

Prüfbericht-Nr.: <i>Test report no.:</i>	50335244 002	Auftrags-Nr.: <i>Order no.:</i>	238106782	Seite 1 von 90 <i>Page 1 of 90</i>
Kunden-Referenz-Nr.: <i>Client reference no.:</i>	N/A	Auftragsdatum: <i>Order date:</i>	24-Jun-2019	
Auftraggeber: <i>Client:</i>	WatchGuard Technologies, Inc. 505 5th Avenue S, Suite 500, Seattle, WA 98104-3892, USA			
Prüfgegenstand: <i>Test item:</i>	Firebox			
Bezeichnung / Typ-Nr.: <i>Identification / Type no.:</i>	Firebox T40-W			
Auftrags-Inhalt: <i>Order content:</i>	FCC Part 15E Test report (Wifi 5GHz)			
Prüfgrundlage: <i>Test specification:</i>	FCC 47CFR Part 15: Subpart E Section 15.407(UNII)			
Wareneingangsdatum: <i>Date of sample receipt:</i>	15-Nov-2019			
Prüfmuster-Nr.: <i>Test sample no.:</i>	A001025301-001 A001025301-003			
Prüfzeitraum: <i>Testing period:</i>	21-Dec-2019 – 16-Jan-2020			
Ort der Prüfung: <i>Place of testing:</i>	EMC/RF Laboratory Taipei			
Prüflaboratorium: <i>Testing laboratory:</i>	TUV Rheinland Taiwan Ltd.			
Prüfergebnis*: <i>Test result*:</i>	Pass			
überprüft von: <i>reviewed by:</i>	genehmigt von <i>authorized by:</i>			
Datum: 04-May-2020 <i>Date:</i>			Datum: 04-May-2020 <i>Date:</i>	
	<u>Jack H.C. Chang</u>			
Stellung / Position:	Project Manager		Stellung / Position: Vice General Manager	
Sonstiges / Other: The test report No. 50335244 001 is replaced by this new test report No. 50335244 002 for added RBW/VBW on page 83. Test report No. 50335244 001 becomes invalid since 2020-05-04.				
Zustand des Prüfgegenstandes bei Anlieferung: <i>Condition of the test item at delivery:</i>		Prüfmuster vollständig und unbeschädigt <i>Test item complete and undamaged</i>		
* Legende:	1 = sehr gut P(ass) = entspricht o.g. Prüfgrundlage(n)	2 = gut F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	3 = befriedigend N/A = nicht anwendbar	4 = ausreichend N/T = nicht getestet
* Legend:	1 = very good P(ass) = passed a.m. test specification(s)	2 = good F(ail) = failed a.m. test specification(s)	3 = satisfactory N/A = not applicable	4 = sufficient N/T = not tested
Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens. <i>This test report only relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any test mark.</i>				

TEST SUMMARY

5.1.1 ANTENNA REQUIREMENT

RESULT: Passed

5.1.2 DUTY CYCLE

RESULT: Passed

5.1.3 MAXIMUM CONDUCTED AVERAGE OUTPUT POWER

RESULT: Passed

5.1.4 26dB BANDWIDTH

RESULT: Passed

5.1.5 6dB BANDWIDTH

RESULT: Passed

5.1.6 POWER DENSITY

RESULT: Passed

5.1.7 FREQUENCY STABILITY MEASUREMENT

RESULT: Passed

5.1.8 SPURIOUS EMISSION

RESULT: Passed

5.2.1 MAINS CONDUCTED EMISSIONS

RESULT: Passed

6.1.1 ELECTROMAGNETIC FIELDS

RESULT: Passed

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1. General Remarks

1.1 Complementary Materials

These attachments are integral parts of this test report:

Appendix P: Photo Documentation

(File Name: 50335244 002 APPENDIX P)

Appendix D: Test Result of Radiated Emissions

(File Name: 50335244 002 APPENDIX D)

Test Specifications

The following standards were applied.

The decision rule of conformity of this test report is following the requirements of the requested standard in the quotation, and agreed among testing laboratory and manufacturer (applicant) to exclude the consideration of Measurement Uncertainty, unless it is required by the specific standard.

Table 1: Applied Standard and Test Levels

Radio
FCC CFR47 Part 15: Subpart E Section 15.407
ANSI C63.10:2013
KDB789033 D02 General UNII Test Procedures New Rules v02r01

1.2 Decision Rule of conformity

The decision rule of conformity of this test report is following the requirements of the requested standard in the quotation, and agreed among testing laboratory and manufacturer (applicant) to exclude the consideration of Measurement Uncertainty, unless it is required by the specific standard.

2. Test Sites

2.1 Test Laboratory

TUV Rheinland Taiwan Ltd.
Taipei Testing Laboratories

11F. No.758, Sec. 4, Bade Rd., Songshan Dist.
Taipei City 105
Taiwan (R.O.C.)

