

TEST REPORT

Part 15 Subpart E 15.407

Equipment under test Wireless Module

Model name EXT AP

FCC ID RNH-EXTAP

Applicant DRTECH Corporation

Manufacturer DRTECH Corporation

Date of test(s) 2020.07.27 ~ 2020.08.22

Date of issue 2020.09.02

Issued to

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Test report No.:
KES-RF1-20T0136
Page (2) of (138)

Revision history

Revision	Date of issue	Test report No.	Description
-	2020.09.02	KES-RF1-20T0136	Initial

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TABLE OF CONTENTS

1.	General information	4
1.1.	EUT description	5
1.2.	Test configuration.....	6
1.3.	Device modifications.....	6
1.4.	Frequency/channel operations	6
1.5.	Maximum average output power	7
1.6.	Accessory information.....	7
1.7.	Measurement results explanation example	7
1.8.	Measurement Uncertainty	7
2.	Summary of tests	8
3.	Test results.....	9
3.1.	26 dB bandwidth & 99% Occupied Bandwidth	9
3.2.	6 dB bandwidth	23
3.3.	Maximum conducted output power	29
3.4.	Maximum Power spectral density	32
3.5.	Frequency Stability.....	39
3.6.	Radiated restricted band and emissions.....	44
3.7.	AC conducted emissions	135
Appendix A.	Measurement equipment	137
Appendix B.	Test setup photos	138

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1. General information

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Test Facility FCC Accreditation Designation No.: KR0100, Registration No.: 444148
FCC rule part(s): 15.407
FCC ID: RNH-EXTAP
Test device serial No.: ☒ Production ☐ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test	Wireless Module	
Frequency range	2 402 MHz ~ 2 480 MHz (BDR) 2 412 MHz ~ 2 462 MHz (11n_HT20) UNII-1 5 180 MHz ~ 5 240 MHz (11n_HT20) 5 190 MHz ~ 5 230 MHz (11n_HT40) 5 210 MHz (11ac_VHT80) UNII-3 5 745 MHz ~ 5 825 MHz (11n_HT20) 5 755 MHz ~ 5 795 MHz (11n_HT40) 5 775 MHz (11ac_VHT80)	
Model:	EXT AP	
Modulation technique	WIFI : OFDM BT : GFSK	
Number of channels	2 402 MHz ~ 2 480 MHz (BDR) : 79 ch 2 412 MHz ~ 2 462 MHz (11n_HT20) : 11 ch 5 180 MHz ~ 5 240 MHz (11n_HT20) : 4ch 5 190 MHz ~ 5 230 MHz (11n_HT40) : 2ch 5 210 MHz (11ac_VHT80) : 1ch 5 745 MHz ~ 5 825 MHz (11n_HT20) : 5ch 5 755 MHz ~ 5 795 MHz (11n_HT40) : 2ch 5 775 MHz (11ac_VHT80) : 1ch	
Antenna specification	2.4 GHz Antenna type : Dipole antenna, 5 GHz Antenna type : : Dipole antenna,	Peak gain : 2.28 dBi Peak gain(UNII-1) : 2.94 dBi Peak gain(UNII-3) : 2.96 dBi
Power source	DC 5.0 V	
H/W version	V2.1	
S/W version	V1.0.7	

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1.2. Test configuration

The **DRTECH Corporation // EXT AP // FCC ID: RNH-EXTAP** was tested per the guidance of KDB 789033 D02 v02r01. ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing and AC line conducted testing.

1.3. Device modifications

N/A

1.4. Frequency/channel operations

UNII-1

Ch.	Frequency (MHz)
36	5 180
44	5 220
48	5 240

UNII-3

Ch.	Frequency (MHz)
149	5 74
157	5 7 5
165	5 825

Table 1.7-1. 802.11n_HT20 mode

UNII-1

Ch.	Frequency (MHz)
38	5 190
46	5 230

UNII-3

Ch.	Frequency (MHz)
151	5 755
159	5 795

Table 1.7-2. 802.11n_HT40 mode

UNII-1

Ch.	Frequency (MHz)
42	5 210

UNII-3

Ch.	Frequency (MHz)
55	5 75

Table 1.7-3. 802.11ac_VHT80 mode

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1.5. Maximum average output power

Refer to the average output power.

Note.

1. Radiated emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.
2. Worst-case data rates as provided by the client were:
 UNII-1 n_HT 20/40 : MCS8, ac_VHT 80 : MCS8
 UNII-3 n_HT 20/40 : MCS8, ac_VHT 80 : MCS8

1.6. Accessory information

Equipment	Manufacturer	Model	Serial No.	Power source
-	-	-	-	-

1.7. 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.

$$\begin{aligned}\text{Offset(dB)} &= \text{RF cable loss(dB)} + \text{attenuator factor(dB)} \\ &= 1.78 + 10 = 11.78 \text{ (dB)}\end{aligned}$$

1.8 Measurement Uncertainty

Test Item		Uncertainty
Uncertainty for Conduction emission test		2.46 dB
Uncertainty for Radiation emission test (include Fundamental emission)	Below 1GHz	4.40 dB
	Above 1GHz	5.94 dB
Note. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.		

2. Summary of tests

Reference	Parameter	Test results
15.407(a)	26 dB bandwidth & 99 % Occupied Bandwidth	Pass
15.407(a)	Maximum conducted output power	Pass
15.407(a)	Power spectral density	Pass
15.407(g)	Frequency stability	Pass
15.205 15.209	Radiated restricted band and emission	Pass
15.407(d)	General field strength limit (Restricted bands and radiated emission limit)	Pass
15.207	AC power line conducted emissions	Pass

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3. Test results

3.1. 26 dB bandwidth & 99% Occupied Bandwidth

Test procedure

KDB 789033 D02 v02r01– Section C.1

Test setup



Section C.1

1. Set RBW = approximately 1% of the emission bandwidth.
2. Set the VBW > RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Measure the maximum width of the emission that is 26 dB down from the peak of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1%.

Limit

N/A

99 % bandwidth

KDB 789033 D02 v02r01– Section D

1. Set span = 1.5 times to 5.0 times the OBW.
2. Set RBW = 1% to 5% of the OBW
3. Set the VBW > 3 x RBW.
4. Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak bandwidth function of the instrument (if available).
5. Use the 99% power bandwidth function of the instrument (if available).
6. If the instrument does not have a 99% power bandwidth function, the trace data points are recovered and directly summed in power units. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% occupied bandwidth is the difference between these two frequencies.

Test results
Antenna port 1

Band	Frequency(MHz)	Mode	26 dB bandwidth(MHz)	99% Bandwidth(MHz)
UNII-1	5 180	HT20	21.71	18.02
	5 220		21.20	18.16
	5 240		21.64	18.31
UNII-3	5745		21.64	18.09
	5785		21.64	18.09
	5825		21.71	18.09
UNII-1	5190	HT40	40.17	36.58
	5230		39.94	36.58
UNII-3	5755		39.94	36.35
	5795		40.17	36.70
UNII-1	5210	VHT80	81.27	75.54
UNII-3	5775		82.14	75.72

Antenna port 2

Band	Frequency(MHz)	Mode	26 dB bandwidth(MHz)	99% Bandwidth(MHz)
UNII-1	5 180	HT20	21.42	17.87
	5 220		21.49	17.80
	5 240		21.49	17.87
UNII-3	5745		21.42	17.80
	5785		21.71	17.87
	5825		21.49	17.80
UNII-1	5190	HT40	39.36	36.35
	5230		39.48	36.35
UNII-3	5755		39.25	36.58
	5795		39.36	36.53
UNII-1	5210	VHT80	80.41	75.37
UNII-3	5775		80.75	75.54

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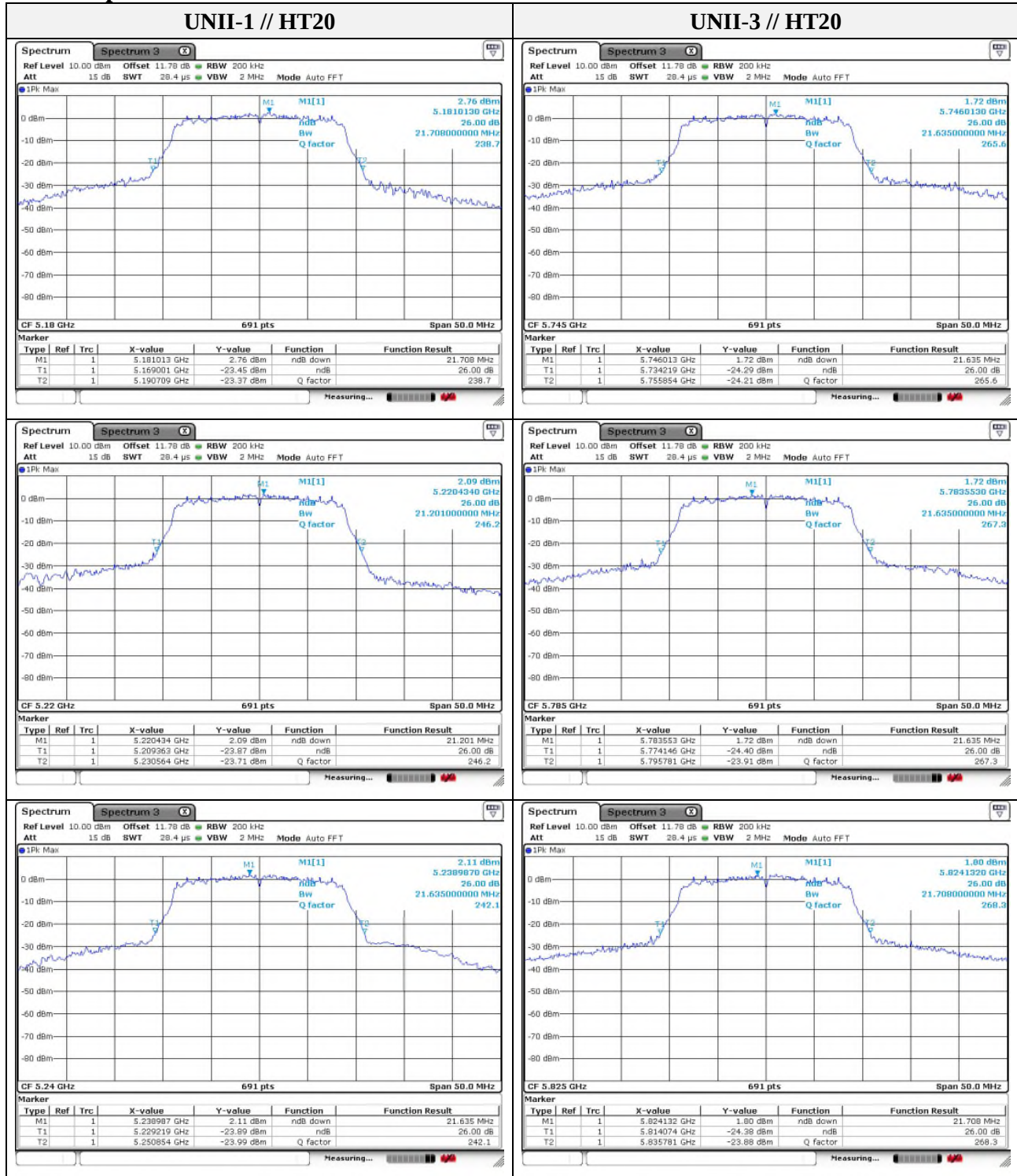
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26 dB bandwidth

