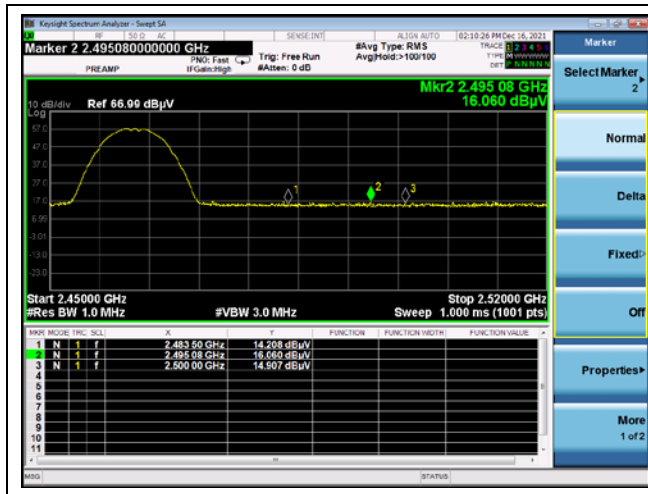
Low channel band edge (Peak)



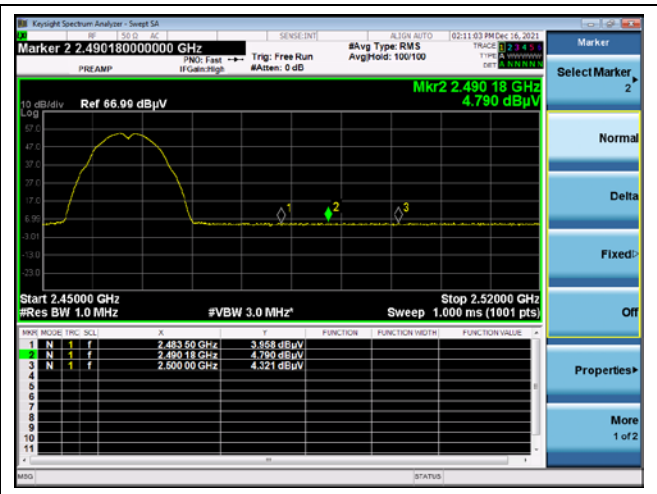
Low channel band edge (Average)


Low channel 2nd harmonic (Peak)

Middle channel 2nd harmonic (Peak)


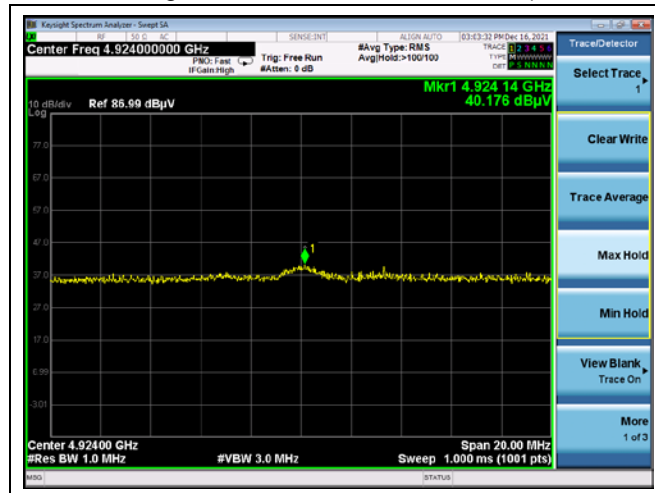
High channel band edge (Peak)



High channel band edge (Average)

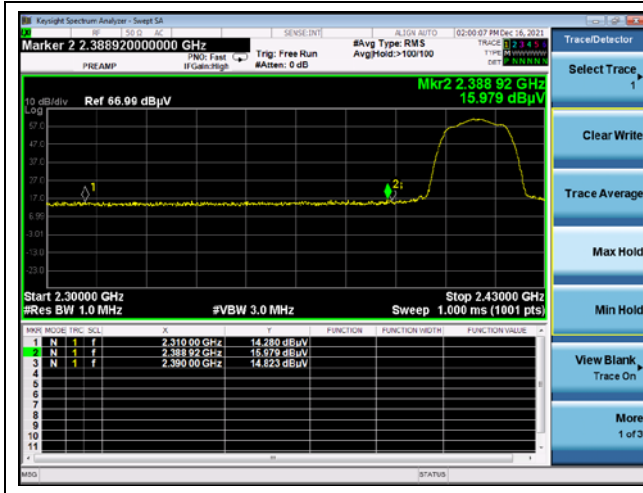


High channel 2nd harmonic (Peak)

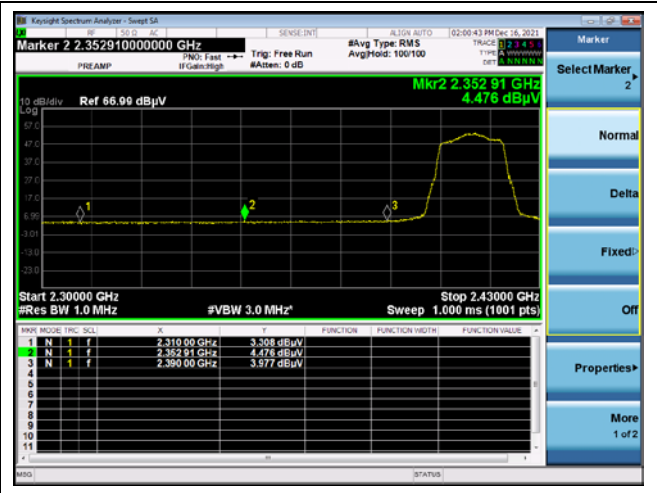


OFDM: 802.11g

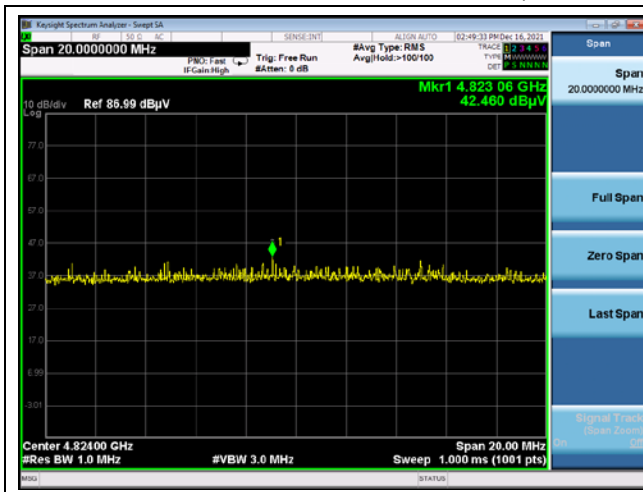
Low channel band edge (Peak)



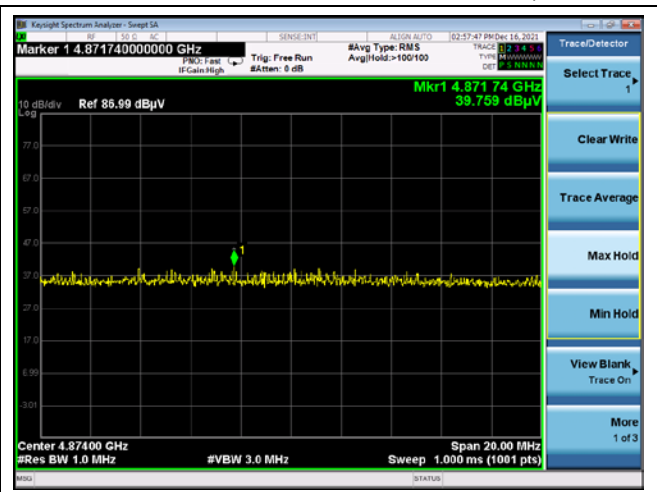
Low channel band edge (Average)



Low channel 2nd harmonic (Peak)



Middle channel 2nd harmonic (Peak)



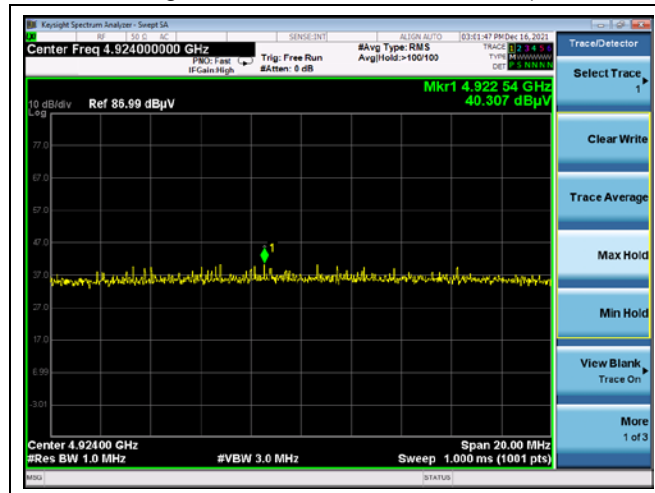
High channel band edge (Peak)



High channel band edge (Average)

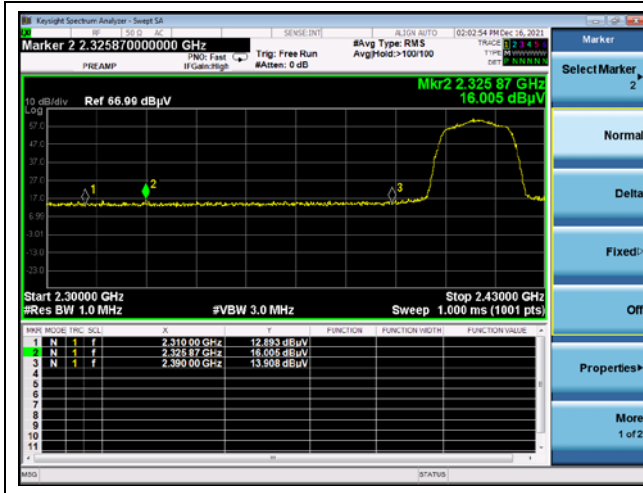


High channel 2nd harmonic (Peak)