2.2 Test Facility

TUV Rheinland Taiwan Ltd.

AC Mains Conduction:
11F. No.758, Sec. 4, Bade Rd., Songshan Dist.
Taipei City 105
Taiwan (R.O.C.)
FCC Registration No.: 180491
IC Canada Registration No.: 9465A

Radiated Test/Conducted Test:
No. 458-18, Sec 2, Fenliao., Linkou Dist.
New Taipei City 244
Taiwan (R.O.C.)
FCC Registration No.: 226631
IC Canada Registration No.: 25563

TAF Accredited NCC Test Lab. No.:3567
TAF ISO17025 Certification effective period: 6th-May-2019 to 05th-May-2022



2.3 List of Test and Measurement Instruments

Table 2: List of Test and Measurement Equipment

Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Due Date
EMI Test Receiver	R&S	ESR7	102108	2019/2/06	2020/2/05
Spectrum Analyzer	R&S	FSV40	101508	2019/2/05	2020/2/04
Pre-Amplifier	Agilent	8447D	2944A10772	2019/2/22	2020/2/21
Pre-Amplifier	EMCI	EMC051845SE	980633	2019/2/25	2020/2/24
Pre-Amplifier	EMCI	EMC184045SE	980657	2019/2/23	2020/2/22
Bilog Antenna	SCHWARZBECK	VULB-9168	00951	2019/1/14	2020/1/31
Horn Antenna	ETS-Lindgren	3117	00218930	2019/12/06	2020/12/05
Horn Antenna	SCHWARZBECK	BBHA 9170	00887	2019/4/12	2020/4/11
Loop Antenna	EMCI	LPA600	287	2019/12/20	2020/12/19
Test Software	Audix	e3	Ver. 9	N/A	N/A
Test Cable	HUBER+SUHNER	SUCOFLEX 104EA 9k~18G	800056/4EA	2019/4/18	2020/4/17
Test Cable	HUBER+SUHNER	SUCOFLEX 104 9k~18G	804680/4	2019/4/18	2020/4/17
Test Cable	HUBER+SUHNER	SUCOFLEX 104 9k~18G	MY37202/4	2019/4/18	2020/4/17
Test Cable	HUBER+SUHNER	SUCOFLEX 102EA 1G~40G	800898/2EA	2019/4/18	2020/4/17
Test Cable	HUBER+SUHNER	SUCOFLEX 102EA 1G~40G	800901/2EA	2019/4/18	2020/4/17
Test Cable	HUBER+SUHNER	SUCOFLEX 102EA 1G~40G	801027/2EA	2019/4/18	2020/4/17
EMI Test Receiver	Rohde & Schwarz	ESCI 7	100797	2019/1/16	2020/1/31
Two-Line V-Network (for EUT)	Rohde & Schwarz	ENV216	101243	2019/6/23	2020/06/22
Two-Line V-Network	Rohde & Schwarz	ENV216	101262	2019/7/16	2020/7/15
Impedance Stabilization Network	TESEQ	ISN T800	51949	2019/2/20	2020/2/19
Pulse Limiter	Rohde & Schwarz	ESH3-Z2	0357.8810.54- 102102-HN	2019/7/25	2020/7/24
Spectrum Analyzer	R&S	FSV40	101513	2019/2/8	2020/2/7
ETSI power meter USB	Dare	RPR6W-1901030	1829913	2019/7/30	2020/7/29

2.4 Traceability

All measurement equipment calibrations are traceable to NML(Taiwan)/NIST(USA) or where calibration is performed outside Taiwan, to equivalent nationally recognized standards organizations.

2.5 Calibration

Equipment requiring calibration is calibrated periodically in a suitably accredited Calibration Lab. Additionally all equipment is verified for proper performance on a regular schedule using in house standards or comparisons.

2.6 Measurement Uncertainty

The estimated combined standard uncertainty for radiated emissions and conducted emissions measurements.

Table 3: Emission Measurement Uncertainty

Parameter	Uncertainty
Radio Frequency	± 0.1 ppm
RF power, conducted	± 1.5 dB
RF power density, conducted	± 3 dB
spurious emissions, conducted	± 3 dB
all emissions, radiated	± 6 dB
Temperature	± 1 °C
Humidity	± 5 %
DC and low frequency voltages	± 3 %

3. General Product Information

3.1 Product Function and Intended Use

The EUT is a Firebox. It contains a WiFi compatible module enabling the user to communicate data through a Wireless interface.

For details refer to the User Guide, Data Sheet and Circuit Diagram.