Test plots

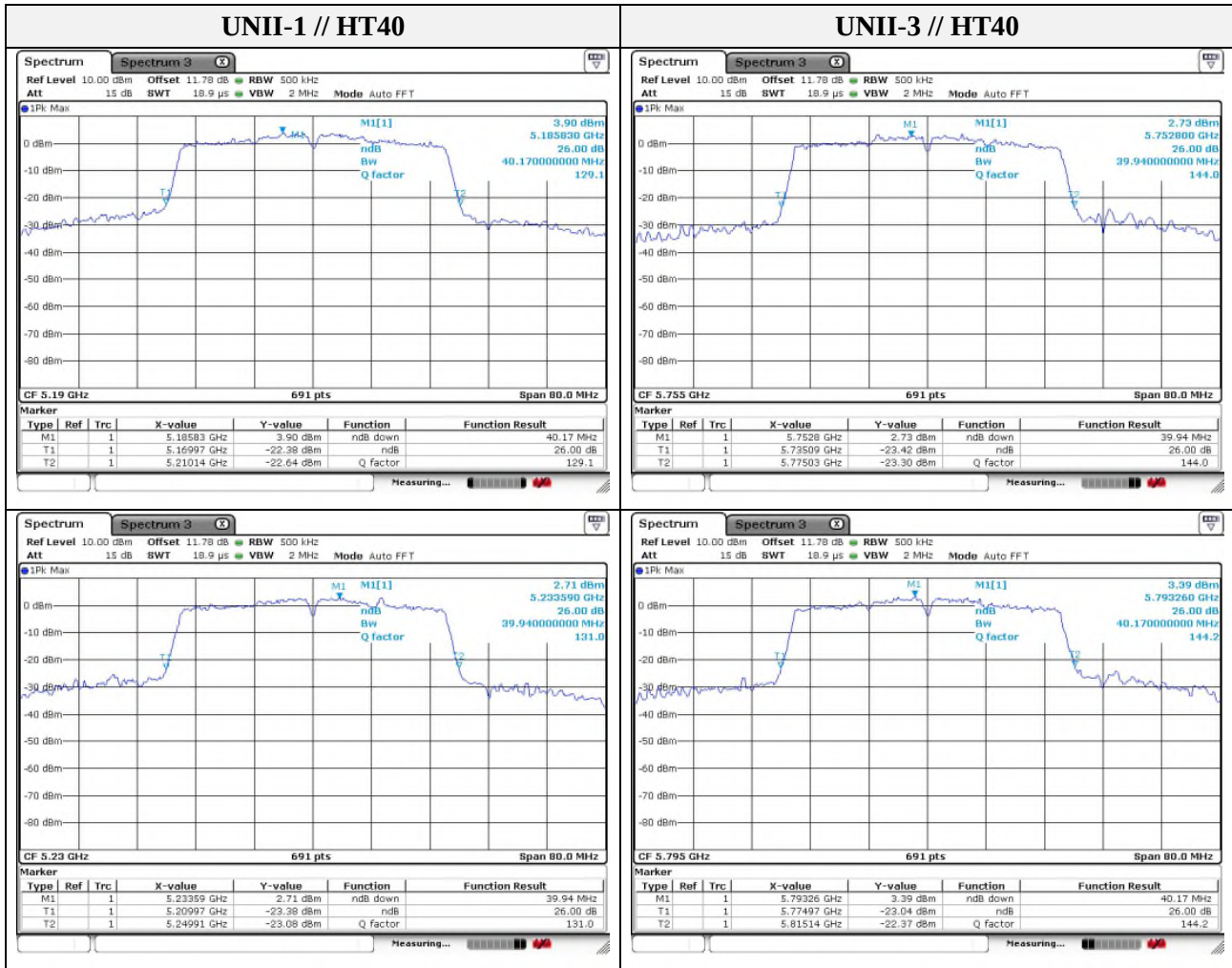
Antenna port 1



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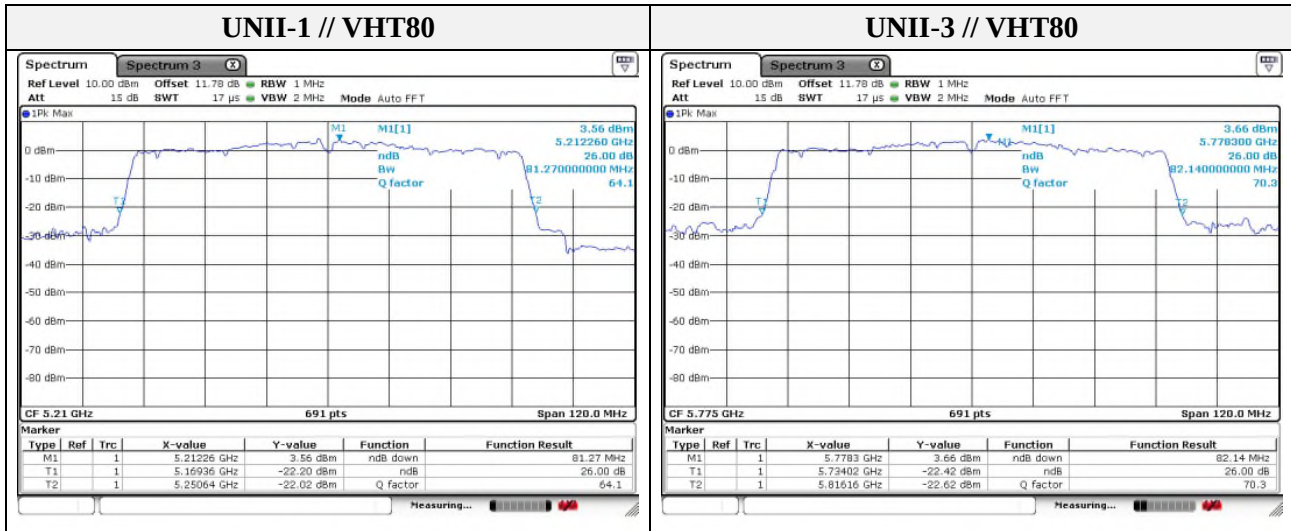
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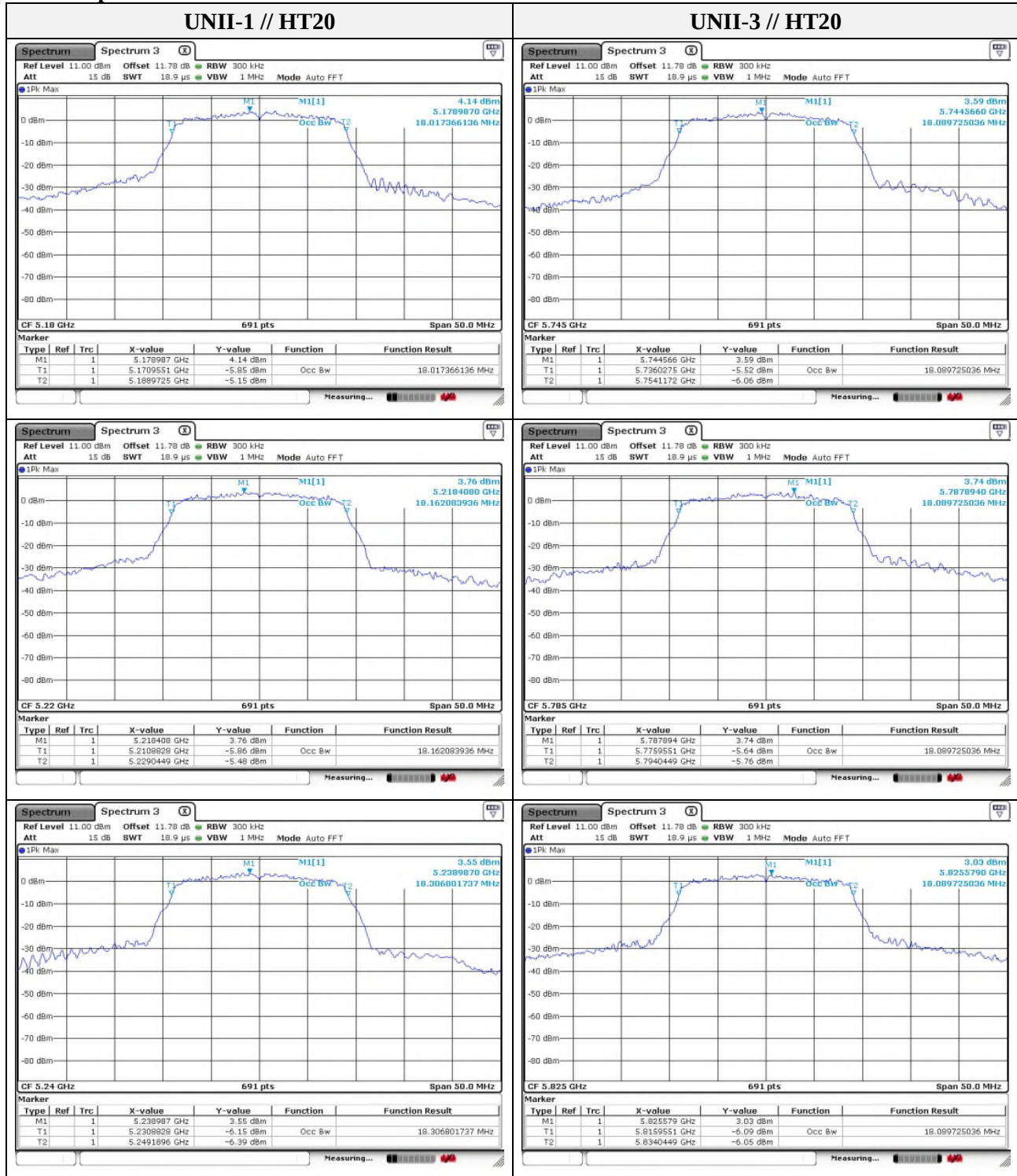
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99% Occupied Bandwidth

Test plots

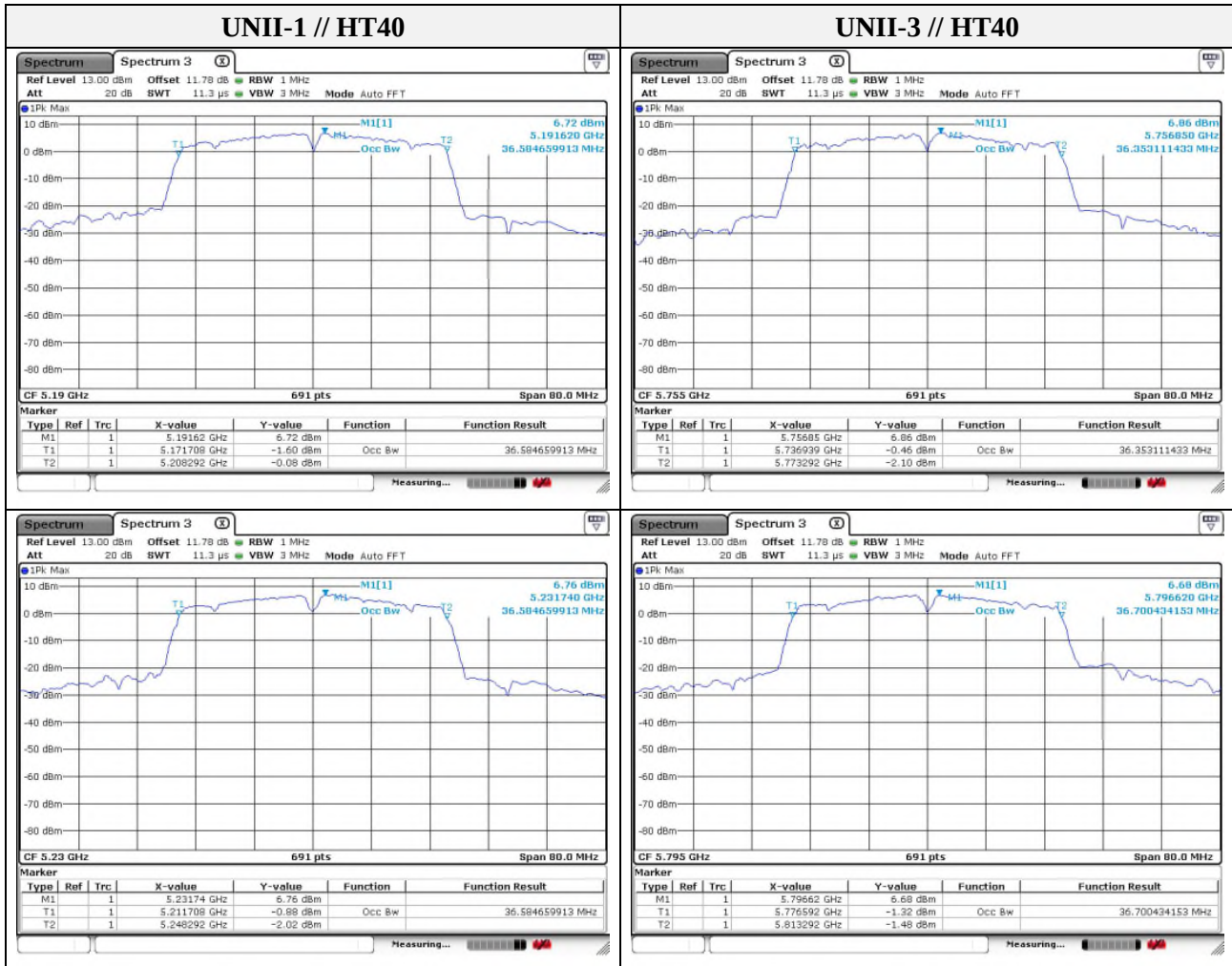
Antenna port 1



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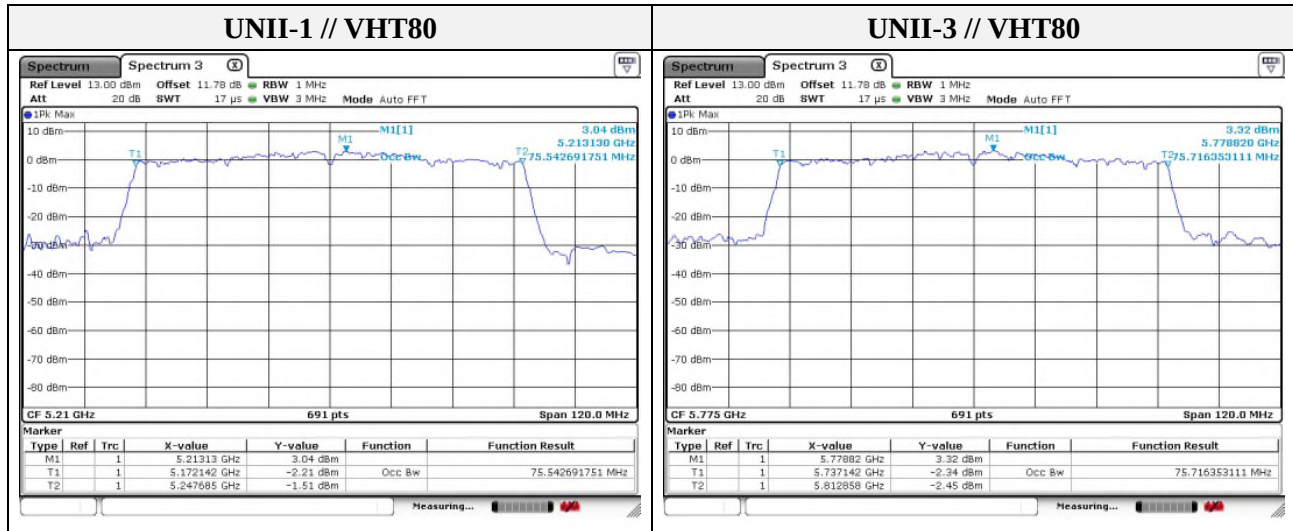
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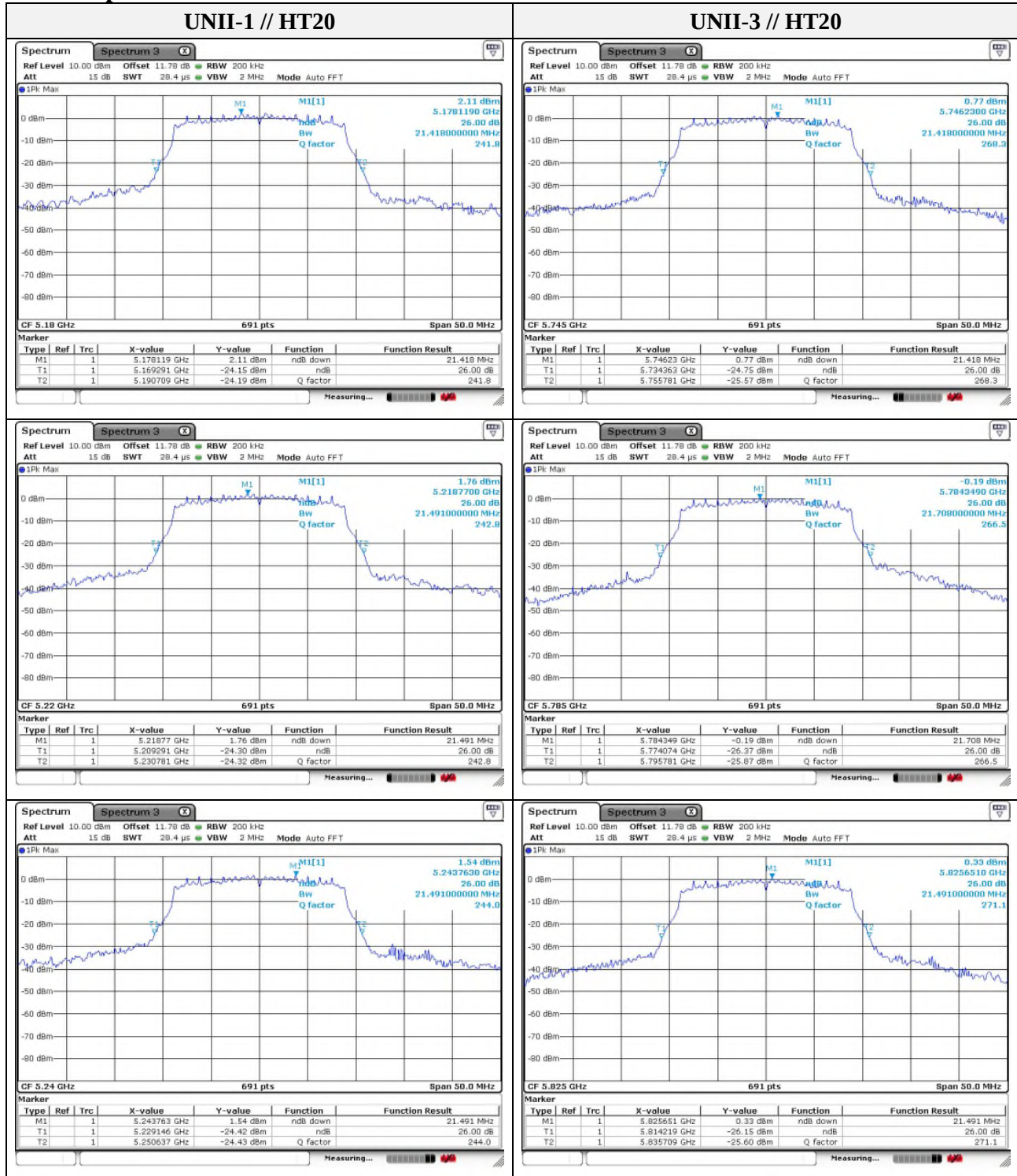
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26 dB bandwidth