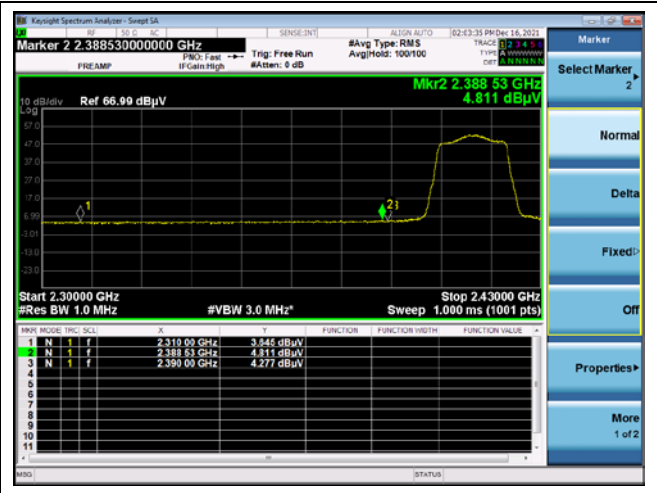


OFDM: 802.11n_HT20

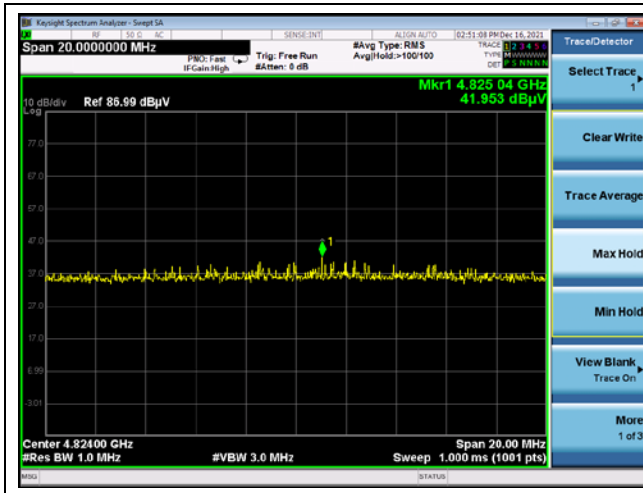
Low channel band edge (Peak)



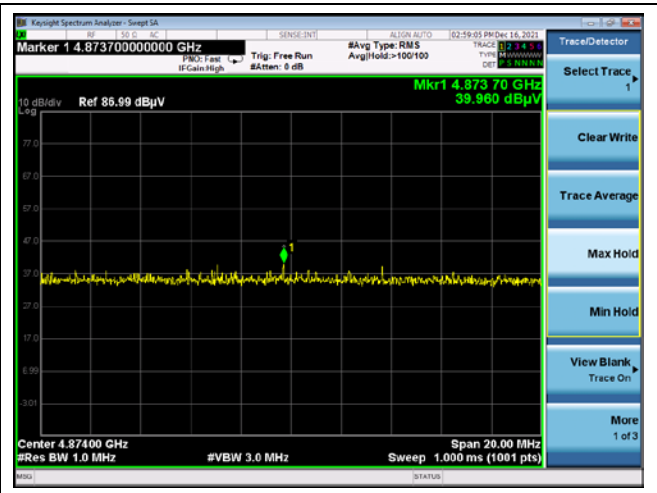
Low channel band edge (Average)



Low channel 2nd harmonic (Peak)



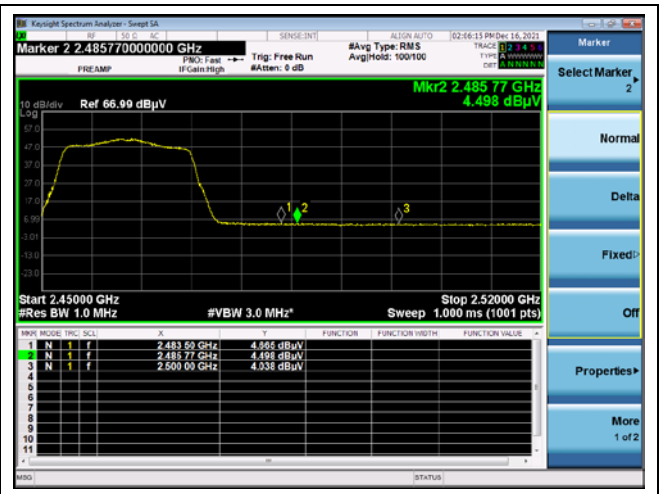
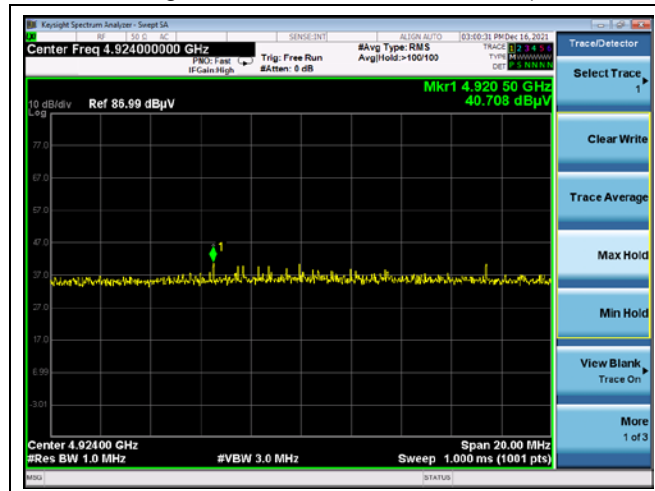
Middle channel 2nd harmonic (Peak)



High channel band edge (Peak)



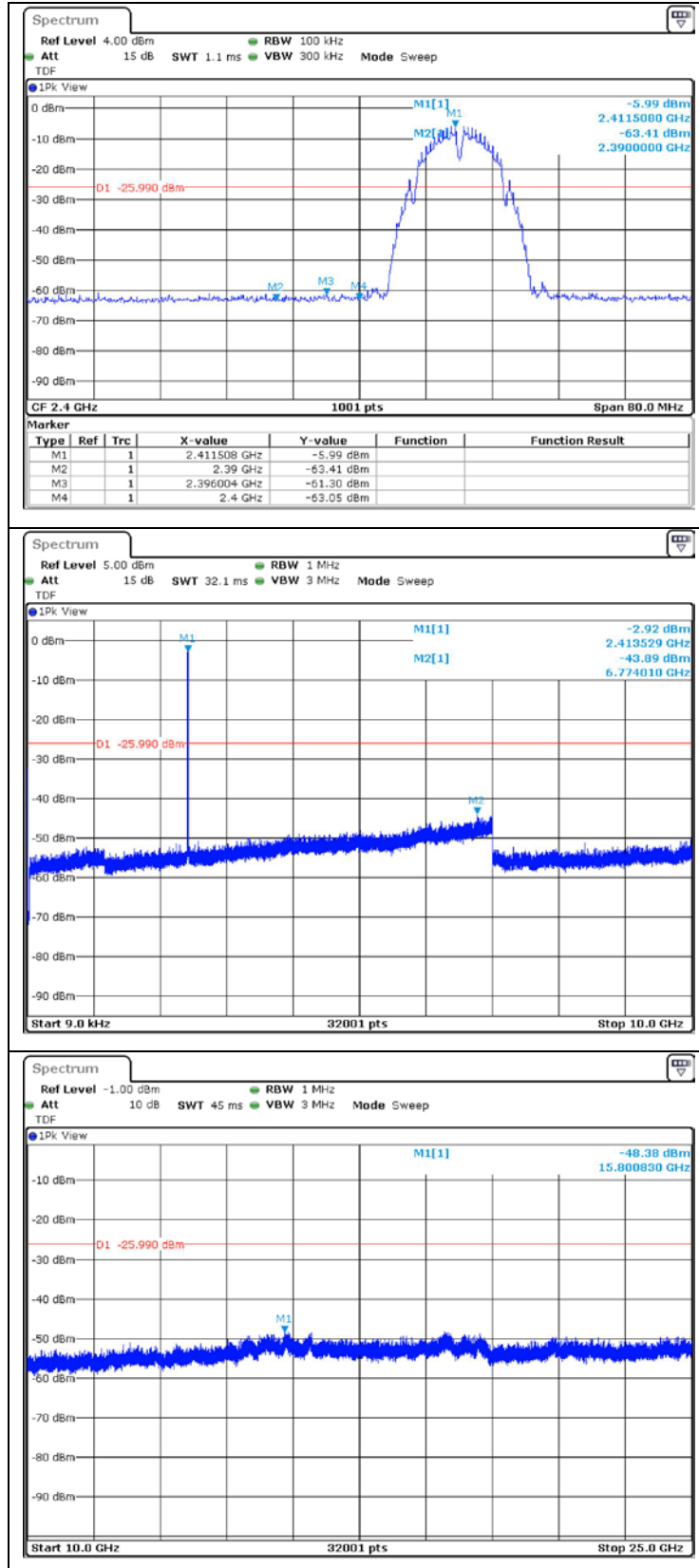
High channel band edge (Average)


High channel 2nd harmonic (Peak)