3.2 System Details and Ratings

Table 4: Basic Information of EUT

Item	EUT information
Kind of Equipment	Firebox
Type Designation	Firebox T40-W
FCC ID	Q6G-FS4AE5W
IC	4657A-FS4AE5W
HVIN	FS4AE5W

Table 5: Technical Specification of EUT

Technical Specification	Value
Operating Frequencies	Band 1: 20M(5180-5240MHz), 40M(5190-5230MHz), 80M(5210MHz) Band 4: 20M(5745-5825MHz), 40M(5755-5795MHz), 80M(5775MHz)
Channel Spacing	10 MHz
Channel number	9 for 20MHz bandwidth 4 for 40MHz bandwidth 2 for 80MHz bandwidth
Operation Voltage	54Vdc
Modulation	802.11a/n: OFDM (BPSK / QPSK / 16QAM / 64QAM) 802.11ac: OFDM (BPSK / QPSK / 16QAM / 64QAM / 256QAM)
Antenna gain	Band 1: 3.78dBi Band 4: 3.96dBi
Product Type	802.11a: WLAN (3TX , 3RX) 802.11n: WLAN (3TX , 3RX) 802.11ac: WLAN (3TX , 3RX)

Table 6: Channel Frequency Table

Band	Channel	Frequency (MHz)	Bandwidth 20M	Bandwidth 40M	Bandwidth 80M
U-NII-1 (Band 1)	36	5180	V		
	38	5190		V	
	40	5200	V		
	42	5210			V
	44	5220	V		
	46	5230		V	
	48	5240	V		
U-NII-3 (Band 4)	149	5745	V		
	151	5755		V	
	153	5765	V		
	155	5775			V
	157	5785	V		
	159	5795		V	
	161	5805	V		
	165	5825	V		

3.3 Independent Operation Modes

Basic operation modes are:

- A. Transmitting
- B. Receiving
- C. Normal
- D. Off

3.4 Noise Generating and Noise Suppressing Parts

Refer to the Block Diagram.

3.5 Submitted Documents

- Block Diagram
- Instruction Manual
- Rating Label
- Technical Description

4. Test Set-up and Operation Modes

4.1 Principle of Configuration Selection

The test modes were adapted accordingly in reference to the instructions for use.

During testing, Channel and Power Controlling Software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product.

Table 7: Table for Parameters of Test Software Setting

UNII Band	NCB: 20MHz			NCB: 40MHz		NCB: 80MHz	
	Channel	Mode		Channel	Mode	Channel	Mode
		802.11a Setting	802.11n/ac Setting		802.11n/ac Setting		802.11n/ac Setting
Band 1	36	14	14	38	12	42	10
	40	15	15	46	18		
	48	15	15				
Band 4	149	13	12	151	15	155	16
	157	12	12	159	15		
	165	12	13				

4.2 Test Operation and Test Software

Setup for testing: The test sample itself is equipped with a touch screen, It was used to enable the operation modes listed in section 3.3 as appropriate by the screen.

The samples were used as follows:

Conducted: A001025301-001

Radiation: A001025301-003

The modulation and bandwidth are similar for 802.11n mode for 20MHz/40MHz and 802.11ac mode for 20MHz/40MHz, therefore investigated worst case to representative mode in test report.

Full test was applied on all test modes, but only worst case was shown

IEEE 802.11a mode:

Band 1 Channel Low (5180MHz), Channel Mid (5200MHz) and Channel High (5240MHz) with 6Mbps data rate were chosen for full testing.

Band 4 Channel Low (5745MHz), Channel Mid (5785MHz) and Channel High (5825MHz) with 6Mbps data rate were chosen for full testing.

IEEE 802.11an/ac HT20/VHT20 mode:

Band 1 Channel Low (5180MHz), Channel Mid (5200MHz) and Channel High (5240MHz) with MCS0/NSS1 data rate were chosen for full testing.

Band 4 Channel Low (5745MHz), Channel Mid (5785MHz) and Channel High (5825MHz) with MCS0/NSS1 data rate were chosen for full testing.

IEEE 802.11an/ac HT40/VHT40 mode:

Band 1 Channel Low (5190MHz) and Channel High (5230MHz) with MCS0/NSS1 data rate were chosen for full testing.

Band 4 Channel Low (5755MHz) and Channel High (5895MHz) with MCS0/NSS1 data rate were chosen for full testing.

IEEE 802.11ac VHT80 mode:

Band 1 Channel Low (5120MHz) with MCS0/NSS1 data rate were chosen for full testing.

Band 4 Channel Low (5775MHz) with MCS0/NSS1 data rate were chosen for full testing.