Test plots

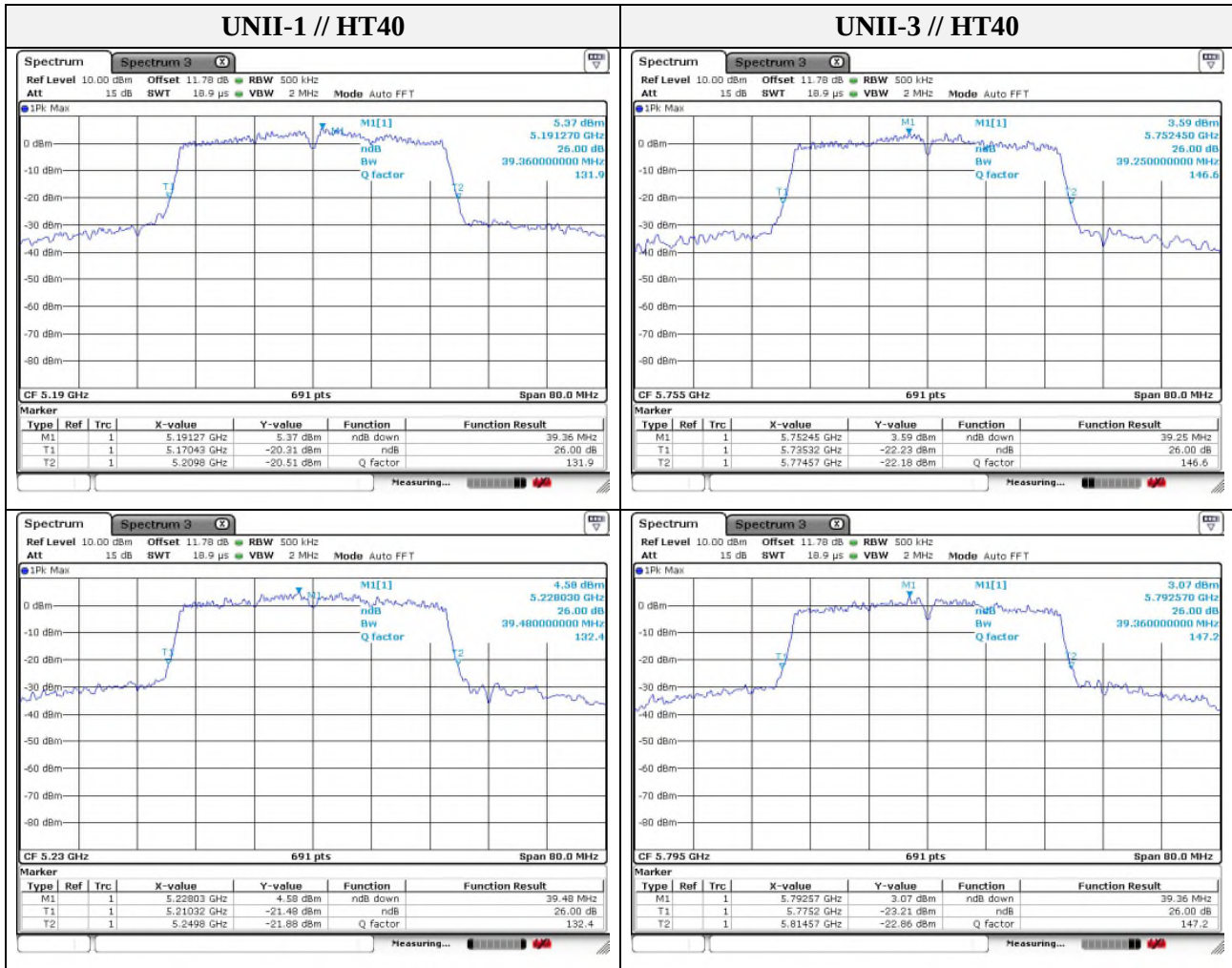
Antenna port 2



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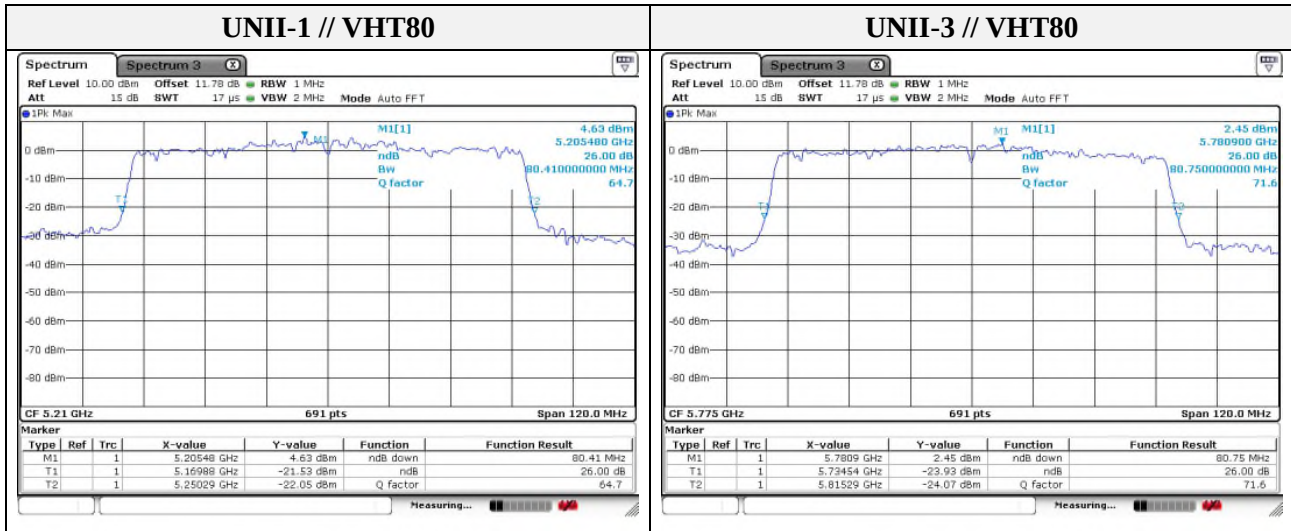
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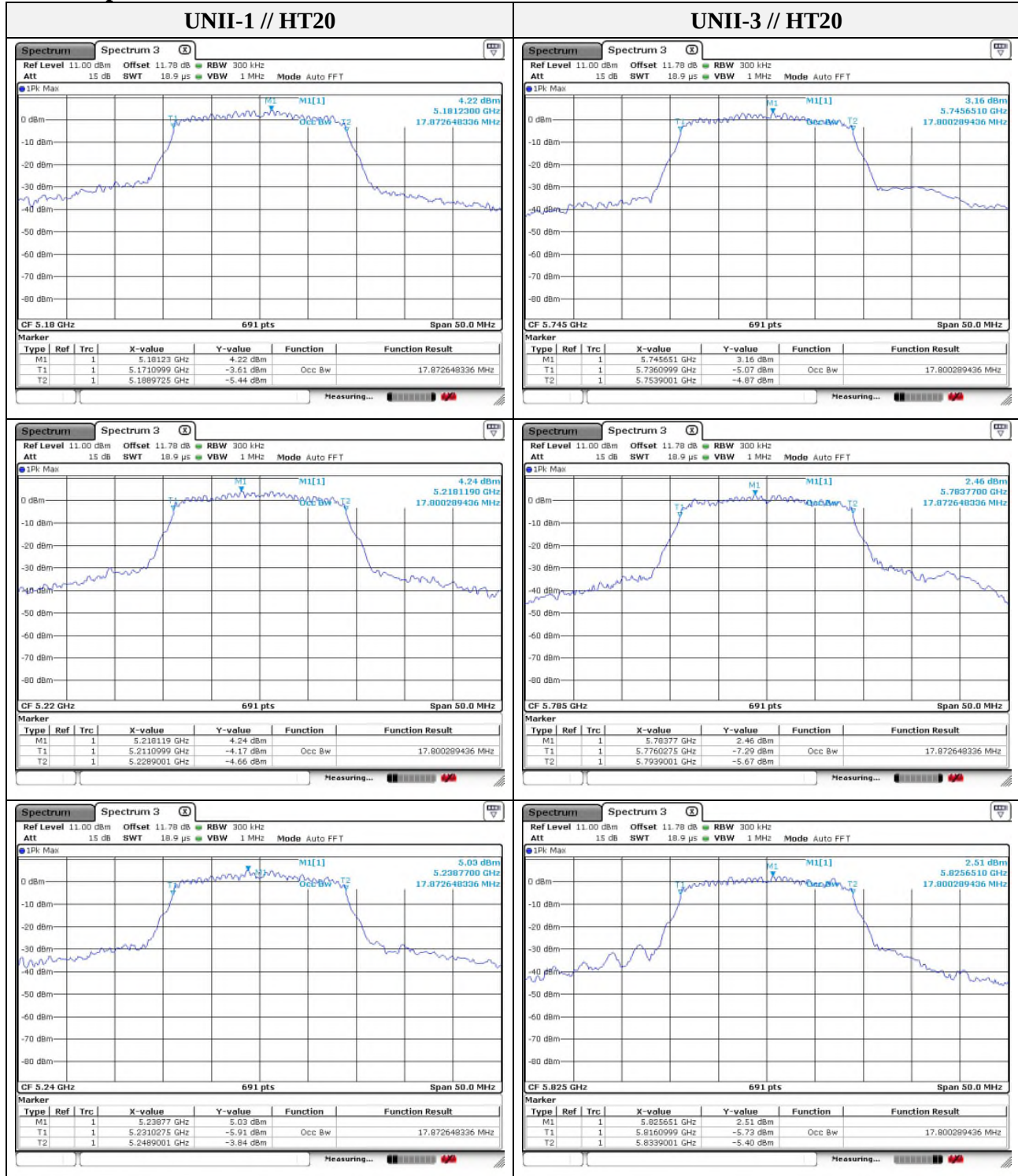
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99% Occupied Bandwidth

Test plots

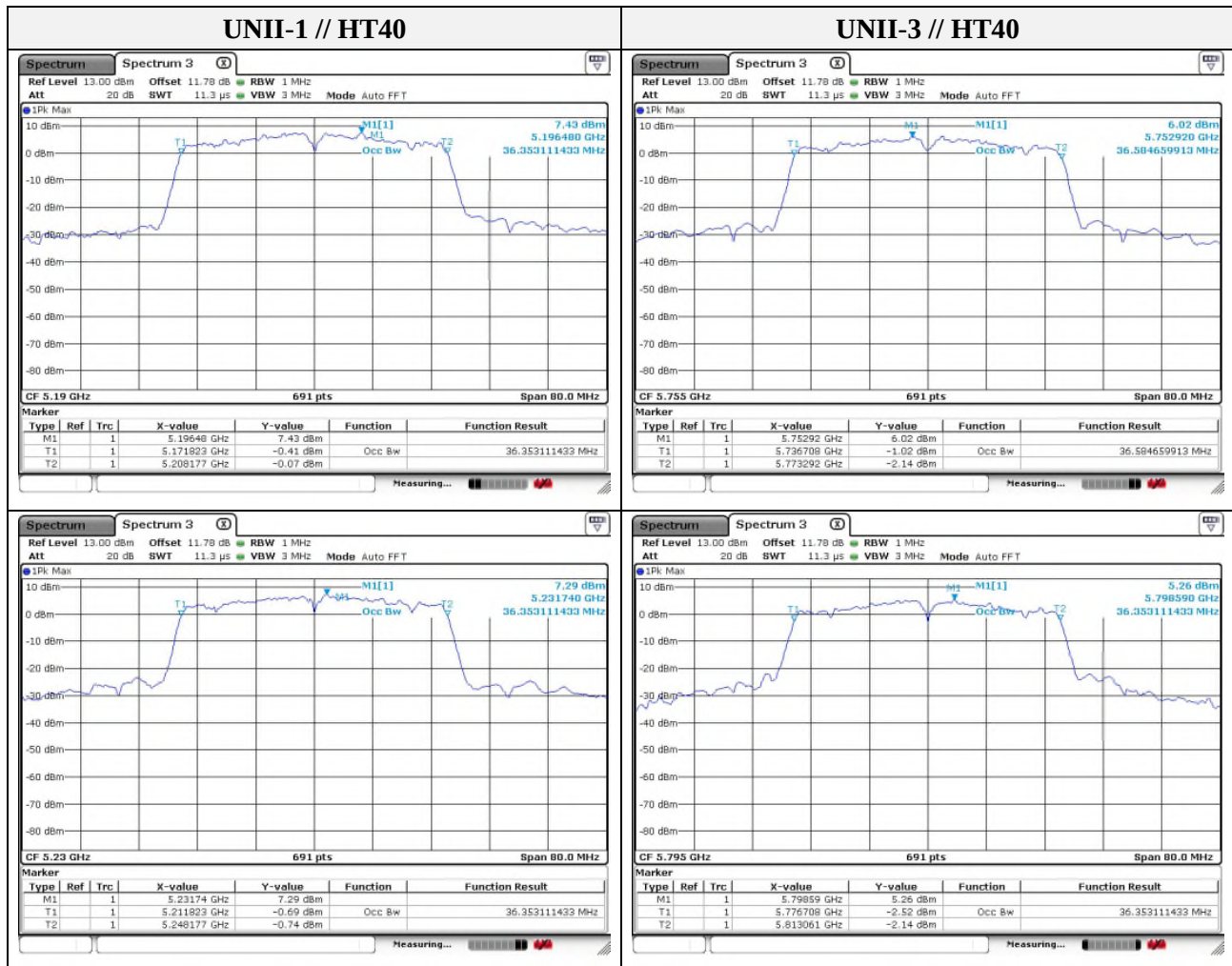
Antenna port 2



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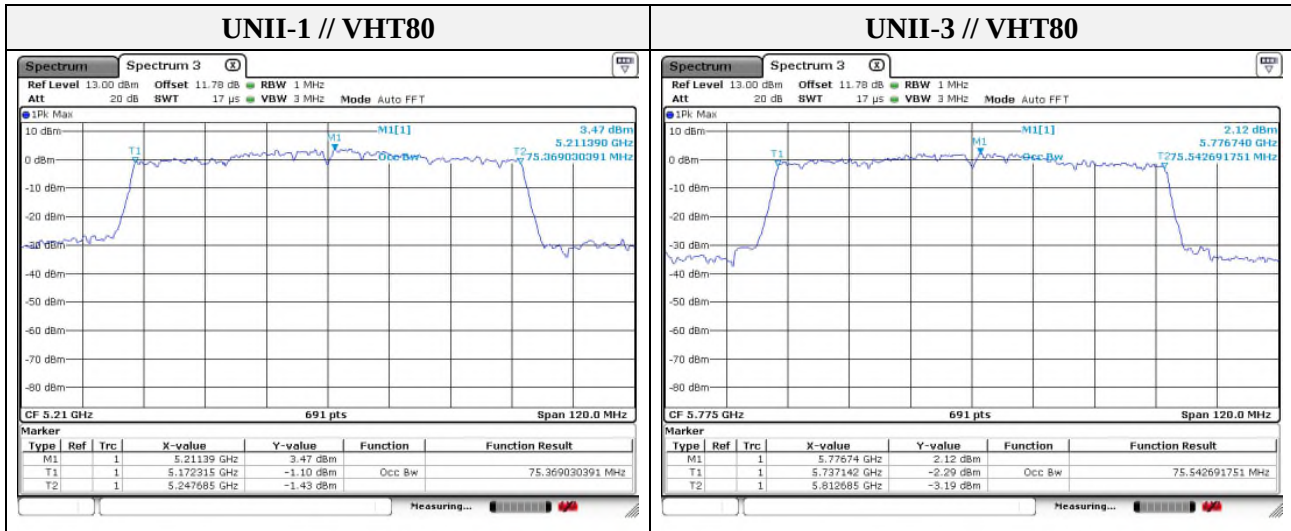
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3.2. 6 dB bandwidth

Test procedure

KDB 789033 D02 v02r01– Section C.2

Test setup



Section C.2

1. Set RBW = 100 kHz
2. Set the video bandwidth (VBW) $\geq 3 \times$ RBW.
3. Detector = peak.
4. Sweep = auto couple.
5. Allow the trace to stabilize
6. 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.

Limit

Within the 5.725-5.85 GHz band, the minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz.

According to RSS-247 6.1 (1), equipment operating in the band 5725-5850 MHz, the minimum 6 dB bandwidth shall be at least 500 kHz.

Test plots
Antenna port 1

Band	Frequency(MHz)	Mode	6 dB bandwidth(MHz)
UNII-3	5 745	VHT20	17.438
	5 785		17.438
	5 825		17.438
	5 755	VHT40	36.120
	5 795		35.940
	5 775	VHT80	75.450

Test plots
Antenna port 2

Band	Frequency(MHz)	Mode	6 dB bandwidth(MHz)
UNII-3	5 745	VHT20	17.511
	5 785		17.511
	5 825		17.583
	5 755	VHT40	36.350
	5 795		36.410
	5 775	VHT80	75.970

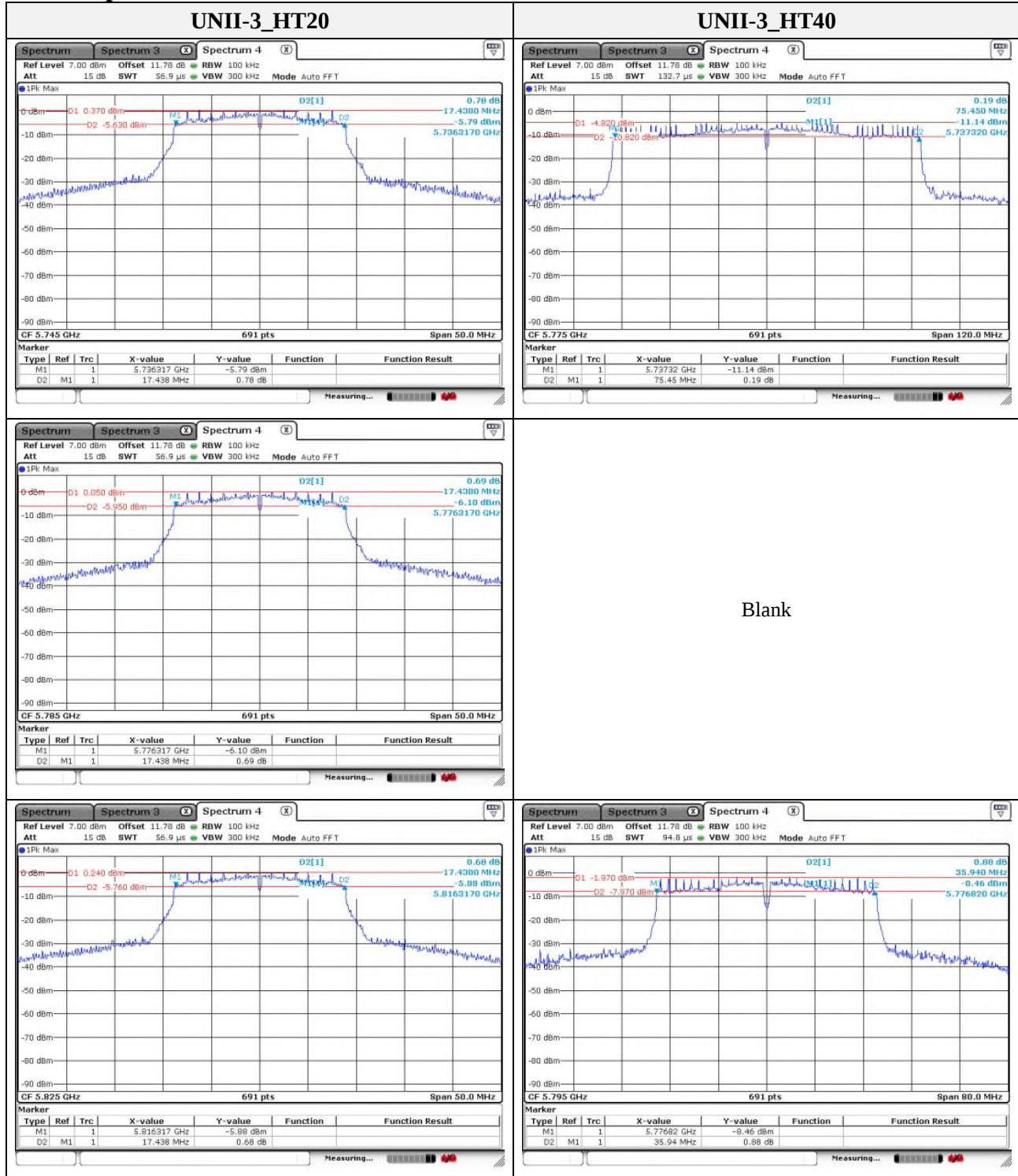
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Test plots