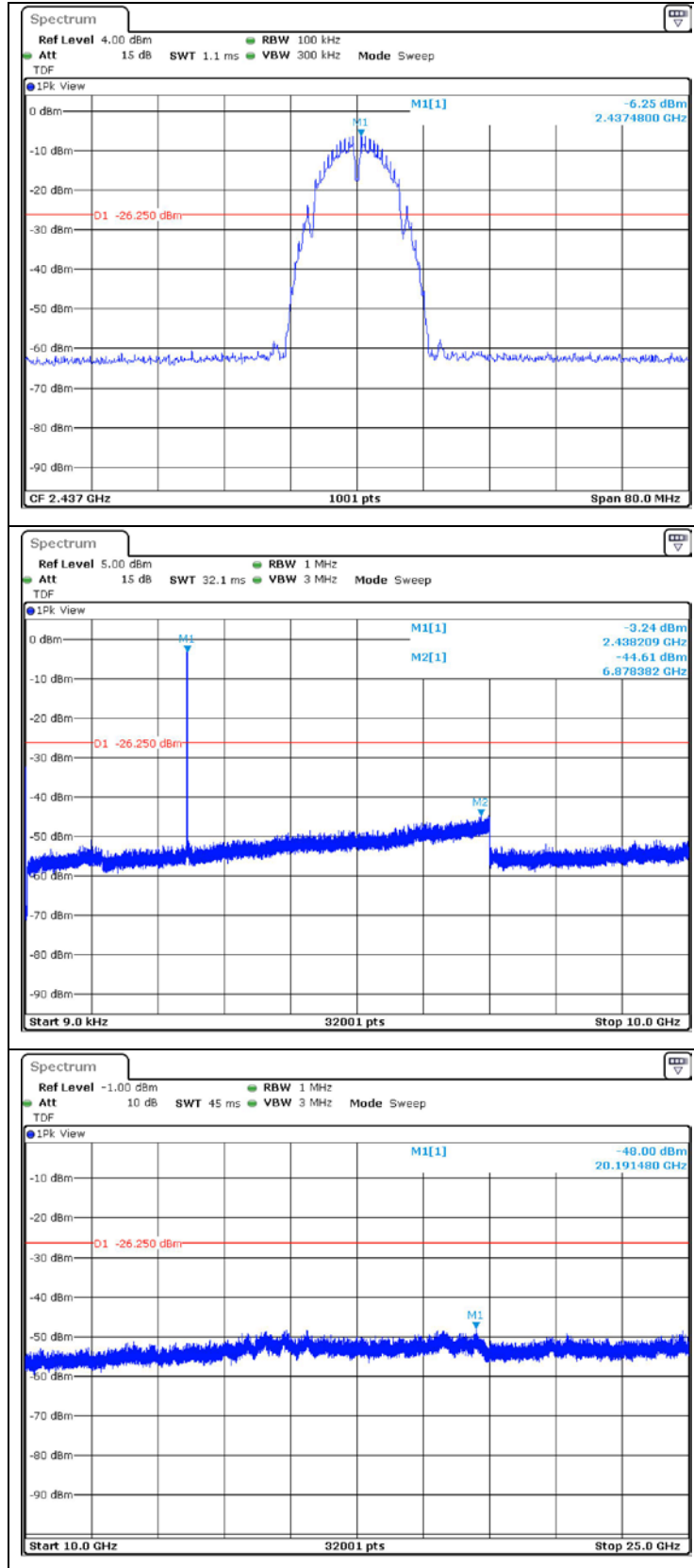
Plot of Conducted Spurious Emissions

DSSS: 802.11b

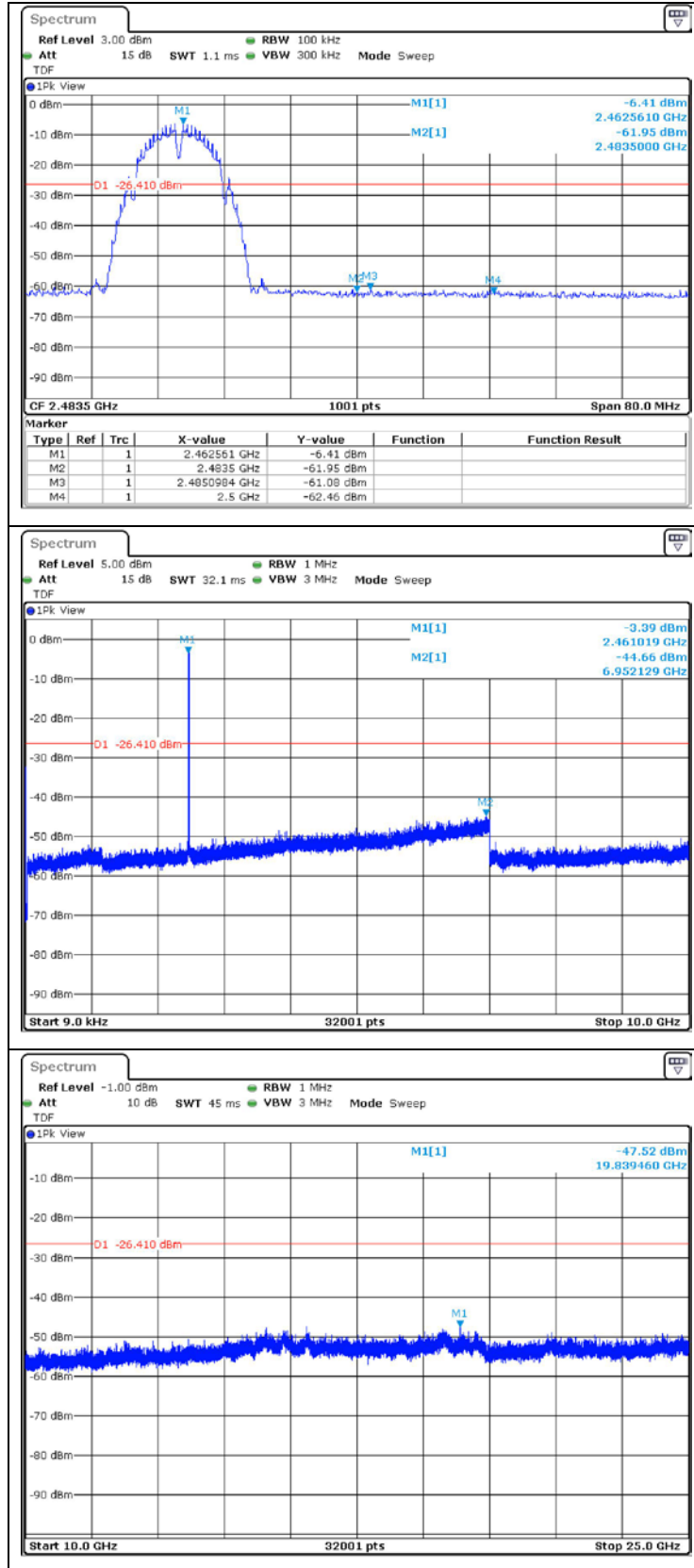
Low Channel

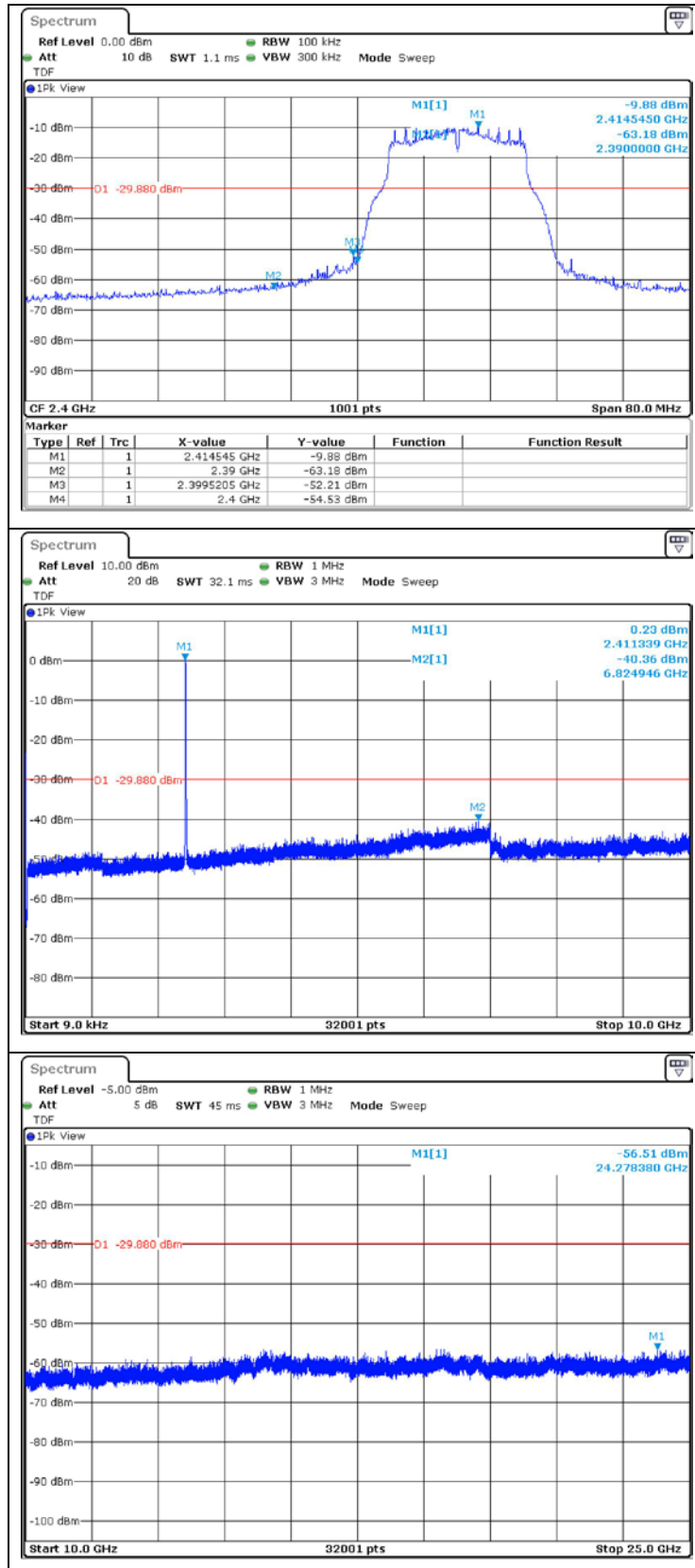


Middle Channel

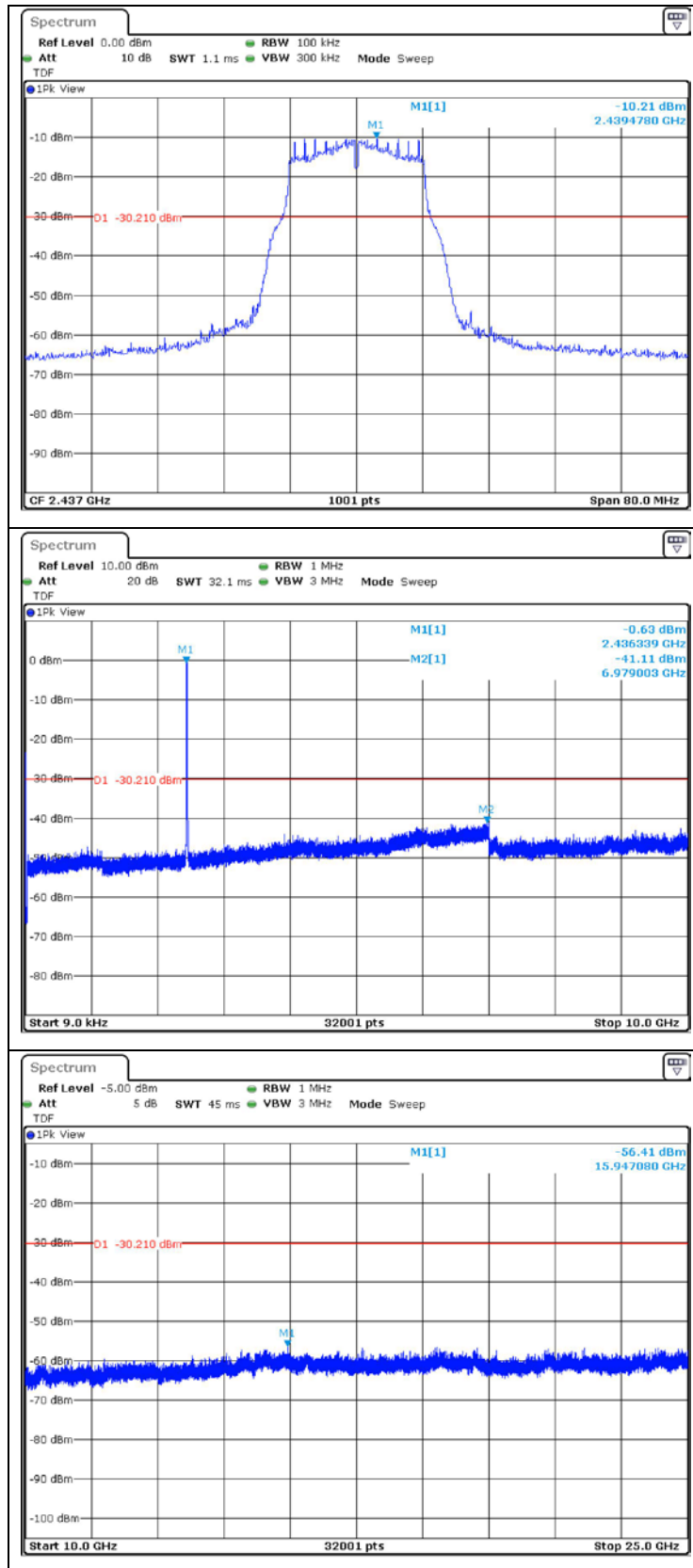


High Channel

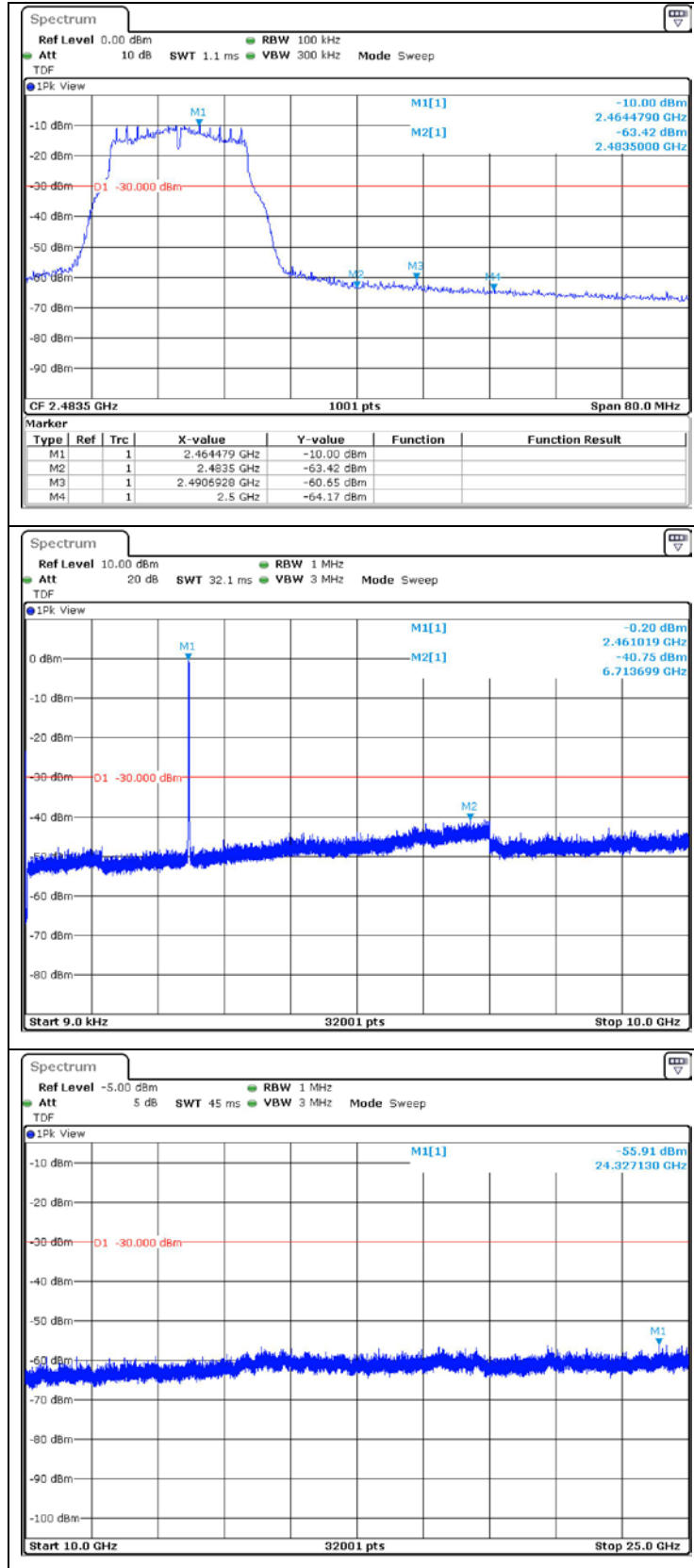


OFDM: 802.11g
Low Channel


Middle Channel

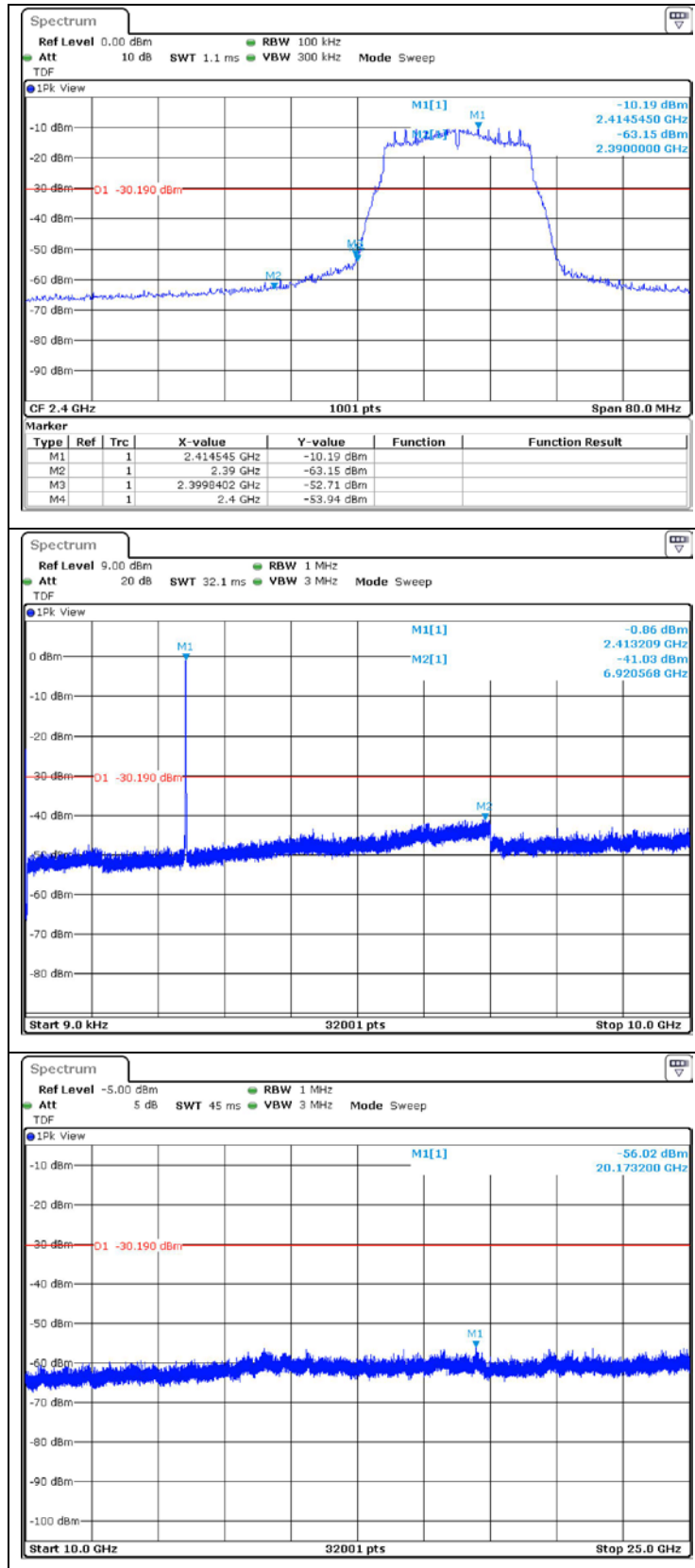


High Channel