4.3 Special Accessories and Auxiliary Equipment

The product has been tested together with the following additional accessories:

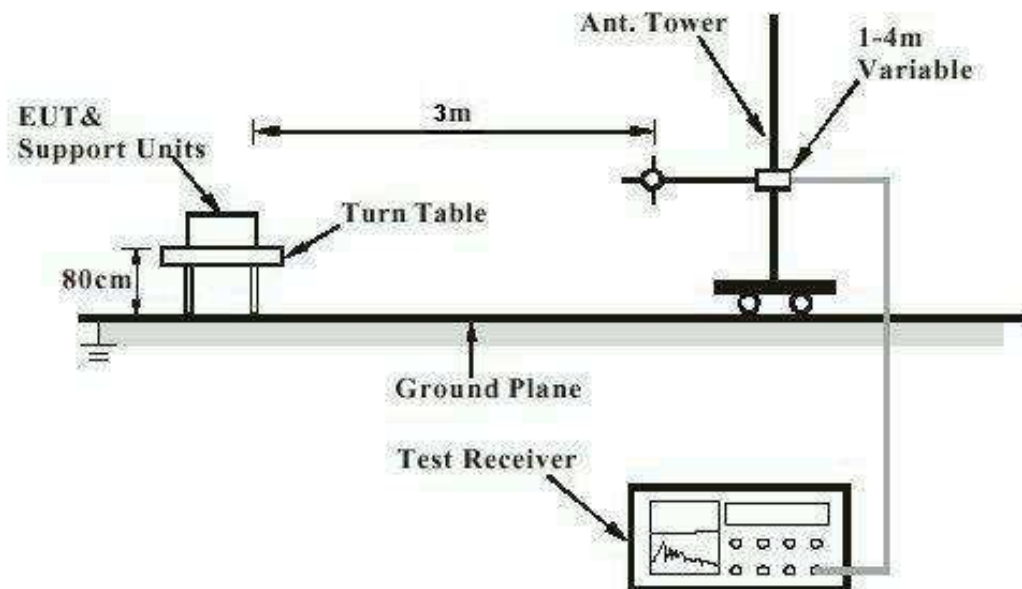
Kind of Equipment	Manufacturer	Model Name
Notebook	Lenovo	G580

4.4 Countermeasures to achieve EMC Compliance

The test sample which has been tested contained the noise suppression parts as described in the Constructional Data Form or the Technical Construction File. No additional measures were employed to achieve compliance.

4.5 Test Setup Diagram

Diagram of Measurement Configuration for Radiation Test



Note: Measurements above 1 GHz are done with a table height of 1.5m

Diagram of Measurement Equipment Configuration for Mains Conduction Measurement (if applicable)

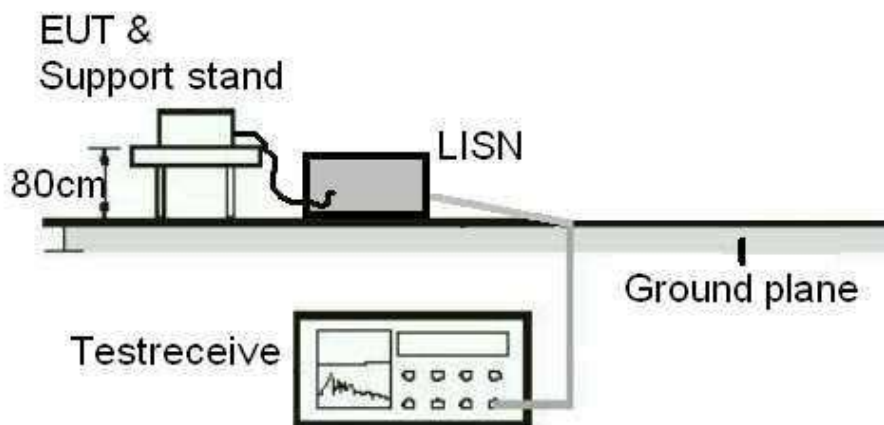
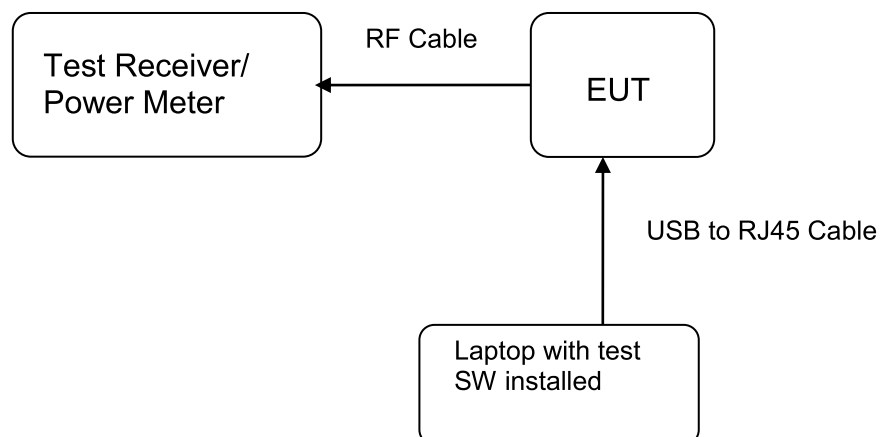


Diagram of Measurement Equipment Configuration for Conducted Transmitter Measurement



5. Test Results

5.1 Transmitter Requirement & Test Suites

5.1.1 Antenna Requirement

RESULT:**Passed**

Test standard : FCC Part 15.407(a), Part 15.203

Requirement : use of approved antennas only with directional gains that do not exceed 6 dBi

According to the manufacturer declaration, the EUT has an antenna with a directional gain of 3.96 dBi. The antenna is a printed PCB trace with no possibility of replacement with a non-approved antenna by the end-user. Therefore, the EUT is considered to comply with this provision.