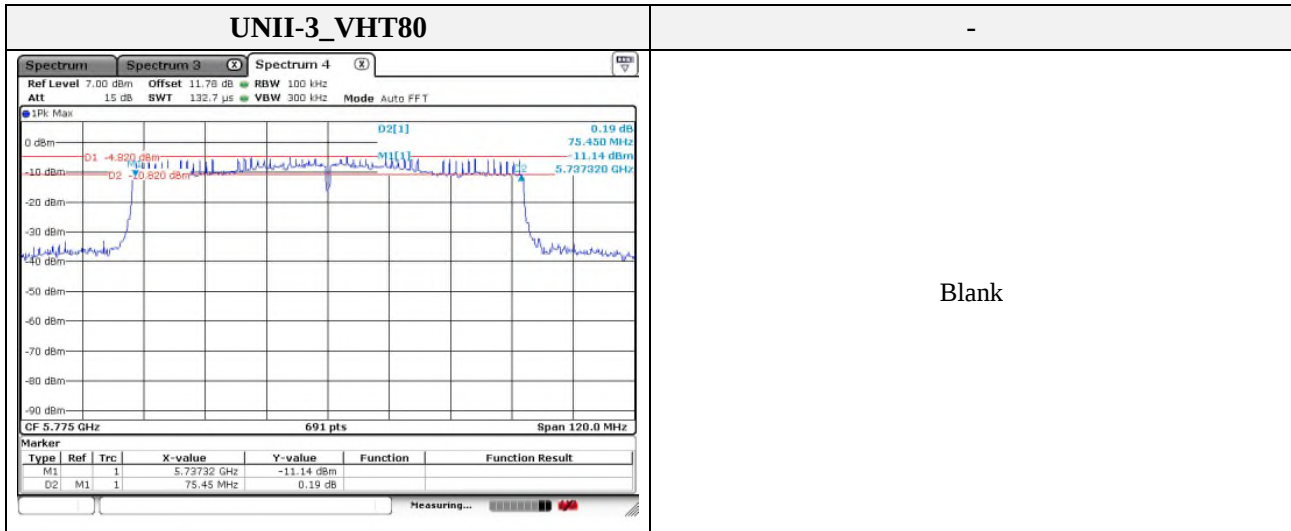
Antenna port 1



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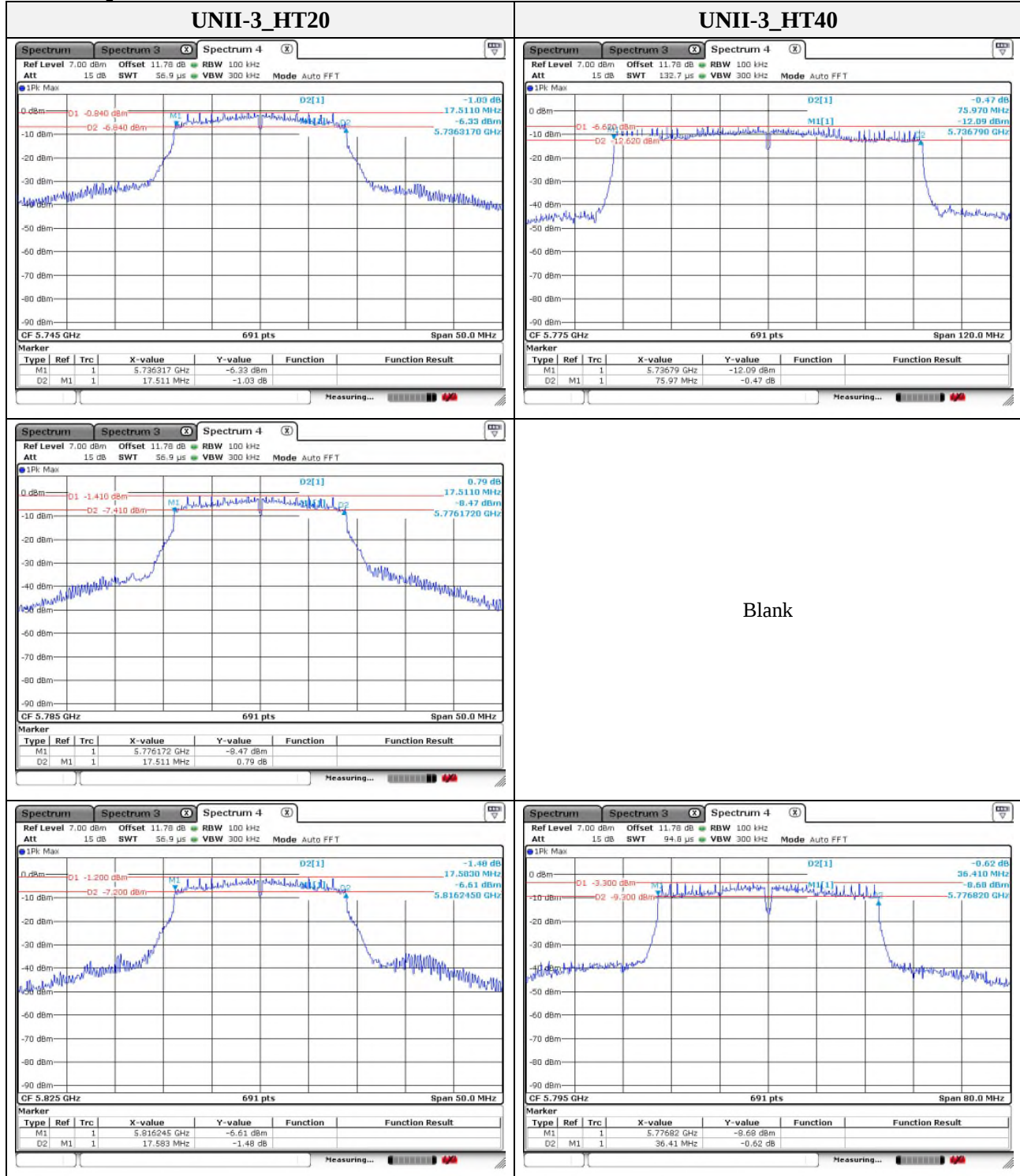
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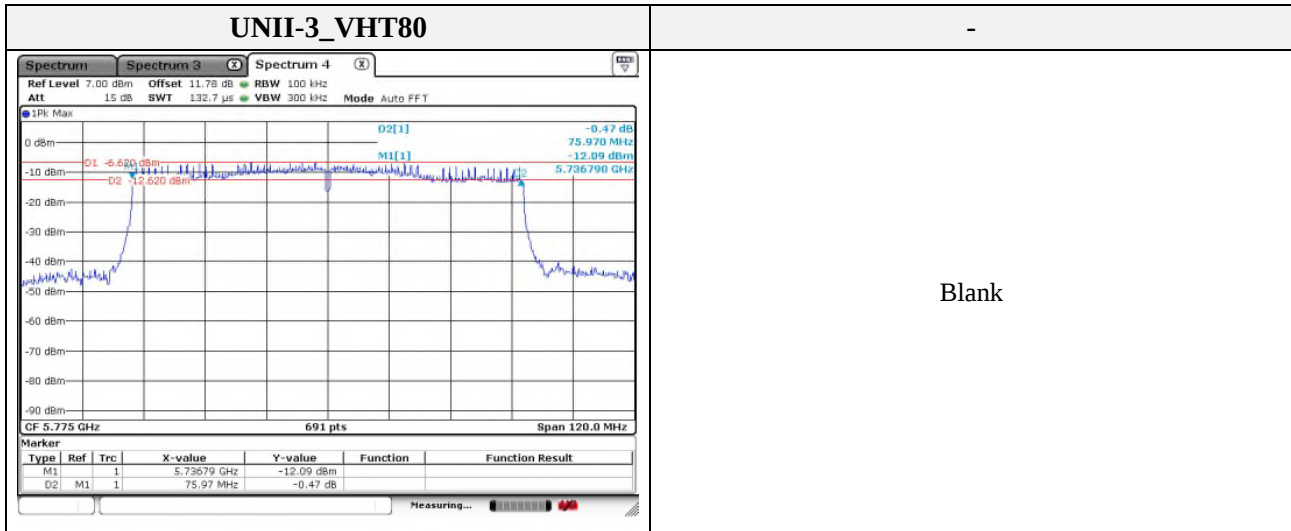
Test plots Antenna port 2



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3.3. Maximum conducted output power

Test procedure

KDB 789033 D02 v02r01– Section E.3.a) or b)

Used test method is Section E.3.b)

Test setup



Section E.3.a)

Method PM (Measurement using an RF average power meter):

- i. Measurements may be performed using a wideband RF power meter with a thermocouple detector or equivalent if all of the conditions listed below are satisfied.
 - The EUT is configured to transmit continuously or to transmit with a constant duty cycle.
 - At all times when the EUT is transmitting, it must be transmitting at its maximum power control level.
 - The integration period of the power meter exceeds the repetition period of the transmitted signal by at least a factor of five.
- ii. If the transmitter does not transmit continuously, measure the duty cycle, x , of the transmitter output signal as described in section II.B.
- iii. Measure the average power of the transmitter. This measurement is an average over both the on and off periods of the transmitter.
- iv. Adjust the measurement in dBm by adding $10 \log (1/x)$ where x is the duty cycle (e.g., $10 \log (1/0.25)$ if the duty cycle is 25 %).
- v. In case of band crossing channels 138, 142 and 144, the measurement is complied with section E.2.d of KDB 644545_D03 v01

Section E.3.b)

Method PM-G (Measurement using a gated RF average power meter):

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 the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

Limit

Band	EUT Category		Limit
UNII-1		Outdoor access point	1 W (30 dBm)
		Indoor access point	
		Fixed point-to-point access point	
	✓	Mobile and portable client device	250 mW(24 dBm)
UNII-2A			250 mW or 11 dBm + 10logB*
UNII-2C			250 mW or 11 dBm + 10logB*
UNII-3	✓		1 W (30 dBm)

Note.

1. FCC Limit B is the 26 dB emission bandwidth.

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Test results

Band	mode	Frequency (MHz)	Detector mode	Output power(dBm)			Limit (dBm)
				ANT1	ANT2	SUM ¹	
UNII-1	HT20	5 180	AV	11.87	11.54	14.72	24.00
		5 220	AV	11.95	11.34	14.67	
		5 240	AV	11.88	11.44	14.68	
UNII-3		5 745	AV	12.12	10.64	14.45	30.00
		5 785	AV	11.91	10.10	14.11	
		5 825	AV	11.74	9.80	13.89	

Band	mode	Frequency (MHz)	Detector mode	Output power(dBm)			Limit (dBm)
				ANT1	ANT2	SUM ¹	
UNII-1	HT40	5 190	AV	12.28	11.77	15.04	24.00
		5 230	AV	11.87	11.76	14.83	
UNII-3		5 755	AV	12.05	10.78	14.47	30.00
		5 795	AV	11.95	10.26	14.20	

Band	mode	Frequency (MHz)	Detector mode	Output power(dBm)			Limit (dBm)
				ANT1	ANT2	SUM ¹	
UNII-1	VHT80	5 210	AV	11.88	11.92	14.91	24.00
UNII-3		5 775	AV	11.81	10.12	14.06	30.00

Note.

$$1. \text{ Sum} = 10\log(10^{\text{Ant0}/10} + 10^{\text{Ant1}/10} \dots 10^{\text{Ant N}/10})$$

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3.4. Maximum Power spectral density

Test procedure

KDB 789033 D02 v02r01 – Section F

Test setup



Section F

1. Create an average power spectrum for the EUT operating mode being tested by following the instructions in section II.E.2. for measuring maximum conducted output power using a spectrum analyzer or EMI receiver: select the appropriate test method (SA-1, SA-2, SA-3, or alternatives to each) and apply it up to, but not including, the step labeled, “Compute power...” (This procedure is required even if the maximum conducted output power measurement was performed using a power meter, method PM.)
2. Use the peak search function on the instrument to find the peak of the spectrum and record its value.
3. Make the following adjustments to the peak value of the spectrum, if applicable:
 - a) If Method SA-2 or SA-2 Alternative was used, add $10 \log(1/x)$, where x is the duty cycle, to the peak of the spectrum.
 - b) If Method SA-3 Alternative was used and the linear mode was used in step II.E.2.g)(viii), add 1 dB to the final result to compensate for the difference between linear averaging and power averaging.
4. The result is the Maximum PSD over 1 MHz reference bandwidth.
5. For devices operating in the bands 5.15-5.25 GHz, 5.25-5.35 GHz, and 5.47-5.725 GHz, the preceding procedures make use of 1 MHz RBW to satisfy directly the 1 MHz reference bandwidth specified in § 15.407(a)(5). For devices operating in the band 5.725-5.85 GHz, the rules specify a measurement bandwidth of 500 kHz. Many spectrum analyzers do not have 500 kHz RBW, thus a narrower RBW may need to be used. The rules permit the use of a RBWs less than 1 MHz, or 500 kHz, “provided that the measured power is integrated over the full reference bandwidth” to show the total power over the specified measurement bandwidth (i.e., 1 MHz, or 500 kHz). If measurements are performed using a reduced resolution bandwidth (< 1 MHz, or < 500 kHz) and integrated over 1 MHz, or 500 kHz bandwidth, the following adjustments to the procedures apply:
 - a) Set $RBW \geq 1/T$, where T is defined in section II.B.1.a)
 - b) Set $VBW \geq 3 RBW$.
 - c) If measurement bandwidth of Maximum PSD is specified in 500 kHz, add $10 \log(500 \text{ kHz}/RBW)$ to the measured result, whereas $RBW (< 500 \text{ kHz})$ is the reduced resolution bandwidth of the spectrum analyzer set during measurement.
 - d) If measurement bandwidth of Maximum PSD is specified in 1 MHz, add $10 \log(1 \text{ MHz}/RBW)$ to the measured result, whereas $RBW (< 1 \text{ MHz})$ is the reduced resolution bandwidth of spectrum analyzer set during measurement.
 - e) Care must be taken to ensure that the measurements are performed during a period of continuous transmission or are corrected upward for duty cycle.

Note.

As a practical matter, it is recommended to use reduced RBW of 100 kHz for the II.F.5.c) and II.F.5.d), since RBW=100 kHz is available on nearly all spectrum analyzers.

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Limit

Band	EUT Category		Limit
UNII-1		Outdoor access point	17 dBm/MHz
		Indoor access point	
		Fixed point-to-point access point	
	✓	Mobile and portable client device	11 dBm/MHz
UNII-2A			11 dBm/MHz
UNII-2C			11 dBm/MHz
UNII-3	✓		30 dBm/500 kHz

Note.

1. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceed 6 dBi.

Test results
Antenna port 1

Band	Frequency (MHz)	Mode	PSD (dBm/MHz)	RBWF Note1	DCF Note2	Sum Note3	Limit(dBm/MHz)
							FCC
UNII-1	5 180	HT20	1.47	-	0.05	1.52	11.00
	5 220		1.18			1.23	
	5 240		1.15			1.20	
	5 190	HT40	-1.18		0.11	-1.07	
	5 230		-1.31			-1.20	
	5 210	HT80	-4.44		0.11	-4.33	

Band	Frequency (MHz)	Mode	PSD (dBm/500kHz)	RBWF Note1	DCF Note2	Sum Note3	Limit(dBm/MHz)
							FCC
UNII-3	5 745	VHT20	-1.58	-	0.06	-1.52	30.00
	5 785		-1.92			-1.86	
	5 825		-2.20			-2.14	
	5 755	VHT40	-4.07		0.11	-3.96	
	5 795		-4.16			-4.05	
	5 775	VHT80	-7.28		0.08	-7.20	

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Antenna port 2

Band	Frequency (MHz)	Mode	PSD (dBm/MHz)	RBWF Note1	DCF Note2	Sum Note3	Limit(dBm/MHz)
							FCC
UNII-1	5 180	HT20	1.08	-	0.05	1.13	11.00
	5 220		0.86			0.91	
	5 240		0.73			0.78	
	5 190	HT40	-1.00		0.11	-0.89	
	5 230		-1.25			-1.14	
	5 210	HT80	-4.20		0.11	-4.09	

Band	Frequency (MHz)	Mode	PSD (dBm/500kHz)	RBWF Note1	DCF Note2	Sum Note3	Limit(dBm/MHz)
							FCC
UNII-3	5 745	VHT20	-3.43	-	0.05	-3.38	30.00
	5 785		-3.37			-3.32	
	5 825		-3.57			-3.52	
	5 755	VHT40	-5.17		0.11	-5.46	
	5 795		-6.46			-6.35	
	5 775	VHT80	-9.06		0.11	-8.95	

Note.

- UNII-1 = $10\log(1 \text{ MHz}/1 \text{ MHz})$
UNII-3 = $10\log(500 \text{ kHz}/500 \text{ kHz})$
- Refer to the page 51 on this report.
- $\text{Sum(dBm)} = \text{PSD(dBm)} + \text{RBWF} + \text{Duty correction factor (dB)}$