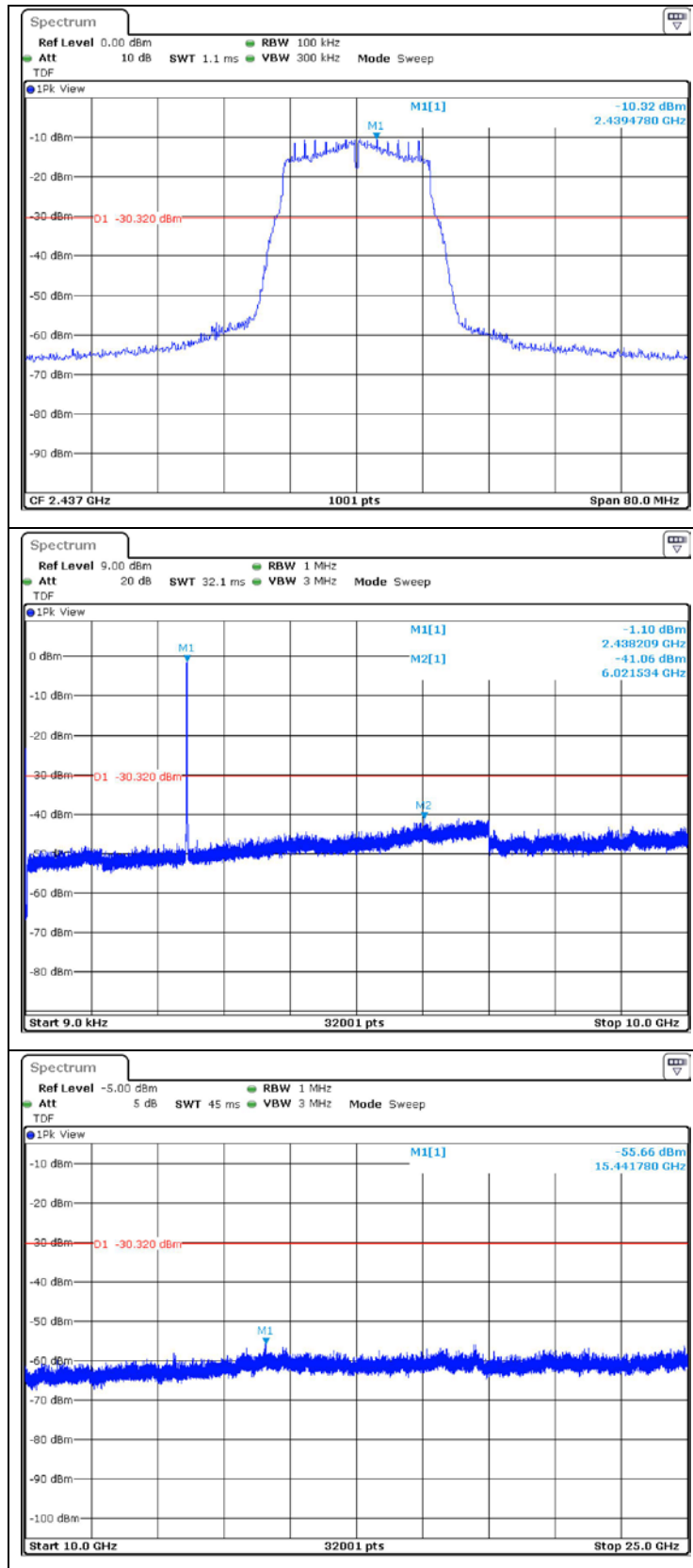


OFDM: 802.11n_HT20

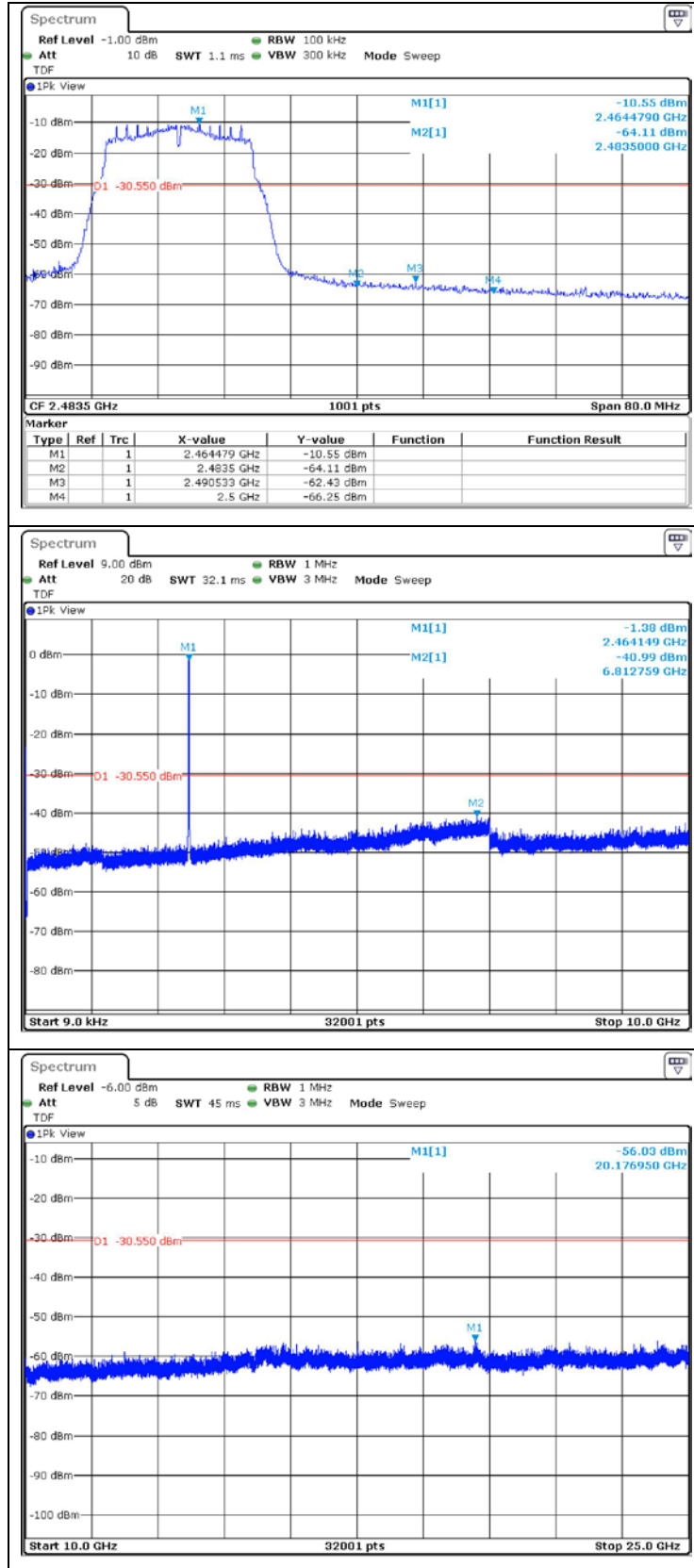
Low Channel



Middle Channel



High Channel



3. 6 dB Bandwidth

3.1. Test Setup



3.2. Limit

According to §15.247(a)(2), systems using digital modulation techniques may operate in the 902-928 MHz, 2 400-2 483.5 MHz, and 5 725-5 850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

3.3. Test Procedure