Refer to EUT photo for details.

5.1.2 Duty Cycle

RESULT:

Passed

Test standard : KDB 789033 Zero-Span Spectrum Analyzer Method,
Limit : None; for reporting purposes only
Kind of test site : Shielded room / Conducted room

Test setup

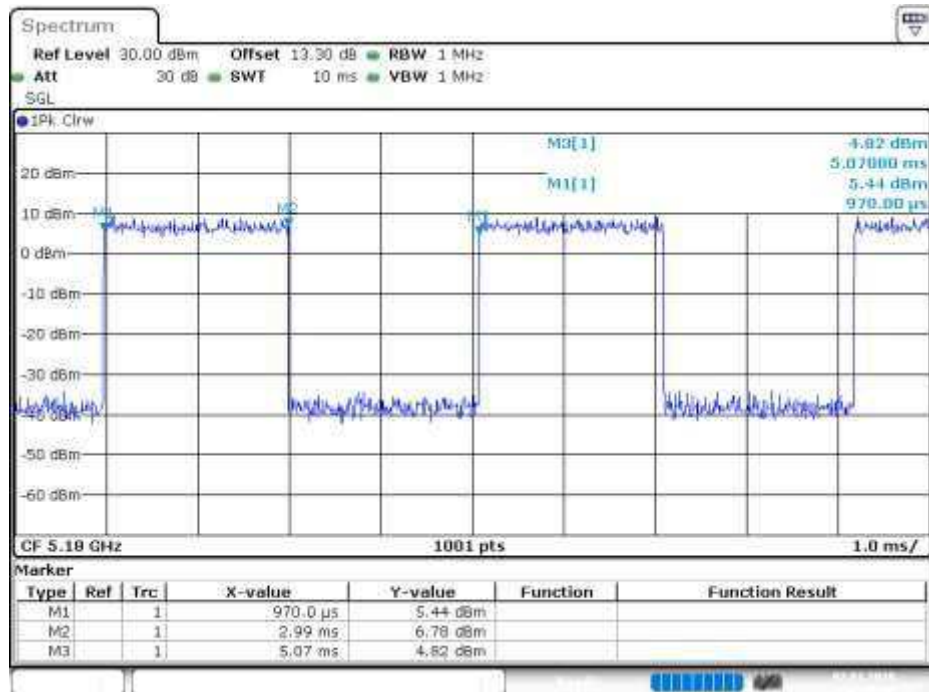
Operation Mode : A
Test Channel : Refer to the Table (Band 1 low channel)

Table 8: Test result of Duty Cycle

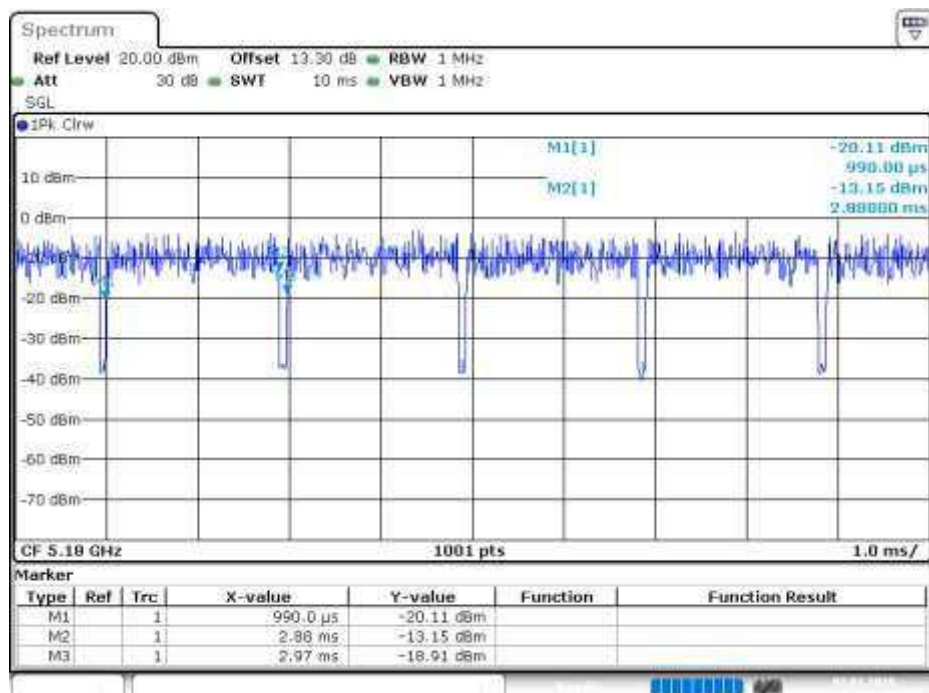
Mode	On Time(ms)	On+Off Time(ms)	Duty Cycle (%)	Duty Factor (dB)
802.11a	2.99	5.07	58.97	2.29
802.11ac VHT20	2.88	2.97	96.97	0.13
802.11ac VHT40	4.11	4.19	98.09	0.08
802.11ac VHT80	2.86	2.93	97.61	0.11

The duty factor is $10\log (1/ (\text{Duty Cycle (\%)} / 100))$.