Test plots

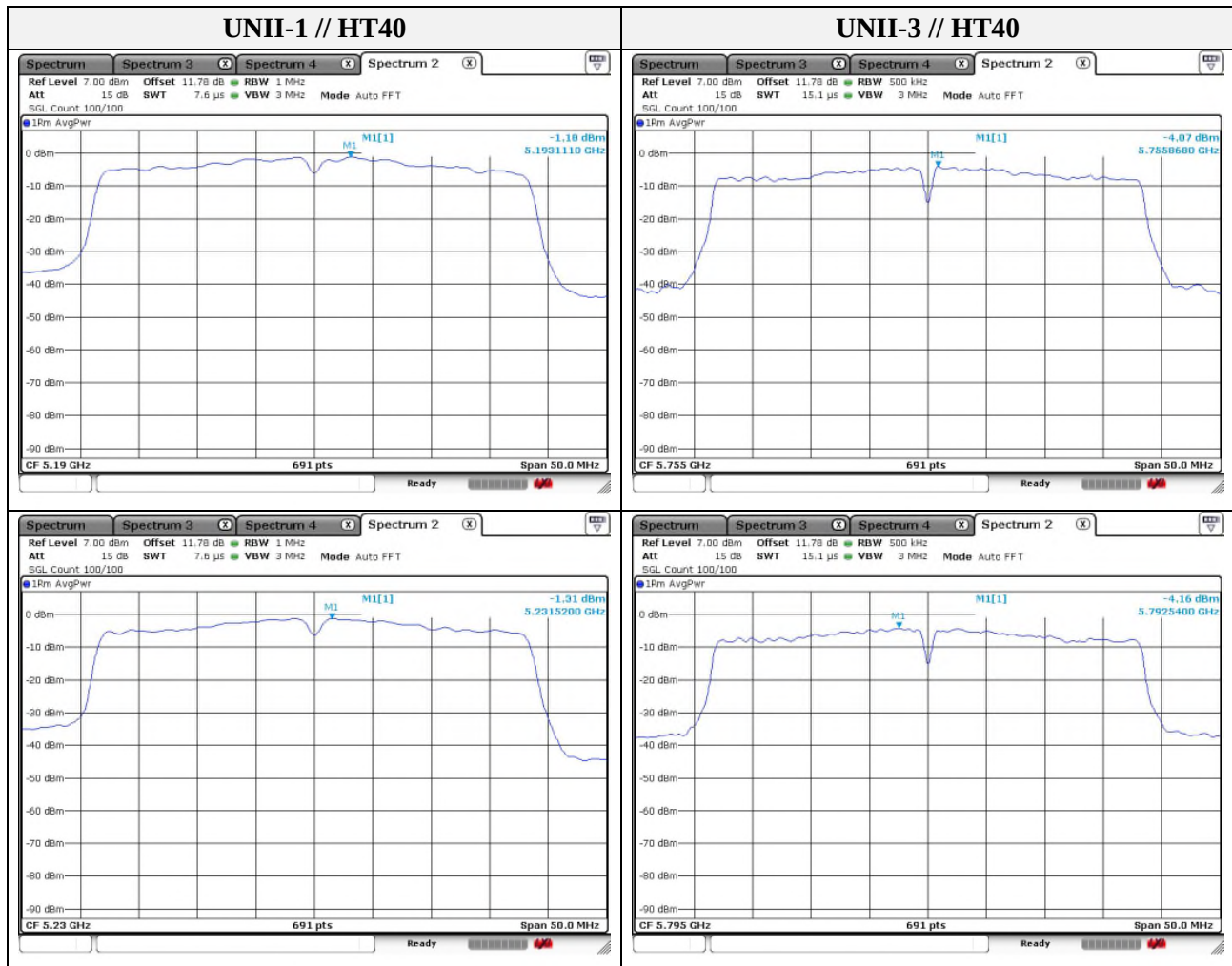
Antenna port 1



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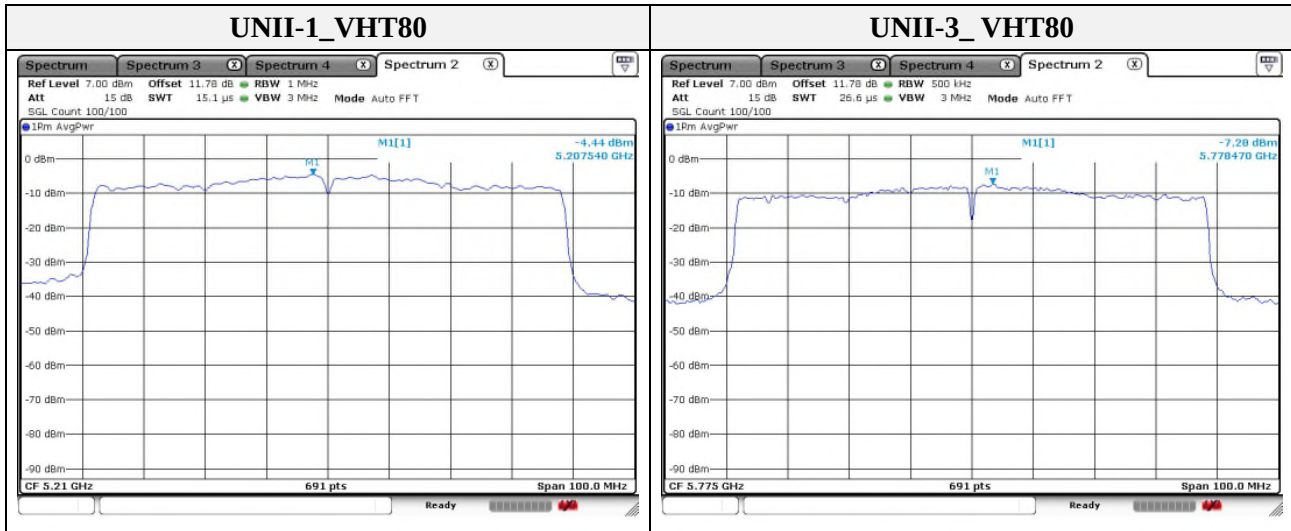
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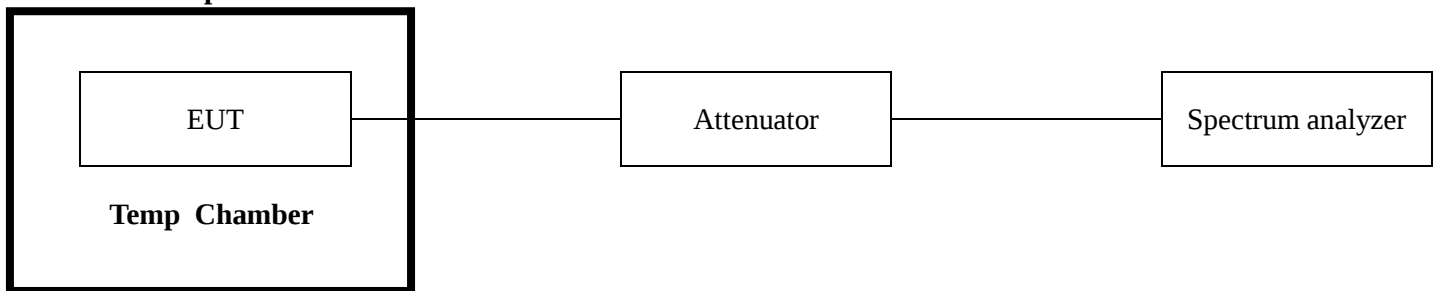
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3.5. Frequency Stability

Test procedure

ANSI C63.10-2013, clause 6.8.1

Test setup



1. The EUT was placed inside the environmental test chamber and powered by nominal DC voltage.
2. Turn the EUT on and couple its output to a spectrum analyzer.
3. Turn the EUT off and set the chamber to the highest temperature specified.
4. Allow sufficient time (approximately 30 min) for the temperature of the chamber to stabilize, turn the EUT on and measure the operating frequency.
5. Repeat step 2 and 3 with the temperature chamber set to the lowest temperature.
6. The test chamber was allowed to stabilize at +20 degree C for a minimum of 30 minutes. The supply voltage was then adjusted on the EUT from 85% to 115% and the frequency record.
7. While maintaining a constant temperature inside the environmental chamber, turn the EUT on and record the operating frequency at startup, and at 2 minutes, 5 minutes, and 10 minutes after the EUT is energized. Four measurements in total are made.

Limit

N/A

Test results

Antenna port 1

Mode:

UNII-1

Operating frequency:

5 180 MHz

Test voltage (%)	Test voltage (V)	Temperature (°C)	Maintaining time	Measure frequency (MHz)	Frequency deviation (Hz)	Deviation (%)
100 %	DC 5	-30	Startup	5180.058750	58750	0.001 134
			2 minutes	5180.003750	3750	0.000 072
			5 minutes	5180.052500	52500	0.001 014
			10 minutes	5180.072500	72500	0.001 400
100 %		-20	Startup	5180.083750	83750	0.001 617
			2 minutes	5180.028750	28750	0.000 555
			5 minutes	5180.013750	13750	0.000 265
			10 minutes	5180.037500	37500	0.000 724
100 %		-10	Startup	5180.031400	31400	0.000 606
			2 minutes	5180.013750	13750	0.000 265
			5 minutes	5180.031250	31250	0.000 603
			10 minutes	5180.021250	21250	0.000 410
100 %		0	Startup	5180.042500	42500	0.000 820
			2 minutes	5180.081250	81250	0.001 569
			5 minutes	5180.053750	53750	0.001 038
			10 minutes	5180.013750	13750	0.000 265
100 %		10	Startup	5180.067500	67500	0.001 303
			2 minutes	5180.042500	42500	0.000 820
			5 minutes	5180.033750	33750	0.000 652
			10 minutes	5180.032500	32500	0.000 627
100 %		20	Startup	5179.936250	-6375	-0.000 123
			2 minutes	5180.091250	91250	0.001 762
			5 minutes	5180.015000	15000	0.000 290
			10 minutes	5180.046250	46250	0.000 893
100 %		23	Startup	5179.972500	-275	-0.000 005
			2 minutes	5180.012500	12500	0.000 241
			5 minutes	5180.041250	41250	0.000 796
			10 minutes	5180.051250	51250	0.000 989
100 %		30	Startup	5180.051250	51250	0.000 989
			2 minutes	5180.093750	93750	0.001 810
			5 minutes	5180.050000	50000	0.000 965
			10 minutes	5180.075000	75000	0.001 448
100 %		40	Startup	5180.060000	60000	0.001 158
			2 minutes	5180.011250	11250	0.000 217
			5 minutes	5180.030000	30000	0.000 579
			10 minutes	5180.091250	91250	0.001 762
100 %		50	Startup	5180.046400	46400	0.000 896
			2 minutes	5180.016100	16100	0.000 311
			5 minutes	5180.058900	58900	0.001 137
			10 minutes	5180.085750	85750	0.001 655
85 %	DC 4.25	23	Startup	5179.967500	-325	-0.000 006
			2 minutes	5180.075000	75000	0.001 448
			5 minutes	5180.065000	65000	0.001 255
			10 minutes	5180.086250	86250	0.001 665
115 %	DC 5.75	23	Startup	5180.051250	51250	0.000 989
			2 minutes	5180.097500	97500	0.001 882
			5 minutes	5180.085000	85000	0.001 641
			10 minutes	5180.016250	16250	0.000 314

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Mode: UNII-3
Operating frequency: 5 745 MHz

Test voltage (%)	Test voltage (V)	Temperature (°C)	Maintaining time	Measure frequency (MHz)	Frequency deviation (Hz)	Deviation (%)
100 %	DC 5	-30	Startup	5745.027500	27500	0.000 479
			2 minutes	5745.025000	25000	0.000 435
			5 minutes	5745.008750	8750	0.000 152
			10 minutes	5745.088750	88750	0.001 545
100 %		-20	Startup	5180.083750	83750	0.000 936
			2 minutes	5745.093750	93750	0.001 632
			5 minutes	5475.046250	46250	0.000 805
			10 minutes	5745.035000	35000	0.000 609
100 %		-10	Startup	5745.032500	32500	0.000 566
			2 minutes	5745.033750	33750	0.000 587
			5 minutes	5745.098750	98750	0.001 719
			10 minutes	5745.056250	56250	0.000 979
100 %		0	Startup	5745.085000	85000	0.001 480
			2 minutes	5745.042500	42500	0.000 740
			5 minutes	5745.097500	97500	0.001 697
			10 minutes	5745.033700	33700	0.000 587
100 %		10	Startup	5745.096250	96250	0.001 675
			2 minutes	5745.081250	81250	0.001 414
			5 minutes	5745.015000	15000	0.000 261
			10 minutes	5745.063750	63750	0.001 110
100 %		20	Startup	5744.946250	-5375	-0.000 094
			2 minutes	5745.018750	18750	0.000 326
			5 minutes	5745.022500	22500	0.000 392
			10 minutes	5745.073750	73750	0.001 283
100 %		23	Startup	5744.986250	-1375	-0.000 024
			2 minutes	5744.902500	-975	-0.000 017
			5 minutes	5745.031250	31250	0.000 544
			10 minutes	5745.043750	43750	0.000 762
100 %		30	Startup	5745.023750	23750	0.000 413
			2 minutes	5745.033750	33750	0.000 587
			5 minutes	5745.065000	65000	0.001 131
			10 minutes	5745.048750	48750	0.000 849
100 %		40	Startup	5745.026250	26250	0.000 457
			2 minutes	5745.086250	86250	0.001 501
			5 minutes	5745.041250	41250	0.000 718
			10 minutes	5745.005000	5000	0.000 087
100 %		50	Startup	5745.014300	14300	0.000 249
			2 minutes	5745.005350	5350	0.000 093
			5 minutes	5745.062500	62500	0.001 088
			10 minutes	5745.060750	60750	0.001 057
85 %	DC 4.25	23	Startup	5745.072500	72500	0.001 262
			2 minutes	5745.085000	85000	0.001 480
			5 minutes	5745.083750	83750	0.001 458
			10 minutes	5745.028750	28750	0.000 500
115 %	DC 5.75	23	Startup	5745.060000	60000	0.001 044
			2 minutes	5475.062500	62500	0.001 088
			5 minutes	5745.012500	12500	0.000 218
			10 minutes	5745.007500	7500	0.000 131

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Test results

Antenna port 2

Mode:

UNII-1

Operating frequency:

5 180 MHz

Test voltage (%)	Test voltage (V)	Temperature (°C)	Maintaining time	Measure frequency (MHz)	Frequency deviation (Hz)	Deviation (%)
100 %	DC 5	-30	Startup	5180.013750	13750	0.000 265
			2 minutes	5180.042500	42500	0.000 820
			5 minutes	5180.011250	11250	0.000 217
			10 minutes	5180.068750	68750	0.001 327
100 %		-20	Startup	5180.041250	41250	0.000 796
			2 minutes	5180.007500	7500	0.000 145
			5 minutes	5180.052500	52500	0.001 014
			10 minutes	5180.071250	71250	0.001 375
100 %		-10	Startup	5179.962500	-37500	-0.000 724
			2 minutes	5180.001250	1250	0.000 024
			5 minutes	5180.012500	12500	0.000 241
			10 minutes	5180.092500	92500	0.001 786
100 %		0	Startup	5180.016250	16250	0.000 314
			2 minutes	5180.013750	13750	0.000 265
			5 minutes	5180.031250	31250	0.000 603
			10 minutes	5180.008750	8750	0.000 169
100 %		10	Startup	5180.075000	75000	0.001 448
			2 minutes	5180.046250	46250	0.000 893
			5 minutes	5180.007500	7500	0.000 145
			10 minutes	5180.055000	55000	0.001 062
100 %		20	Startup	5180.017500	17500	0.000 338
			2 minutes	5180.023750	23750	0.000 458
			5 minutes	5180.036250	36250	0.000 700
			10 minutes	5180.073750	73750	0.001 424
100 %		23	Startup	5180.081250	81250	0.001 569
			2 minutes	5180.018750	18750	0.000 362
			5 minutes	5180.012500	12500	0.000 241
			10 minutes	5180.027500	27500	0.000 531
100 %		30	Startup	5180.067500	67500	0.001 303
			2 minutes	5180.083750	83750	0.001 617
			5 minutes	5180.016250	16250	0.000 314
			10 minutes	5180.030000	30000	0.000 579
100 %		40	Startup	5180.051250	51250	0.000 989
			2 minutes	5180.092500	92500	0.001 786
			5 minutes	5180.008750	8750	0.000 169
			10 minutes	5180.066250	66250	0.001 279
100 %		50	Startup	5180.098200	98200	0.001 896
			2 minutes	5180.076800	76800	0.001 483
			5 minutes	5180.030350	30350	0.005 859
			10 minutes	5180.060700	60700	0.001 172
85 %	DC 4.25	23	Startup	5180.095000	95000	0.001 834
			2 minutes	5180.066250	66250	0.001 279
			5 minutes	5180.061250	61250	0.001 182
			10 minutes	5180.062500	62500	0.001 207
115 %	DC 5.75	23	Startup	5180.016250	16250	0.000 314
			2 minutes	5180.012500	12500	0.000 241
			5 minutes	5180.018750	18750	0.000 362
			10 minutes	5180.016250	16250	0.000 314

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Mode: UNII-3
Operating frequency: 5 745 MHz

Test voltage (%)	Test voltage (V)	Temperature (°C)	Maintaining time	Measure frequency (MHz)	Frequency deviation (Hz)	Deviation (%)
100 %	DC 5	-30	Startup	5745.082500	82500	0.001 436
			2 minutes	5475.041250	41250	0.000 718
			5 minutes	5745.023750	23750	0.000 413
			10 minutes	5745.080000	80000	0.001 393
100 %		-20	Startup	5745.037500	37500	0.000 623
			2 minutes	5745.006250	6250	0.000 109
			5 minutes	5745.040000	40000	0.000 696
			10 minutes	5745.003750	3750	0.000 065
100 %		-10	Startup	5744.988750	-11250	0.000 196
			2 minutes	5745.040000	40000	0.000 696
			5 minutes	5745.001250	1250	0.000 022
			10 minutes	5745.052500	52500	0.000 914
100 %		0	Startup	5745.032500	32500	0.000 566
			2 minutes	5745.052500	52500	0.000 914
			5 minutes	5745.040000	40000	0.000 696
			10 minutes	5745.010000	10000	0.000 174
100 %		10	Startup	5745.053750	53750	0.000 936
			2 minutes	5745.017500	17500	0.000 305
			5 minutes	5745.011250	11250	0.000 196
			10 minutes	5745.042500	42500	0.000 740
100 %		20	Startup	5745.068750	68750	0.001 197
			2 minutes	5745.085000	85000	0.001 480
			5 minutes	5745.025000	25000	0.000 435
			10 minutes	5745.076250	76250	0.001 327
100 %		23	Startup	5745.031250	31250	0.000 544
			2 minutes	5745.011250	11250	0.000 196
			5 minutes	5745.031250	31250	0.000 544
			10 minutes	5745.002500	2500	0.000 044
100 %		30	Startup	5745.050000	50000	0.000 870
			2 minutes	5745.023750	23750	0.000 413
			5 minutes	5745.047500	47500	0.000 827
			10 minutes	5745.031250	31250	0.000 544
100 %		40	Startup	5745.095000	95000	0.001 654
			2 minutes	5745.033750	33750	0.000 587
			5 minutes	5745.005000	5000	0.000 087
			10 minutes	5745.016250	16250	0.000 283
100 %		50	Startup	5745.007150	7150	0.000 124
			2 minutes	5745.026800	26800	0.000 466
			5 minutes	5745.073200	73200	0.001 274
			10 minutes	5745.048200	48200	0.000 839
85 %	DC 4.25	23	Startup	5745.078750	78750	0.001 371
			2 minutes	5745.025000	25000	0.000 435
			5 minutes	5745.018750	18750	0.000 326
			10 minutes	5745.028750	28750	0.000 500
115 %	DC 5.75	23	Startup	5744.948750	-51250	-0.000 892
			2 minutes	5745.070000	70000	0.001 218
			5 minutes	5745.062500	62500	0.001 088
			10 minutes	5745.091250	91250	0.001 588

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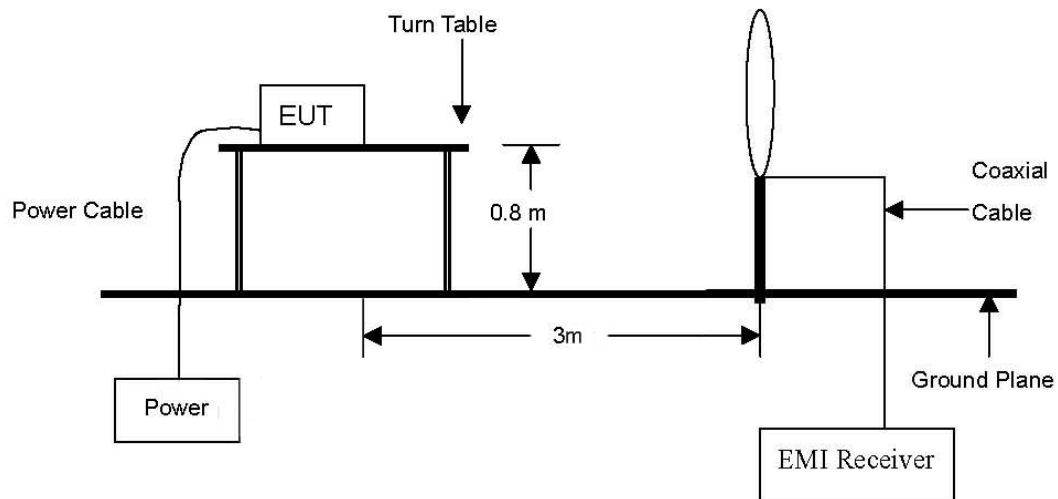
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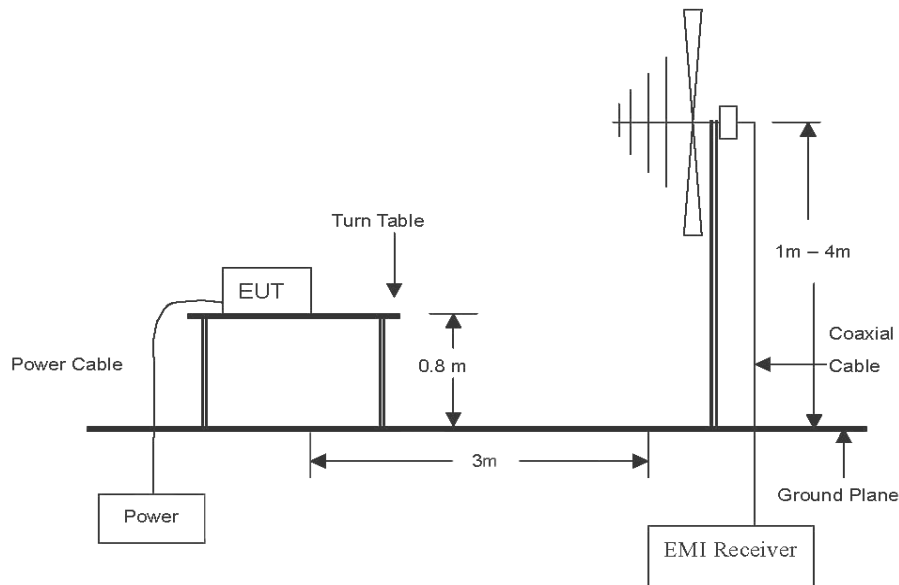
3.6. Radiated restricted band and emissions

Test setup

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.