6 dB Bandwidth

The test follows section 11.8 DTS bandwidth of ANSI C63.10-2013.
 Tests performed using section 11.8.1 Option 1.

- Option 1:

1. Set RBW to = 100 kHz.
2. Set the VBW $\geq [3 \times \text{RBW}]$.
3. Detector = peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

3.4. Test Results

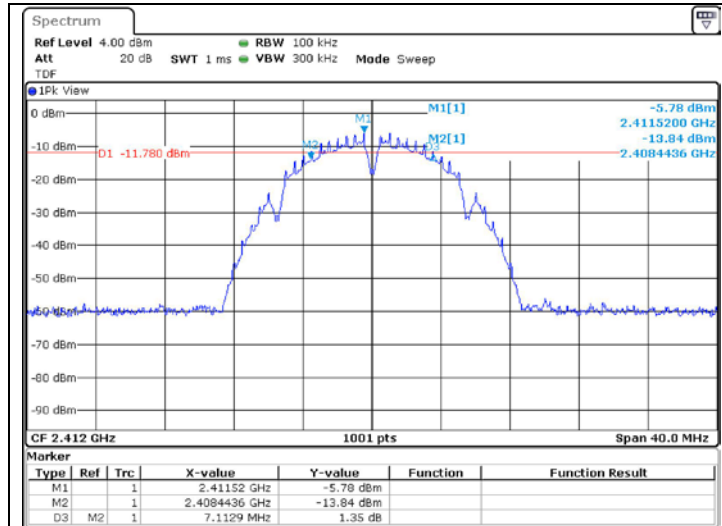
Ambient temperature : (23 ± 1) °C
 Relative humidity : 47 % R.H.