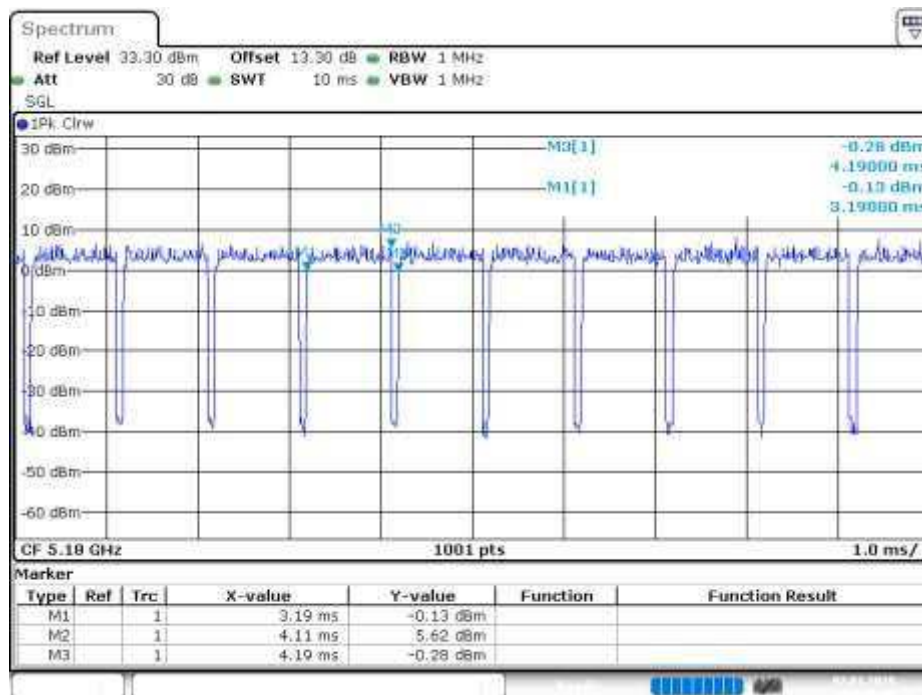
Test Plot of Duty Cycle

802.11a


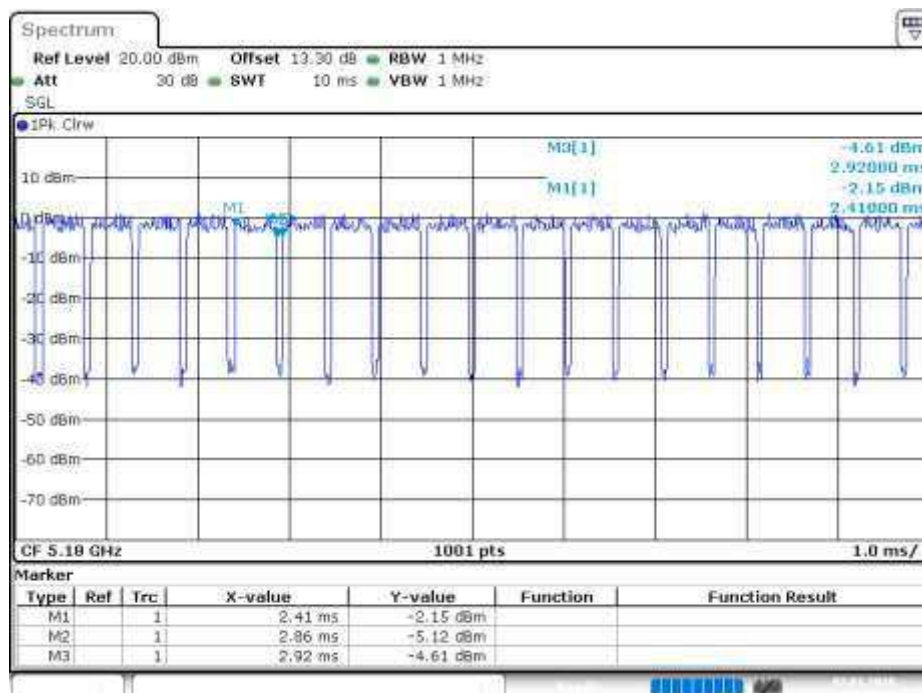
Date: 2.JAN.2020 12:49:08

802.11n HT20


Date: 2.JAN.2020 12:56:46

802.11n HT40


Date: 2.JAN.2020 13:05:10

802.11ac VHT80


Date: 2.JAN.2020 13:17:52

5.1.3 Maximum Conducted Average Output Power

RESULT:**Passed**

Test standard	:	FCC Part 15.407(a)
Basic standard	:	ANSI C63.10:2013
Kind of test site	:	Shielded room

Test setup

Test Channel	:	Refer to the Table 7
Operation Mode	:	A

Ambient temperature	:	20-24 °C
Relative humidity	:	50-65 %
Atmospheric pressure	:	100-103 kPa

FCC Limit

For client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi.