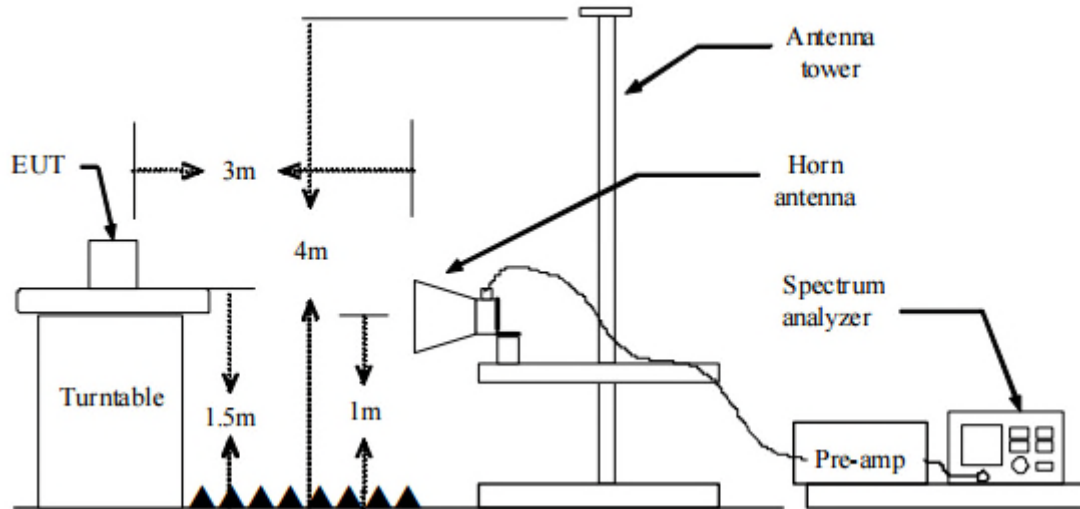


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The diagram below shows the test setup that is utilized to make the measurements for emission from 1 GHz to the tenth harmonic of the highest fundamental frequency or to 40 GHz emissions, whichever is lower.



Test procedure 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. We have done x, y, z planes in EUT and horizontal and vertical polarization and Parallel to the ground plane in detecting antenna.
4. 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.
5. The test-receiver system was set to average or quasi peak detect function and Specified Bandwidth with Maximum hold mode.

Test procedure above 30 MHz

1. Spectrum analyzer settings for $f < 1$ GHz:
 - ① Span = wide enough to fully capture the emission being measured
 - ② RBW = 120 kHz
 - ③ VBW $\geq$ RBW
 - ④ Detector = quasi peak
 - ⑤ Sweep time = auto
 - ⑥ Trace = max hold
2. Spectrum analyzer settings for $f \geq 1$ GHz: Peak
 - ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
 - ② RBW = 1 MHz
 - ③ VBW = 3 MHz ($\geq 3 \times$ RBW)
 - ④ Detector = peak
 - ⑤ Sweep time = auto
 - ⑥ Trace = max hold
 - ⑦ Trace was allowed to stabilize

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3. Spectrum analyzer settings for $f \geq 1$ GHz: Average

- ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
- ② RBW = 1 MHz
- ③ VBW $\geq 3 \times$ RBW
- ④ 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.
- ⑤ Averaging type = power(i.e., RMS)
 - 1) As an alternative, the detector and averaging type may be set for linear voltage averaging.
 - 2) Some instruments require linear display mode in order to use linear voltage averaging. Log or dB averaging shall not be used.
- ⑥ Sweep = auto
- ⑦ Trace = max hold
- ⑧ Perform a trace average of at least 100 traces.
- ⑨ 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 ⑤, then the applicable correction factor is $10 \log(1/x)$, where x is the duty cycle.
 - 2) If linear voltage averaging mode was used in step ⑤, then the applicable correction factor is $20 \log(1/x)$, where x is the duty cycle.
 - 3) If a specific emission is demonstrated to be continuous (≥ 98 percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.

Note.

1. $f < 30$ MHz, extrapolation factor of 40 dB/decade of distance. $F_d = 40 \log(D_m/D_s)$
 $f \geq 30$ MHz, extrapolation factor of 20 dB/decade of distance. $F_d = 20 \log(D_m/D_s)$
 Where:
 F_d = Distance factor in dB
 D_m = Measurement distance in meters
 D_s = Specification distance in meters
2. CF(Correction factors(dB)) = Antenna factor(dB/m) + Cable loss(dB) + or Amp. gain(dB) + or F_d (dB)
4. Field strength(dB μ V/m) = Level(dB μ V) + CF (dB) + or DCF(dB)
5. Margin(dB) = Limit(dB μ V/m) - Field strength(dB μ V/m)
6. Emissions below 18 GHz were measured at a 3 meter test distance while emissions above 18 GHz were measured at a 1 meter test distance with the application of a distance correction factor.
7. The fundamental of the EUT was investigated in three orthogonal orientations X, Y and Z, it was determined that **X orientation** was worst-case orientation; therefore, all final radiated testing was performed with the EUT in **X orientation**.
8. The worst-case emissions are reported however emissions whose levels were not within 20 dB of respective limits were not reported.
9. According to exploratory test no any obvious emission were detected from 9 kHz to 30 MHz. Although these tests were performed other than open field site, adequate comparison measurements were confirmed against 30 m open field site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.

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Limit

According to 15.209(a), for an intentional radiator devices, the general required of field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values :

Frequency (MHz)	Distance (Meters)	Radiated ($\mu V/m$)
0.009 ~ 0.490	300	2400/F(kHz)
0.490 ~ 1.705	30	24000/F(kHz)
1.705 ~ 30.0	30	30
30 ~ 88	3	100**
88 ~ 216	3	150**
216 ~ 960	3	200**
Above 960	3	500

**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., Sections 15.231 and 15.241.

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According to 15.407(b), (b) Undesirable emission limits: Except as shown in paragraph (b)(7) of this section, the maximum emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:

- (1) For transmitters operating in the 5.15–5.25 GHz band: all emissions outside of the 5.15–5.35 GHz band shall not exceed an e.i.r.p. of -27 dBm/MHz.
- (2) For transmitters operating in the 5.25–5.35 GHz band: All emissions outside of the 5.15–5.35 GHz band shall not exceed an e.i.r.p. of -27 dBm/MHz.
- (3) For transmitters operating in the 5.47–5.725 GHz band: All emissions outside of the 5.47–5.725 GHz band shall not exceed an e.i.r.p. of -27 dBm/MHz.
- (4) For transmitters operating in the 5.725–5.85 GHz band:
 - i) All emissions shall be limited to a level of -27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.
 - ii) Devices certified before March 2, 2017 with antenna gain greater than 10 dBi may demonstrate compliance with the emission limits in §15.247(d), but manufacturing, marketing and importing of devices certified under this alternative must cease by March 2, 2018. Devices certified before March 2, 2018 with antenna gain of 10 dBi or less may demonstrate compliance with the emission limits in §15.247(d), but manufacturing, marketing and importing of devices certified under this alternative must cease before March 2, 2020.
- (5) The emission measurements shall be performed using a minimum resolution bandwidth of 1 MHz. A lower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 1 MHz.
- (6) Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in § 15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in § 15.207.
- (7) The provisions of §15.205 apply to intentional radiators operating under this section.
- (8) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the upper and lower frequency band edges as the design of the equipment permits.

Duty cycle

Regarding to KDB 789033 D02 v02r01, B)2)b), the maximum duty cycles of all modes were investigated and set the spectrum analyzer as below.

Set RBW $\geq$ 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 $> 50/T$, where T is defined in II.B.1.a), and the number of sweep points across duration T exceeds 100.

Antenna port 1

For the band 5.15-5.25 GHz

Test mode	T _{on} time (ms)	Period (ms)	Duty cycle (Linear)	Duty cycle (%)	Duty cycle correction factor (dB)
802.11n_HT20	1.326	1.342	0.988	98.81	0.05
802.11n_HT40	0.664	0.680	0.976	97.64	0.11
802.11ac_VHT80	0.617	0.633	0.975	97.47	0.11

For the band 5.725-5.85 GHz

Test mode	T _{on} time (ms)	Period (ms)	Duty cycle (Linear)	Duty cycle (%)	Duty cycle correction factor (dB)
802.11n_HT20	1.325	1.342	0.987	98.73	0.06
802.11n_HT40	0.662	0.678	0.976	97.64	0.11
802.11ac_VHT80	0.621	0.633	0.981	98.10	0.08

Antenna port 2

For the band 5.15-5.25 GHz

Test mode	T _{on} time (ms)	Period (ms)	Duty cycle (Linear)	Duty cycle (%)	Duty cycle correction factor (dB)
802.11n_HT20	1.325	1.341	0.988	98.81	0.05
802.11n_HT40	0.662	0.679	0.975	97.49	0.11
802.11ac_VHT80	0.617	0.632	0.976	97.47	0.11

For the band 5.725-5.85 GHz

Test mode	T _{on} time (ms)	Period (ms)	Duty cycle (Linear)	Duty cycle (%)	Duty cycle correction factor (dB)
802.11n_HT20	1.330	1.346	0.988	98.81	0.05
802.11n_HT40	0.661	0.677	0.976	97.63	0.11
802.11ac_VHT80	0.618	0.634	0.975	97.48	0.11

Note:

Duty cycle (Linear) = T_{on} time/Period

DCF(Duty cycle correction factor (dB)) = 10log(1/duty cycle)

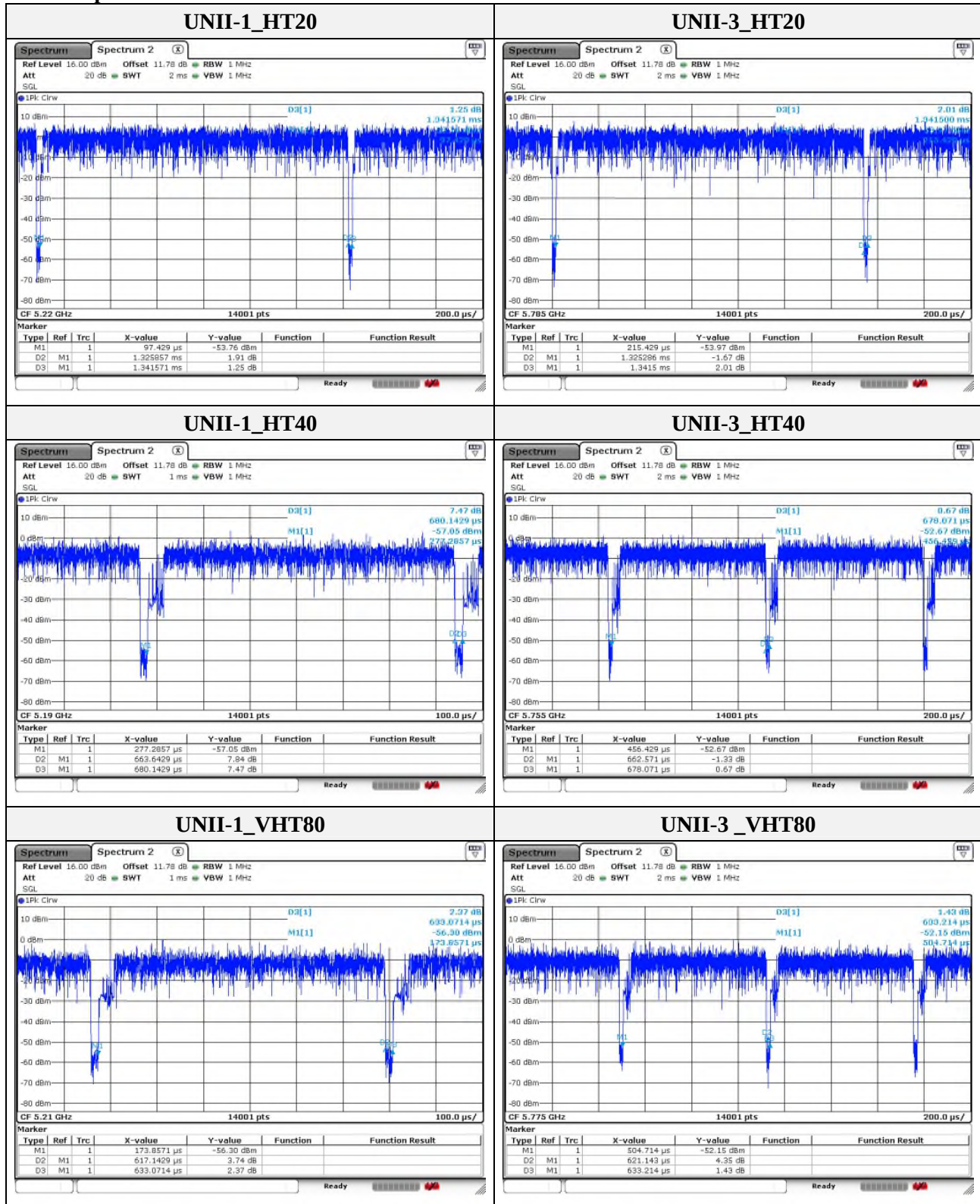
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Test plots

Antenna port 1



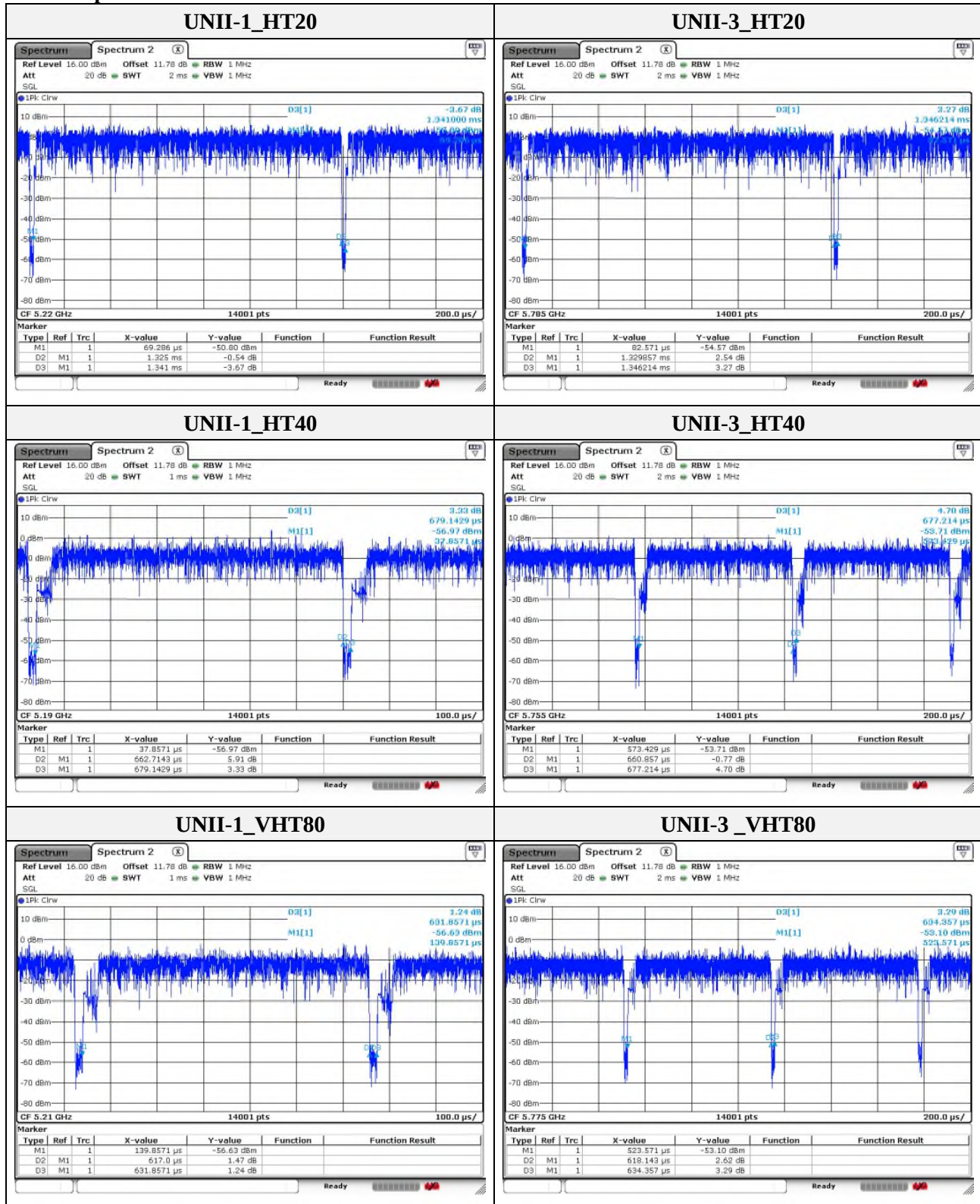
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Test plots