Operation Mode	Data Rate (Mbps)	Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (kHz)
DSSS (802.11b)	1	Low	2 412	7.113	500
		Middle	2 437	7.113	
		High	2 462	7.153	
OFDM (802.11g)	6	Low	2 412	16.344	
		Middle	2 437	16.344	
		High	2 462	16.384	
OFDM (802.11n_HT20)	MCS0	Low	2 412	17.622	
		Middle	2 437	17.343	
		High	2 462	17.343	

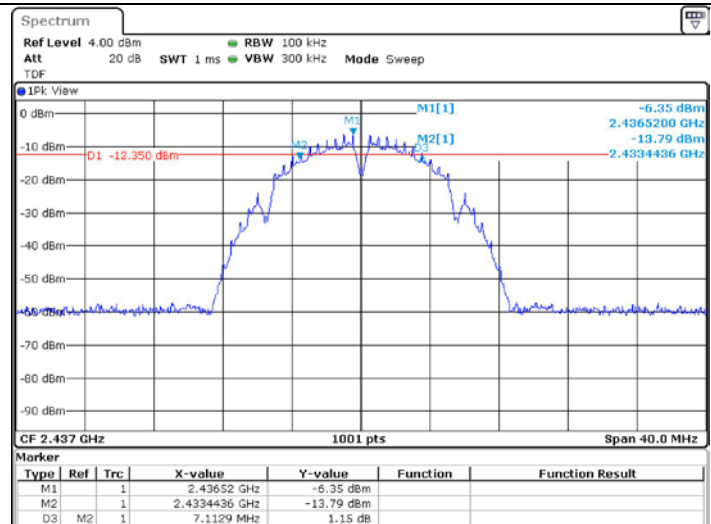
- Test plots

DSSS: 802.11b

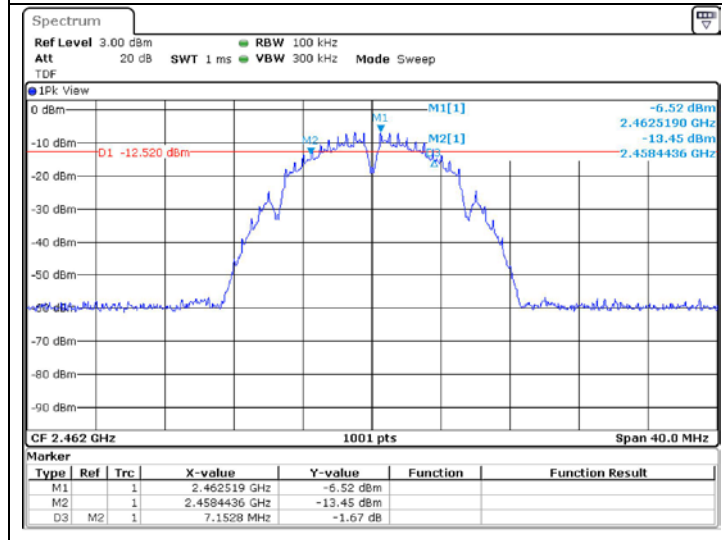
Low Channel



Middle Channel

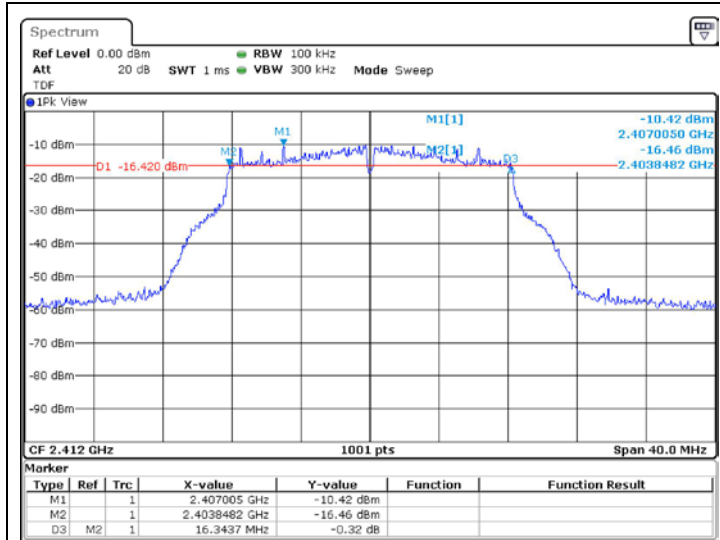


High Channel

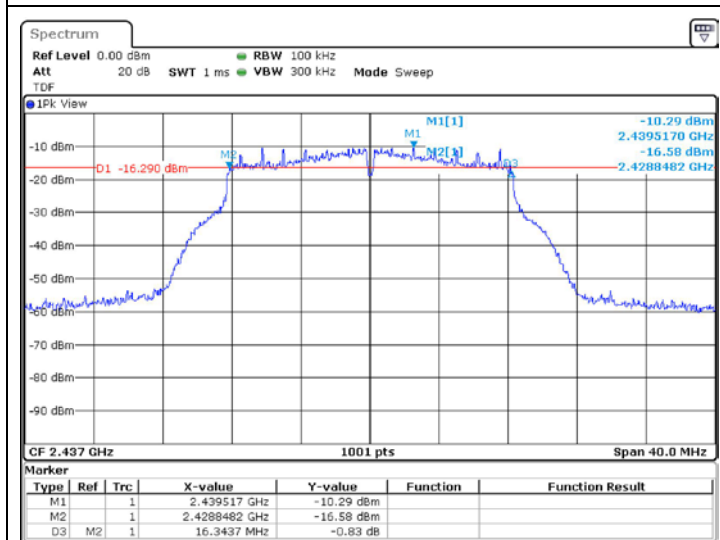


OFDM: 802.11g

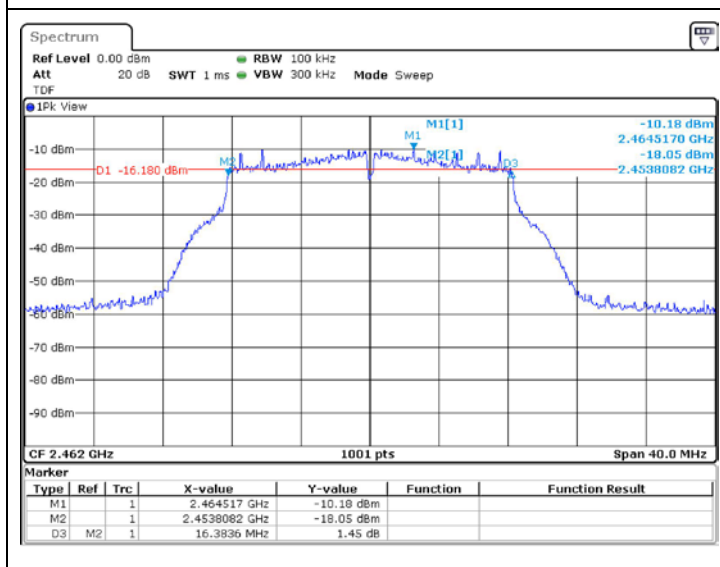
Low Channel



Middle Channel

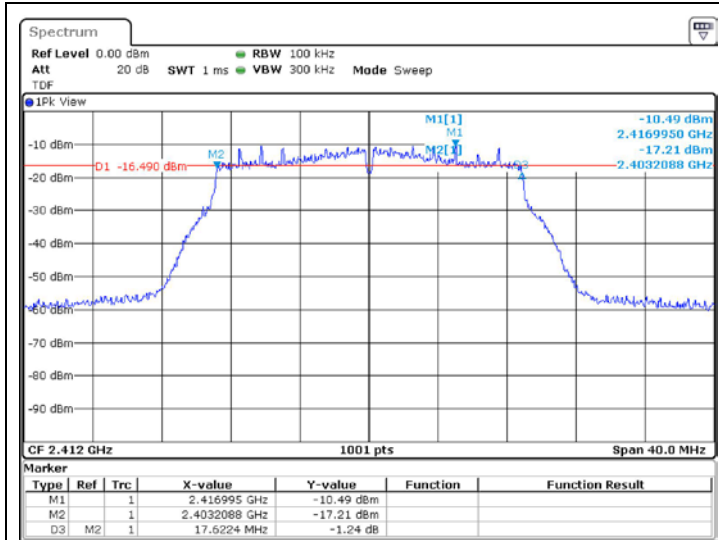


High Channel

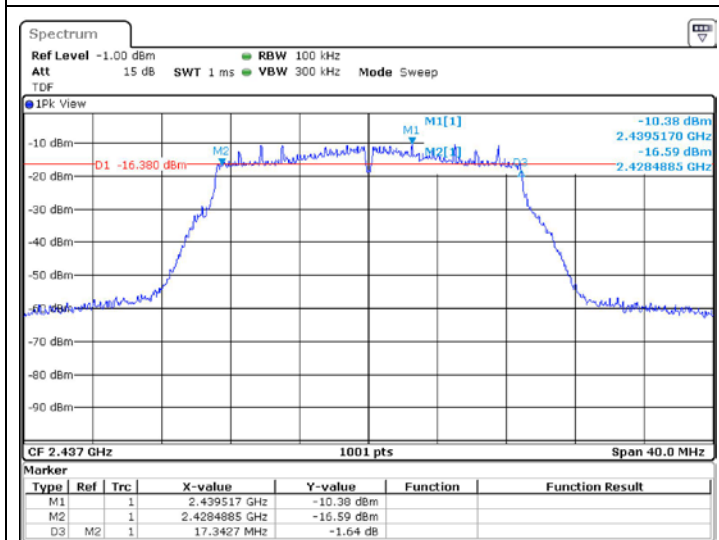


OFDM: 802.11n_HT20

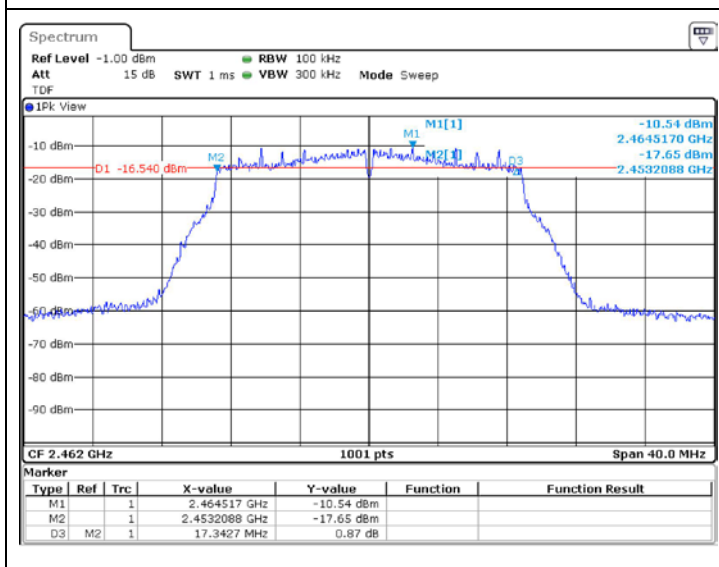
Low Channel



Middle Channel

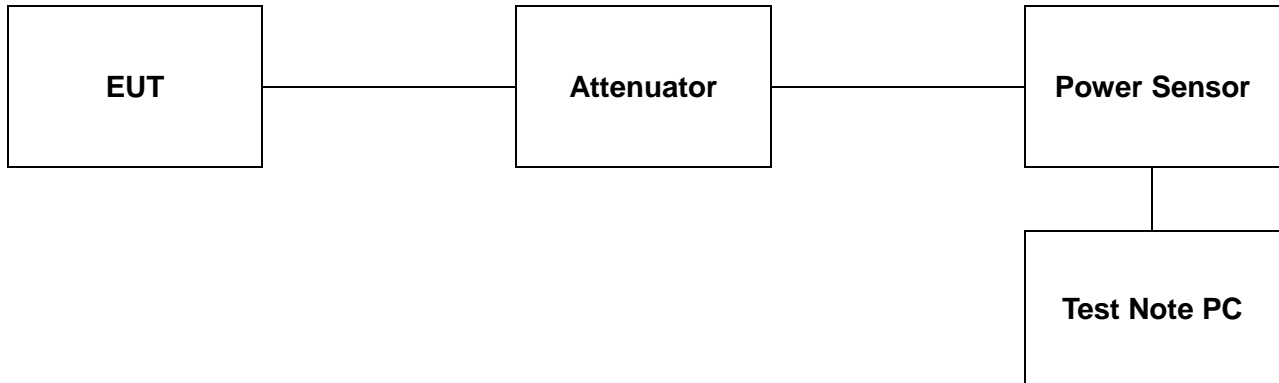


High Channel



4. Maximum Peak Conducted Output Power

4.1. Test Setup



4.2. Limit

According to §15.247(b)(3), for systems using digital modulation in the 902-928 MHz, 2 400-2 483.5 MHz, and 5 725-5 850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

According to §15.247(b)(4), the conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraph (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

4.3. Test Procedure

The test follows section 11.9.1.3 of ANSI C63.10-2013.

PKPM1 Peak-reading power meter method

- The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall utilize a fast-responding diode detector.

The test follows section 11.9.2.3.2 of ANSI C63.10-2013.

Method AVGPM-G (Measurement using a gated RF average-reading power meter)

- Alternatively, measurements may be performed using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since this measurement is made only during the ON time of the transmitter, no duty cycle correction is required.

Test program: (S/W name: R&S Power Viewer, Version: 3.2.0)

1. Initially overall offset for attenuator and cable loss is measured per frequency.