For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W.

Table 9: FCC Test result of Average Output Power

Mode	Channel Frequency (MHz)	Average Output Power				Limit (dBm)
		Ant 1 (dBm)	Ant 2 (dBm)	Ant 3 (dBm)	Total (dBm)	
802.11a	5180	14.50	13.49	15.28	19.26	30.00
	5200	17.07	14.64	15.92	20.76	30.00
	5240	16.34	14.77	16.67	20.77	30.00
	5745	11.21	12.27	13.55	17.22	30.00
	5785	10.72	11.21	12.11	16.16	30.00
	5825	11.52	10.66	11.79	16.12	30.00
802.11n HT20	5180	14.12	13.68	15.18	19.14	30.00
	5200	17.01	14.62	16.04	20.77	30.00
	5240	16.02	14.54	16.26	20.44	30.00
	5745	9.90	11.21	12.24	15.99	30.00
	5785	10.82	10.74	11.34	15.75	30.00
	5825	11.88	11.47	11.65	16.44	30.00
802.11n HT40	5190	12.22	11.13	11.28	16.34	30.00
	5230	18.01	16.87	17.43	22.23	30.00
	5755	13.93	14.53	15.21	19.36	30.00
	5795	13.92	14.24	14.69	19.07	30.00
802.11ac VHT20	5180	13.91	13.52	15.11	19.01	30.00
	5200	16.88	14.41	15.96	20.64	30.00
	5240	15.72	14.06	15.92	20.08	30.00
	5745	10.02	10.98	11.91	15.81	30.00
	5785	10.98	10.65	11.39	15.79	30.00
	5825	11.84	11.98	11.61	16.58	30.00
802.11ac VHT40	5190	11.86	11.05	11.29	16.18	30.00
	5230	17.85	16.78	17.21	22.07	30.00
	5755	14.03	14.55	15.03	19.33	30.00
	5795	13.93	14.22	14.61	19.03	30.00
802.11ac VHT80	5210	9.90	8.67	9.15	14.04	30.00
	5775	15.11	15.27	15.61	20.11	30.00

5.1.4 26dB Bandwidth

RESULT:

Passed

Test standard : FCC Part 15.407(a)
 Basic standard : ANSI C63.10:2013
 Kind of test site : Conducted room