Antenna port 2



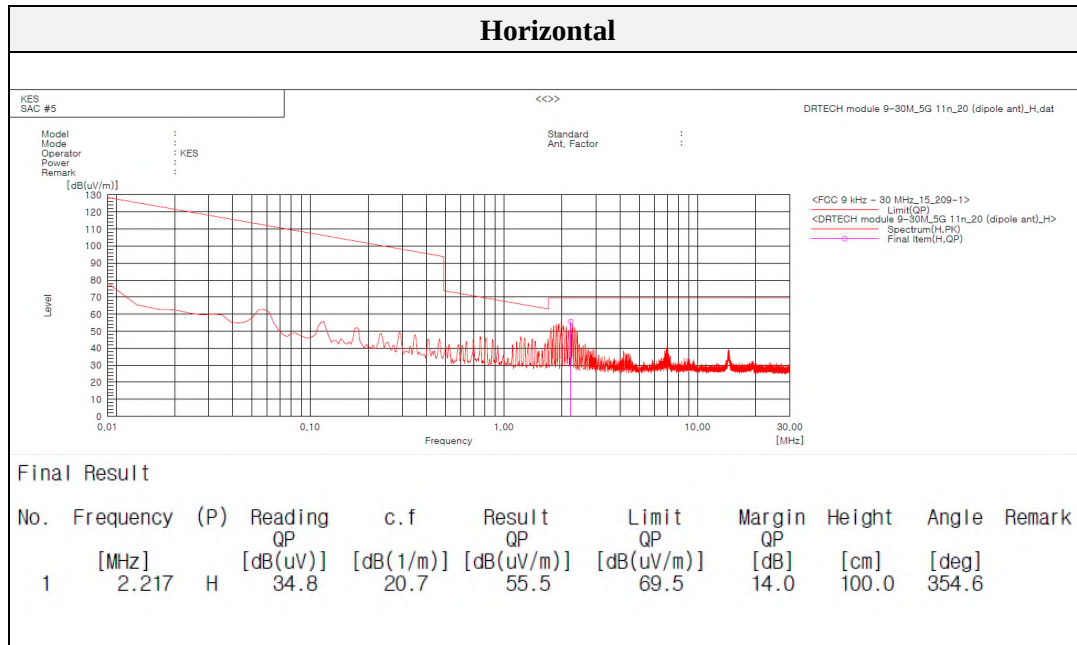
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Test results (Below 30 MHz) – Worst case

Mode: UNII-1_HT40
 Distance of measurement: 3 meter
 Channel: 38 (Worst case)
 ANT #1: Dipole Antenna

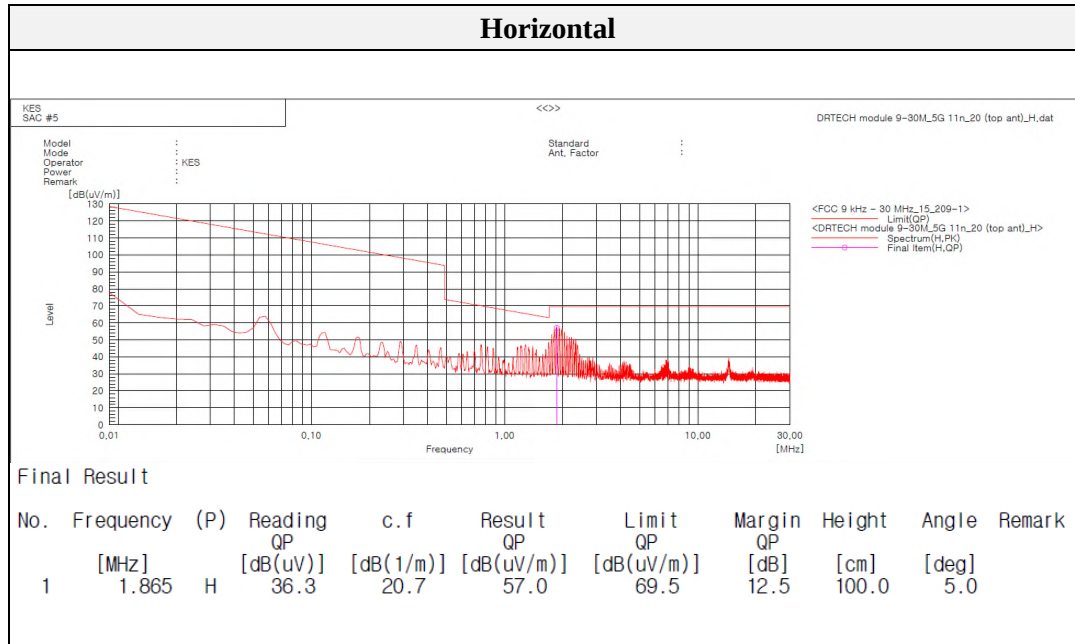


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Mode: UNII-1_HT40
 Distance of measurement: 3 meter
 Channel: 38 (Worst case)
 ANT #2: PCB Antenna(Top)



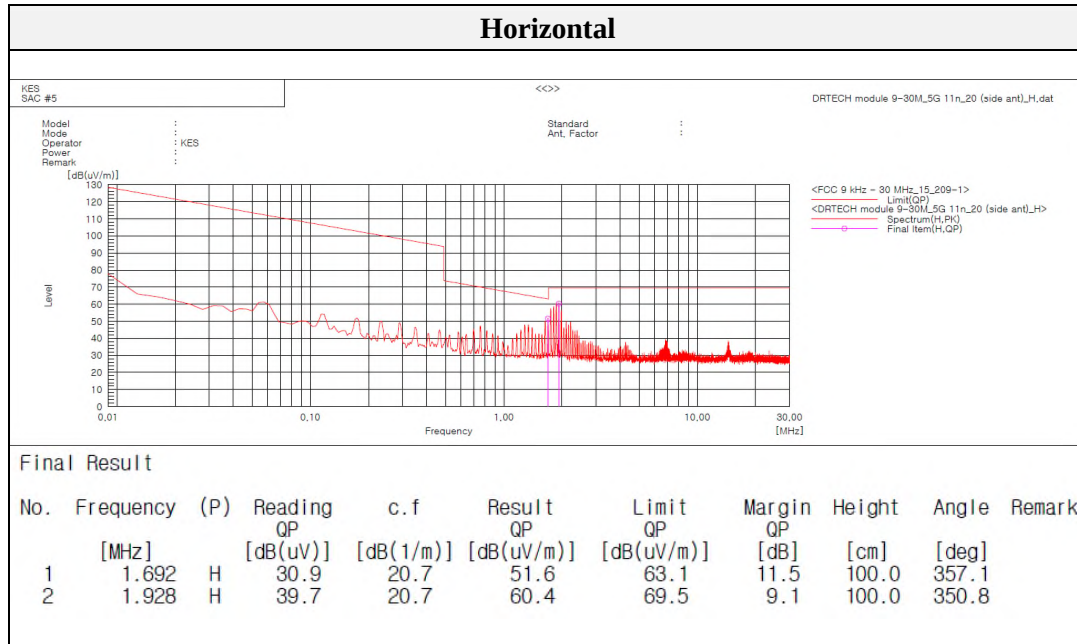
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Mode: UNII-1_HT40
Distance of measurement: 3 meter
Channel: 38 (Worst case)
ANT #3 PCB Antenna(Side)



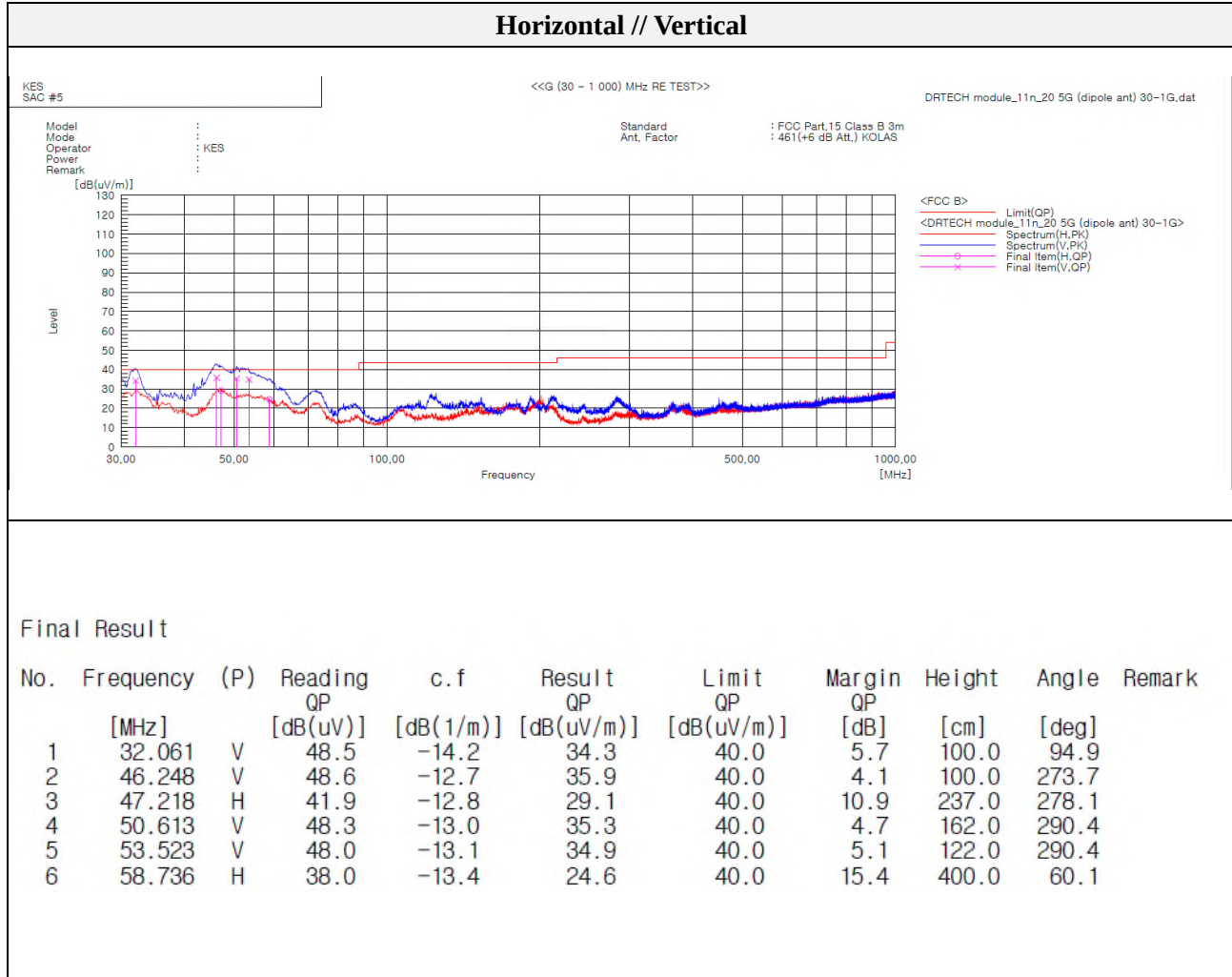
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Test results (Below 1 000 MHz) – Worst case

Mode: UNII-1_HT40
Distance of measurement: 3 meter
Channel: 38 (Worst case)
ANT #1: Dipole Antenna



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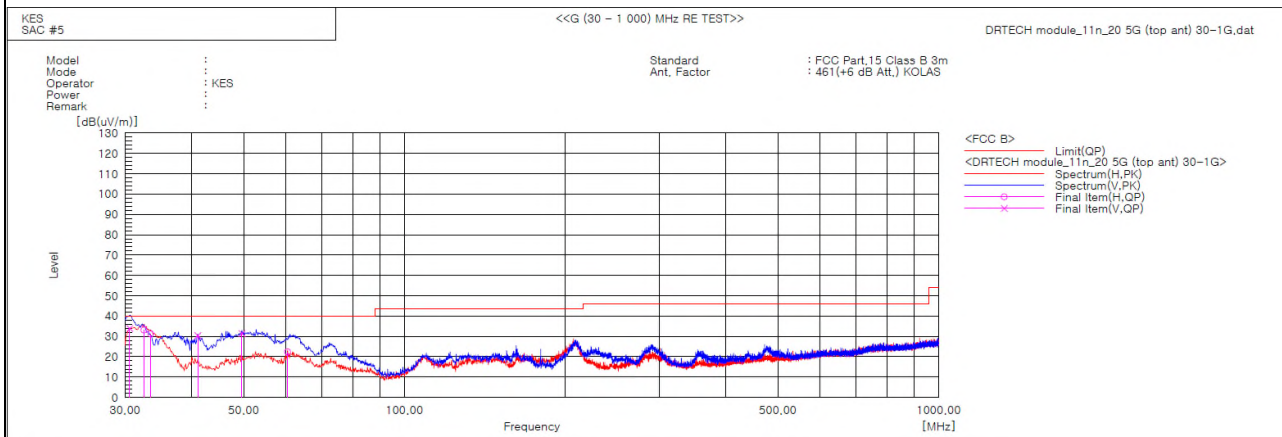
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Mode: UNII-1_HT40
Distance of measurement: 3 meter
Channel: 38 (Worst case)
ANT #2 PCB Antenna(Top)

Horizontal // Vertical



Final Result

No.	Frequency [MHz]	(P)	Reading QP [dB(uV)]	c.f [dB(1/m)]	Result QP [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]	Remark
1	30.606	V	48.2	-14.3	33.9	40.0	6.1	100.0	162.7	
2	32.546	H	47.3	-14.1	33.2	40.0	6.8	377.0	217.3	
3	33.516	H	45.3	-14.0	31.3	40.0	8.7	400.0	139.2	
4	41.034	V	43.6	-13.2	30.4	40.0	9.6	100.0	289.2	
5	49.643	V	44.3	-12.9	31.4	40.0	8.6	125.0	284.7	
6	60.434	H	35.9	-13.5	22.4	40.0	17.6	400.0	55.8	

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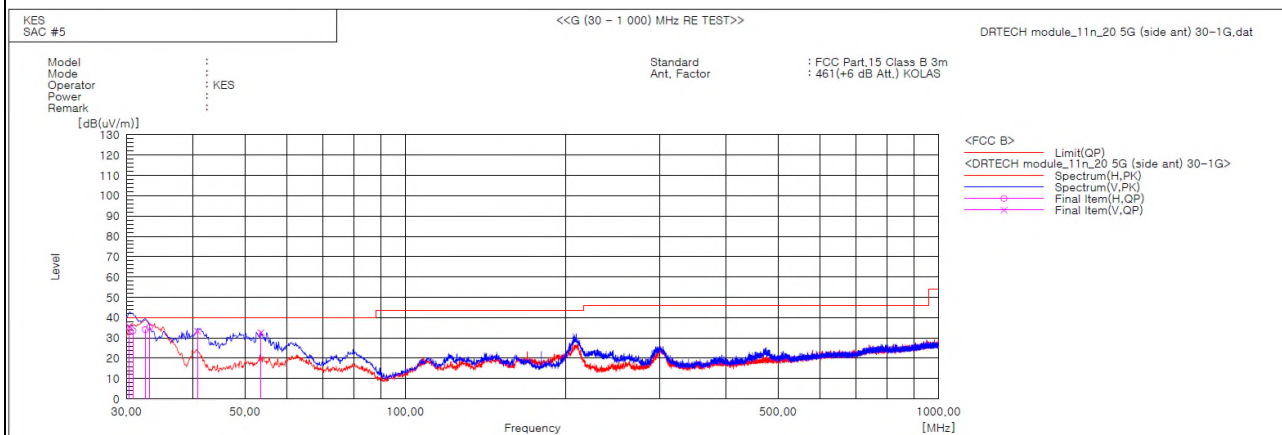
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Mode: UNII-1_HT40
Distance of measurement: 3 meter
Channel: 38 (Worst case)
ANT #3 PCB Antenna(Side)

Horizontal // Vertical



Final Result

No.	Frequency [MHz]	(P)	Reading QP [dB(uV)]	c.f [dB(1/m)]	Result QP [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]	Remark
1	30.364	V	50.1	-14.3	35.8	40.0	4.2	100.0	97.9	
2	30.849	H	47.8	-14.2	33.6	40.0	6.4	376.0	226.3	
3	32.546	H	48.2	-14.1	34.1	40.0	5.9	388.0	122.3	
4	33.153	H	49.4	-14.1	35.3	40.0	4.7	312.0	231.9	
5	40.791	V	46.5	-13.2	33.3	40.0	6.7	100.0	175.5	
6	53.644	V	45.7	-13.1	32.6	40.0	7.4	100.0	333.0	

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Test results (Above 1 000 MHz)