2. Measured offset is inserted in test program in advance of measurement for output power.
3. Power for each frequency (channel) of device is investigated as final result.
4. Final result reported on this section from R&S power viewer program includes with several factors and test program shows only final result.

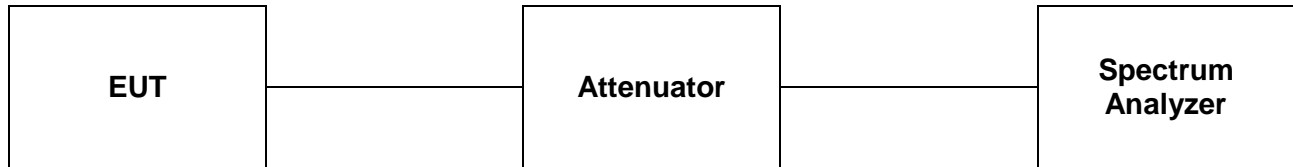
4.4. Test Results

Ambient temperature : (23 ± 1) °C
 Relative humidity : 47 % R.H.

Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	Average Power Result (dB m)	Peak Power Result (dB m)	Limit (dB m)
DSSS (802.11b)	Low	2 412	1	<u>3.32</u>	<u>6.61</u>	30
	Middle	2 437		2.93	6.23	
	High	2 462		2.96	6.25	
OFDM (802.11g)	Low	2 412	6	<u>4.17</u>	<u>15.32</u>	
	Middle	2 437		3.68	14.83	
	High	2 462		3.36	14.58	
OFDM (802.11n_HT20)	Low	2 412	MCS0	<u>3.18</u>	14.97	
	Middle	2 437		3.15	<u>15.40</u>	
	High	2 462		2.88	14.83	

5. Power Spectral Density

5.1. Test Setup



5.2. Limit

According to §15.247(e), for digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

5.3. Test Procedure

The measurements are recorded using the PKPSD measurement procedure in section 11.10.2 of ANSI C63.10-2013.

- This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance, and is optional if the maximum conducted (average) output power was used to demonstrate compliance.

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the DTS bandwidth.
3. Set the RBW to $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.
4. Set the VBW $\geq [3 \times \text{RBW}]$.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat.

5.4. Test Results

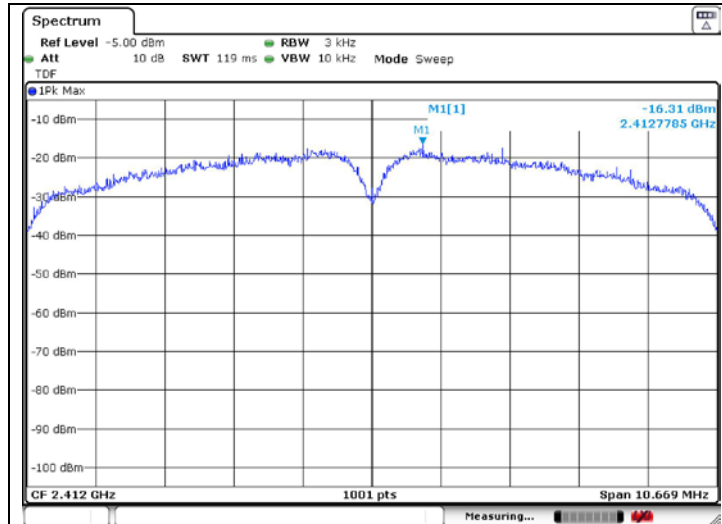
Ambient temperature : (23 ± 1) °C
 Relative humidity : 47 % R.H.

Operation Mode	Data Rate (Mbps)	Channel	Frequency (MHz)	Measured PSD (dB m/3 kHz)	Limit (dB m/3 kHz)
DSSS (802.11b)	1	Low	2 412	-16.31	8
		Middle	2 437	-16.81	
		High	2 462	-17.14	
OFDM (802.11g)	6	Low	2 412	-18.87	
		Middle	2 437	-19.12	
		High	2 462	-19.27	
OFDM (802.11n_HT20)	MCS0	Low	2 412	-19.34	
		Middle	2 437	-20.54	
		High	2 462	-20.48	