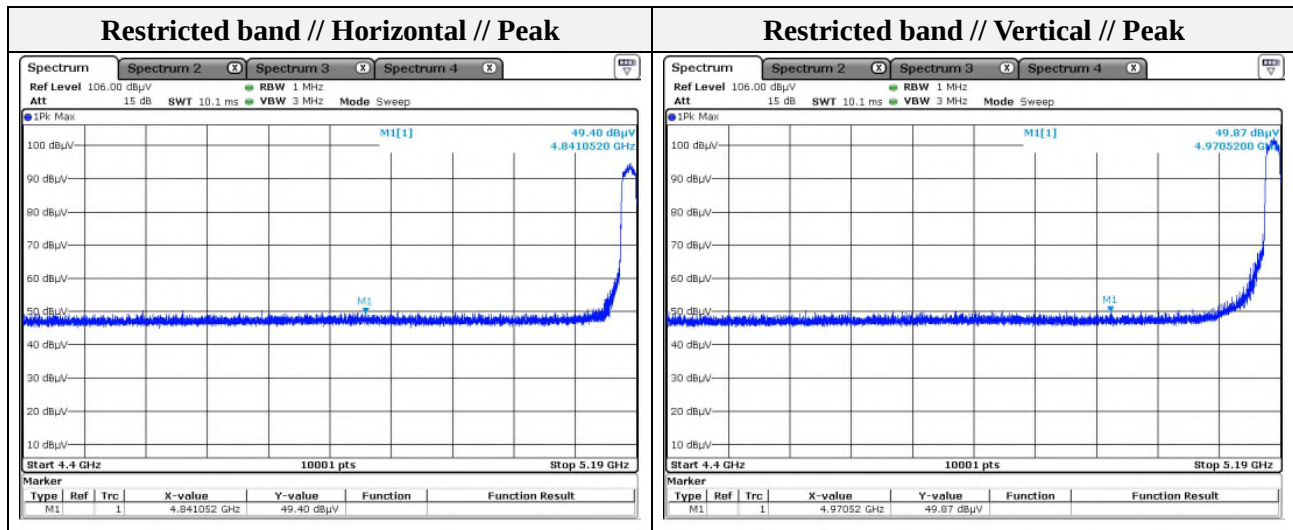
Mode:	UNII-1(HT20)
Distance of measurement:	3 meter
Channel:	36
ANT #1	Dipole Antenna

- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1600.69	48.80	Peak	H	-7.51	-	41.29	74.00	32.71
3130.59	47.43	Peak	H	-1.85	-	45.58	68.20	22.62
1293.72	48.22	Peak	V	-11.21	-	37.01	74.00	36.99
3130.59	48.35	Peak	V	-1.85		46.50	68.20	21.70

- Band edge

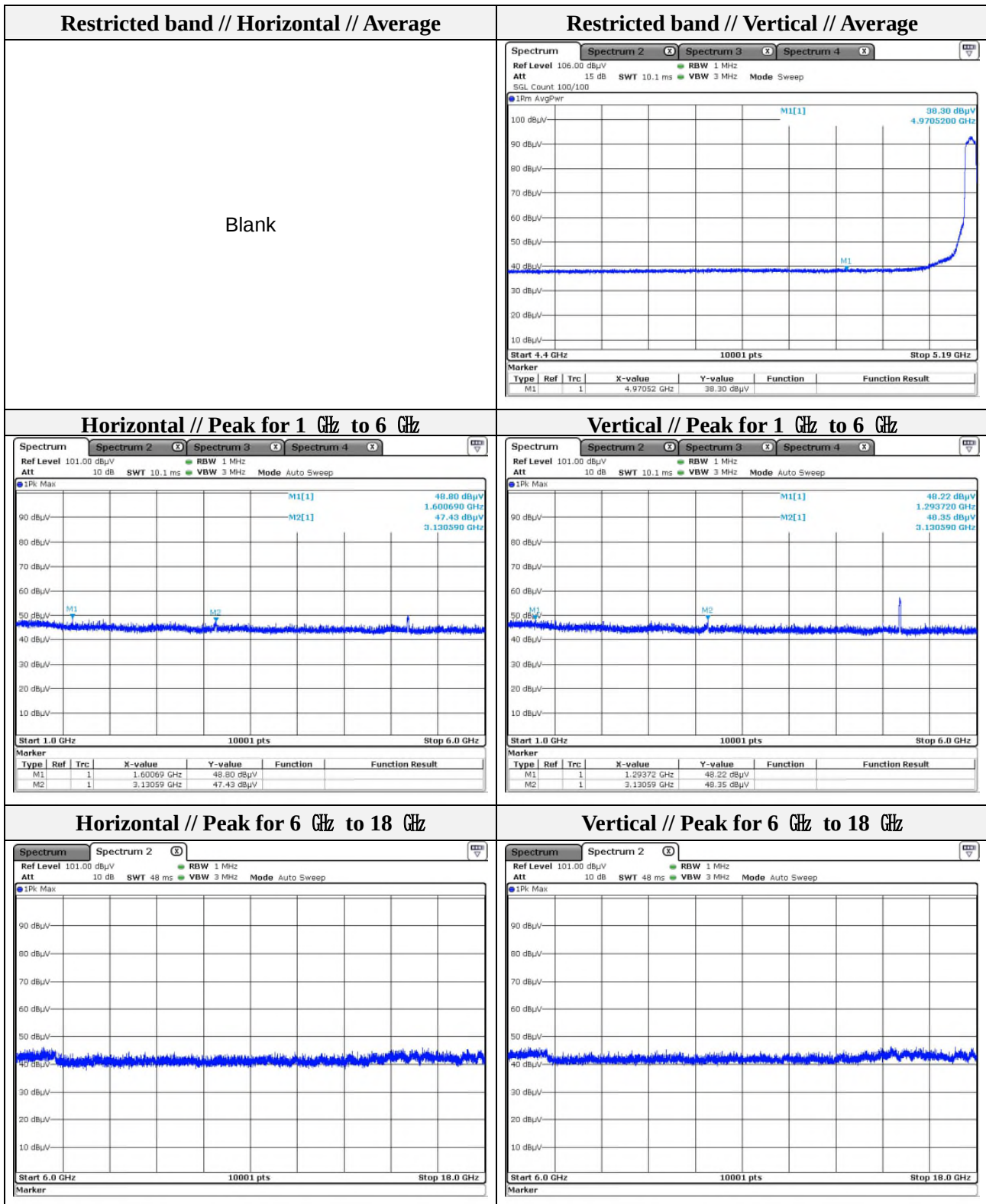
Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4841.05	49.40	Peak	H	3.72	-	53.12	74.00	20.88
4970.52	49.87	Peak	V	4.72	-	54.59	74.00	19.41
4970.52	38.30	Average	V	4.72	-	43.02	54.00	10.98



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Note.

1. No spurious emission were detected above 6 GHz.
2. Average test would be performed if the peak result were greater than the average limit.

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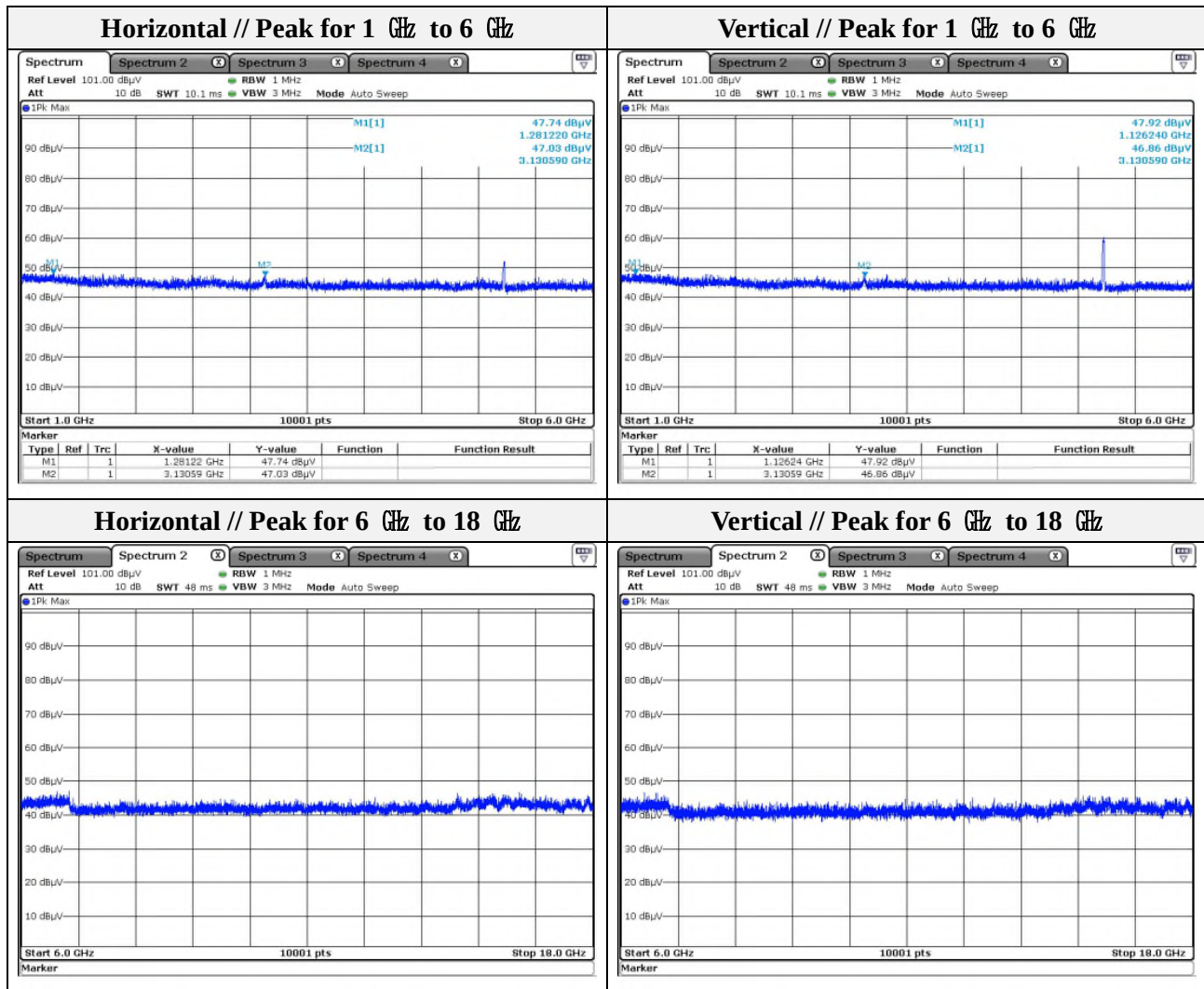
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Mode: UNII-1(HT20)
Distance of measurement: 3 meter
Channel: 44
ANT #1 Dipole Antenna

- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1281.22	47.74	Peak	H	-11.22	-	36.52	74.00	37.48
3130.59	47.03	Peak	H	-1.85	-	45.18	68.20	23.02
1126.24	47.92	Peak	V	-11.28	-	36.64	74.00	37.36
3130.59	46.86	Peak	V	-1.85	-	45.01	68.20	23.19



Note.

1. No spurious emission were detected above 6 GHz.

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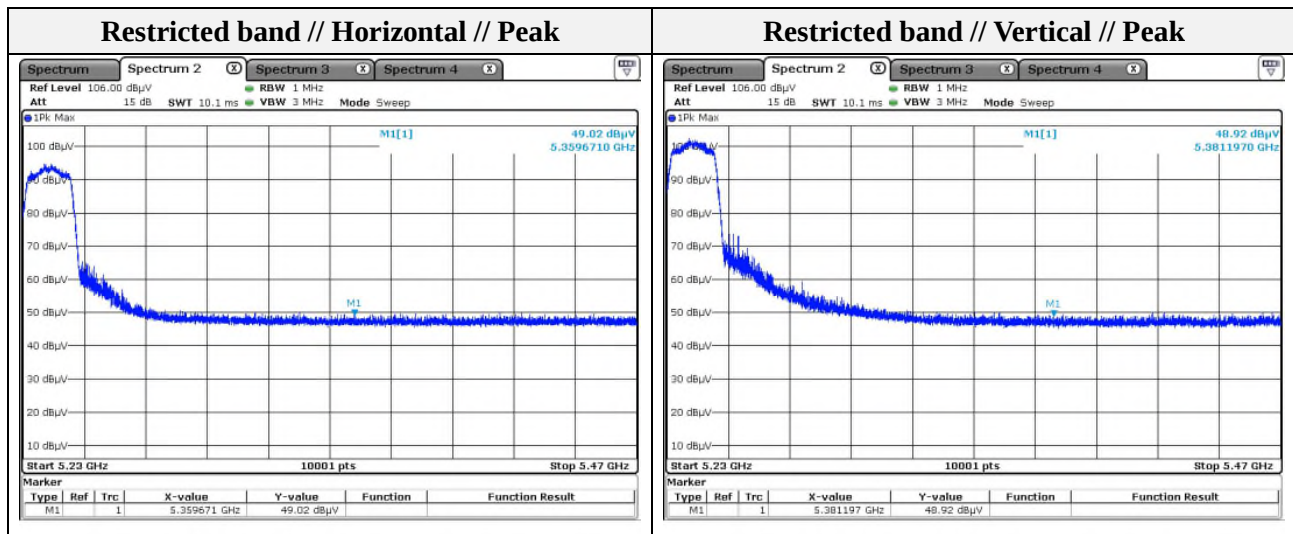
Mode: UNII-1(HT20)
Distance of measurement: 3 meter
Channel: 48
ANT #1 Dipole Antenna

- Spurious

Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
1170.00	48.91	Peak	H	-5.99	-	37.02	74.00	36.98
1929.80	47.73	Peak	H	4.22	-	45.32	68.20	22.88
1097.70	47.72	Peak	V	-6.20	-	37.19	74.00	36.81
2479.70	46.74	Peak	V	0.19	-	47.19	68.20	21.01

- Band edge

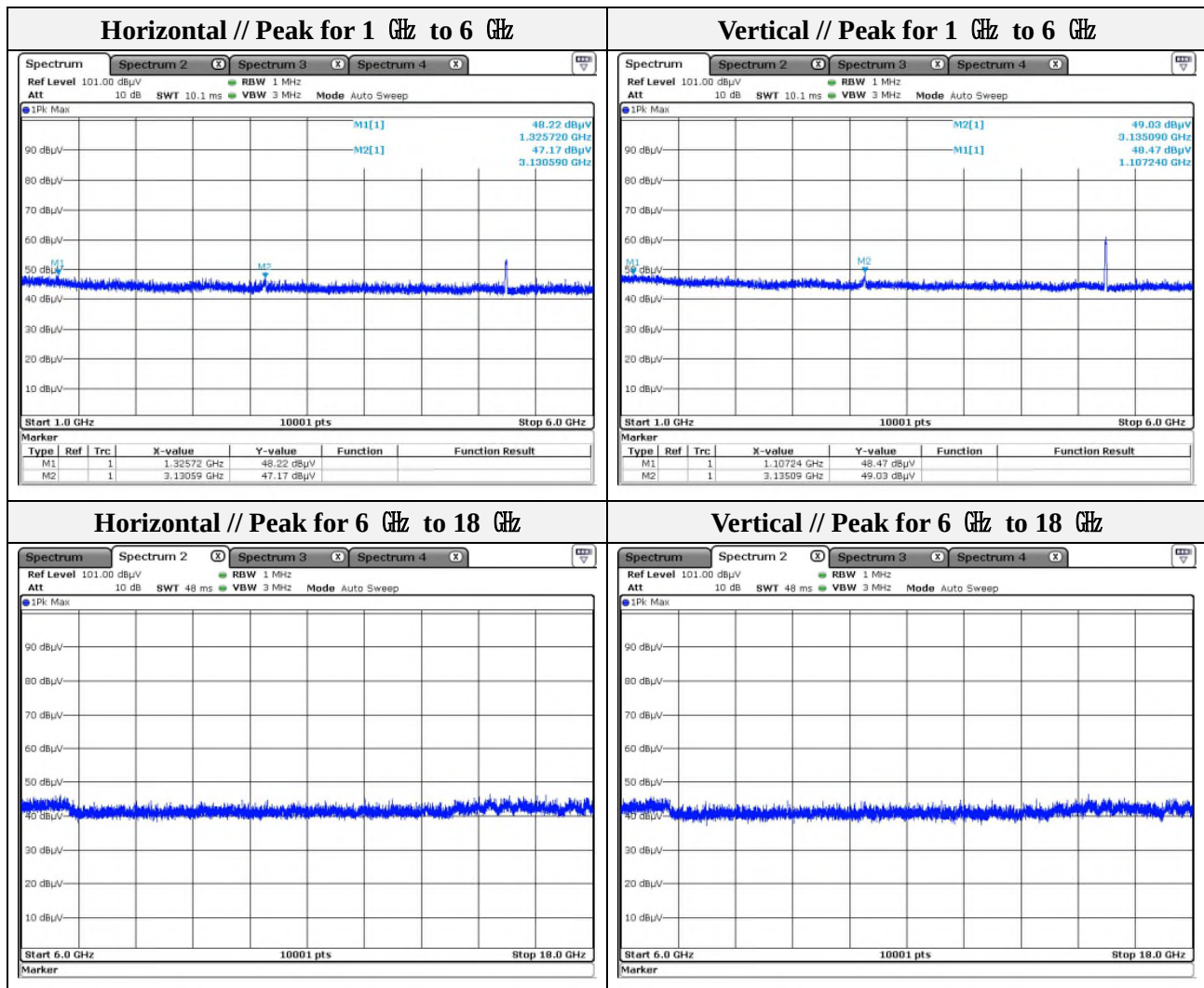
Frequency (MHz)	Level (dBμV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
5359.67	49.02	Peak	H	3.12	-	52.14	74.00	21.86
5381.20	48.92	Peak	V	3.03	-	51.95	74.00	22.05



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Note.

1. No spurious emission were detected above 6 GHz.

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