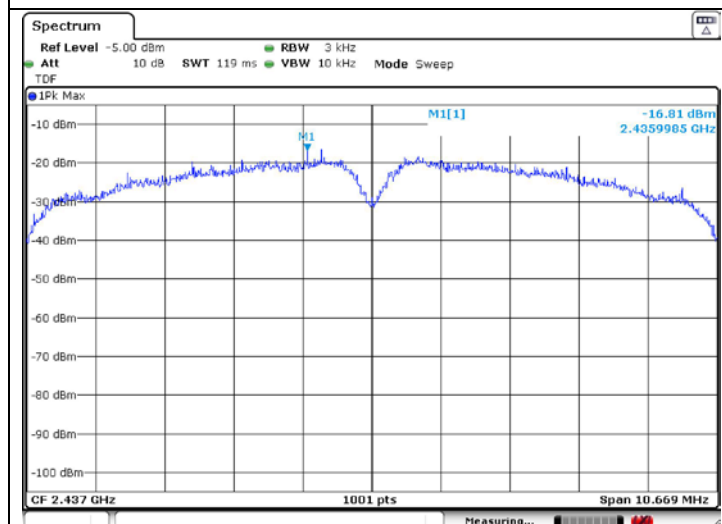
- Test plots

DSSS: 802.11b

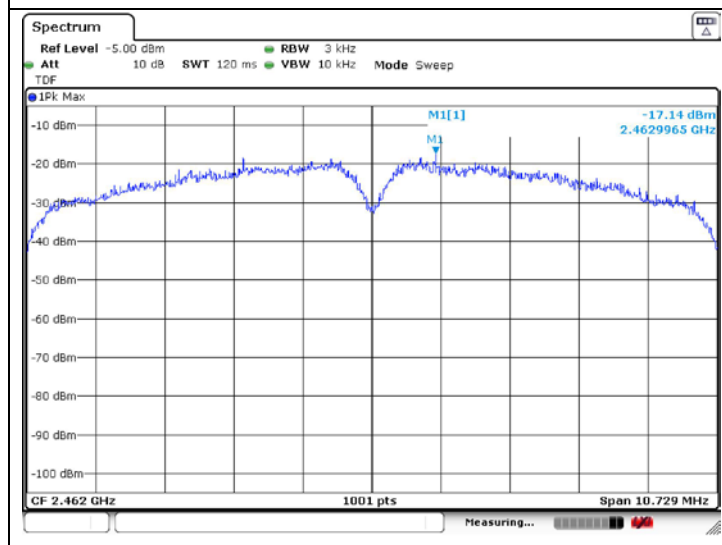
Low Channel



Middle Channel

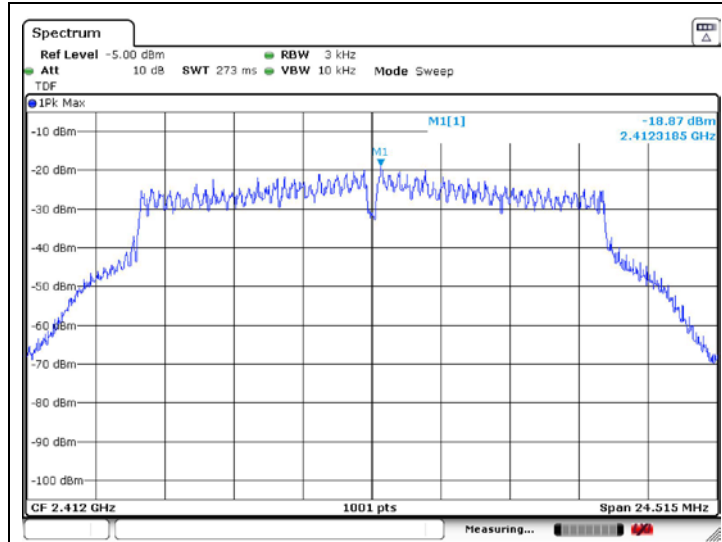


High Channel

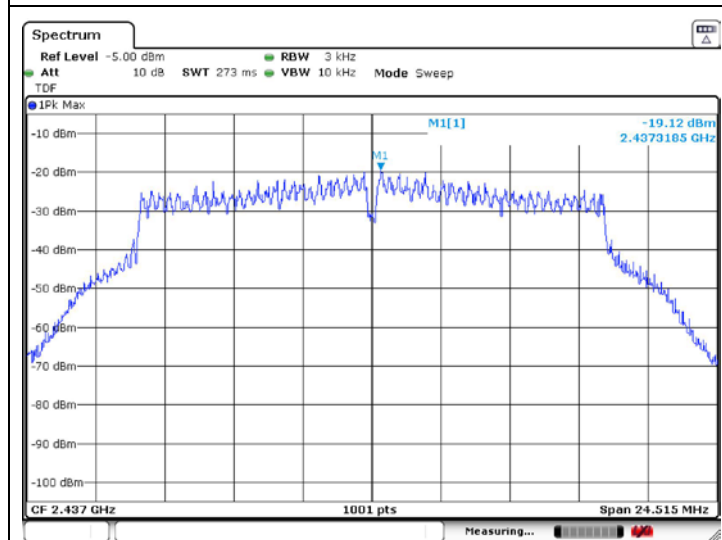


OFDM: 802.11g

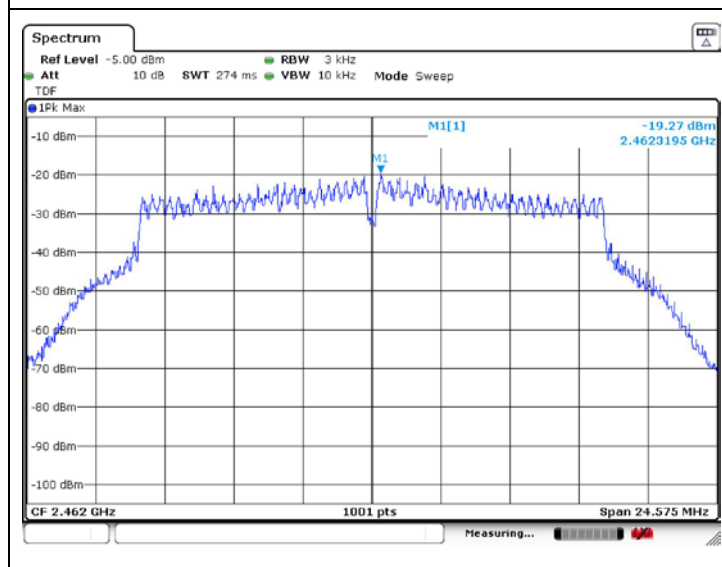
Low Channel



Middle Channel

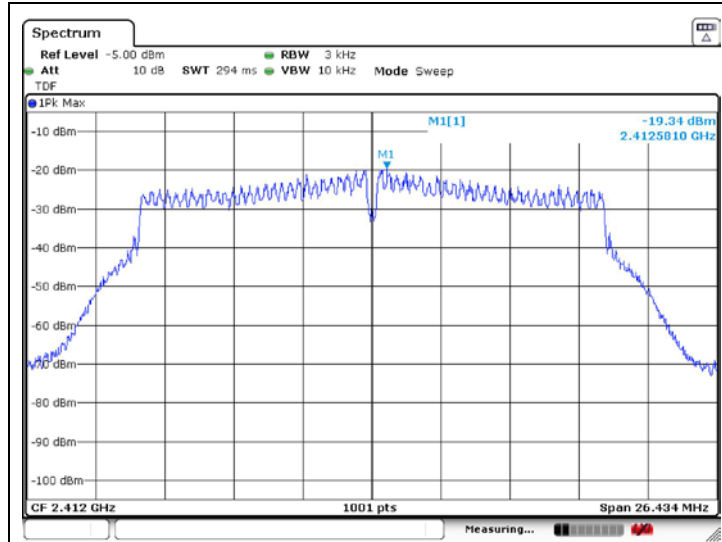


High Channel

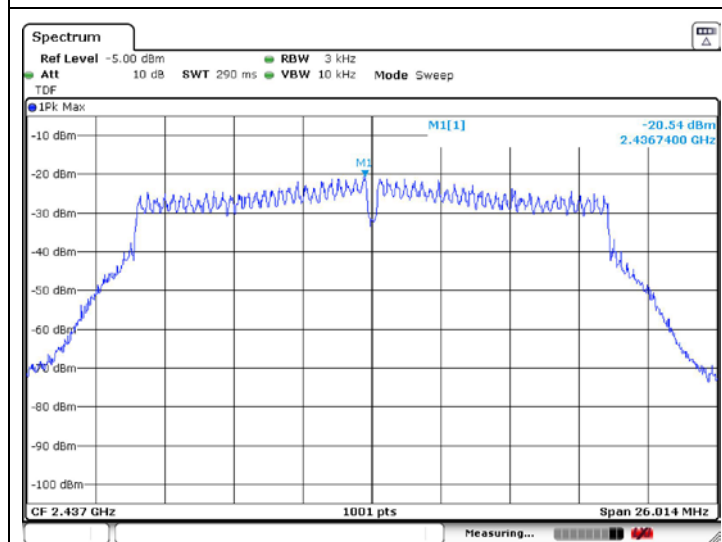


OFDM: 802.11n_HT20

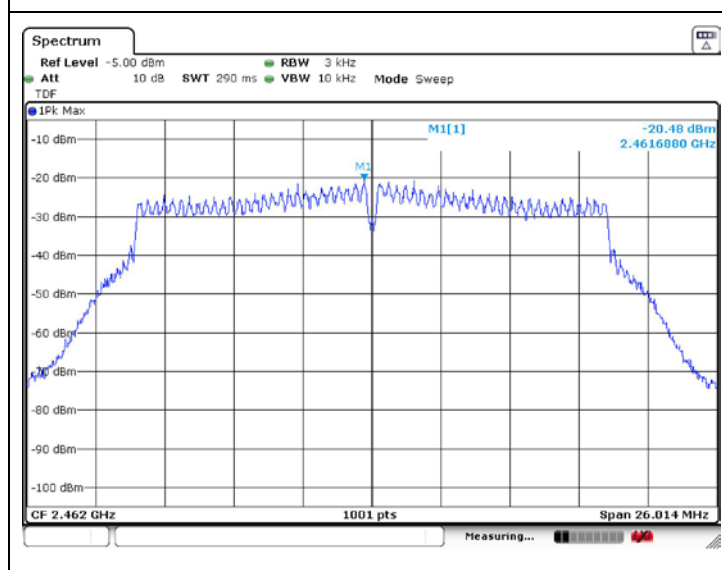
Low Channel



Middle Channel



High Channel



6. Antenna Requirement

6.1. Standard Applicable

For intentional device, according to FCC 47 CFR Section §15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section and according to FCC 47 CFR Section §15.247(b) if transmitting antennas of directional gain greater than 6 dB i are used, the power shall be reduced by the amount in dB that the gain of the antenna exceeds 6 dB i.

6.2. Antenna Connected Construction

Antenna used in this product is Pattern Antenna with gain of -0.01 dB i.

- End of the Test Report -