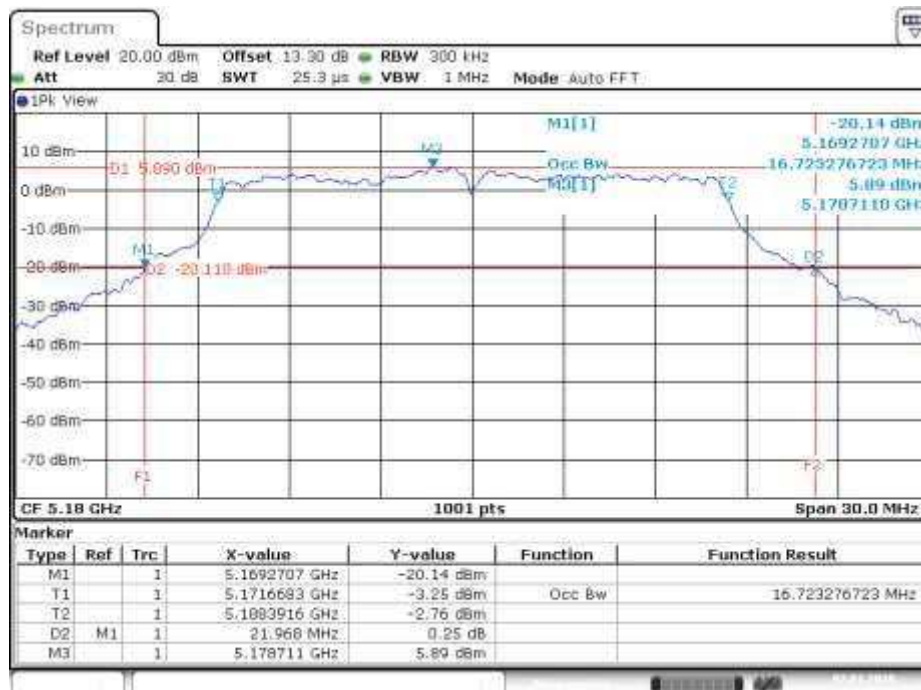
Test setup

Test Channel : Refer to the Table 7
 Operation Mode : A

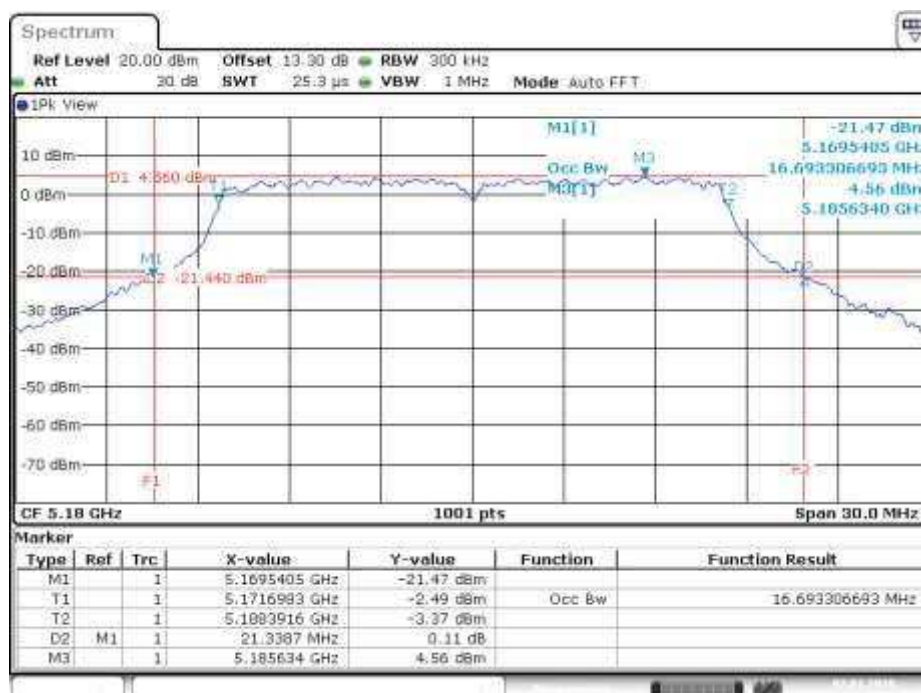
Table 10: Test result of 26dB Bandwidth

Mode	Channel Frequency (MHz)	26dB Bandwidth (MHz)		
		Ant 1	Ant 2	Ant 3
802.11a	5180	21.97	21.34	21.01
	5200	22.24	21.46	21.25
	5240	20.77	20.98	21.46
802.11n HT20	5180	21.64	22.60	21.82
	5200	22.01	21.61	21.46
	5240	21.10	21.85	22.42
802.11n HT40	5190	46.60	45.70	44.86
	5230	49.10	47.10	46.40
802.11ac VHT80	5210	86.81	87.71	87.51

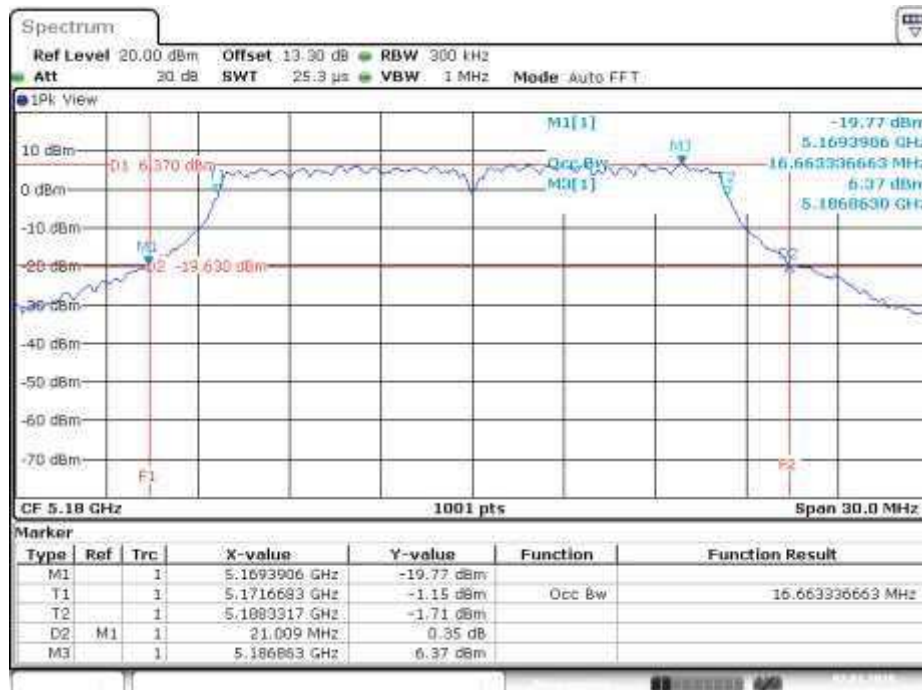
Test Plot of 26dB Bandwidth

802.11a 5180MHz
Ant 1


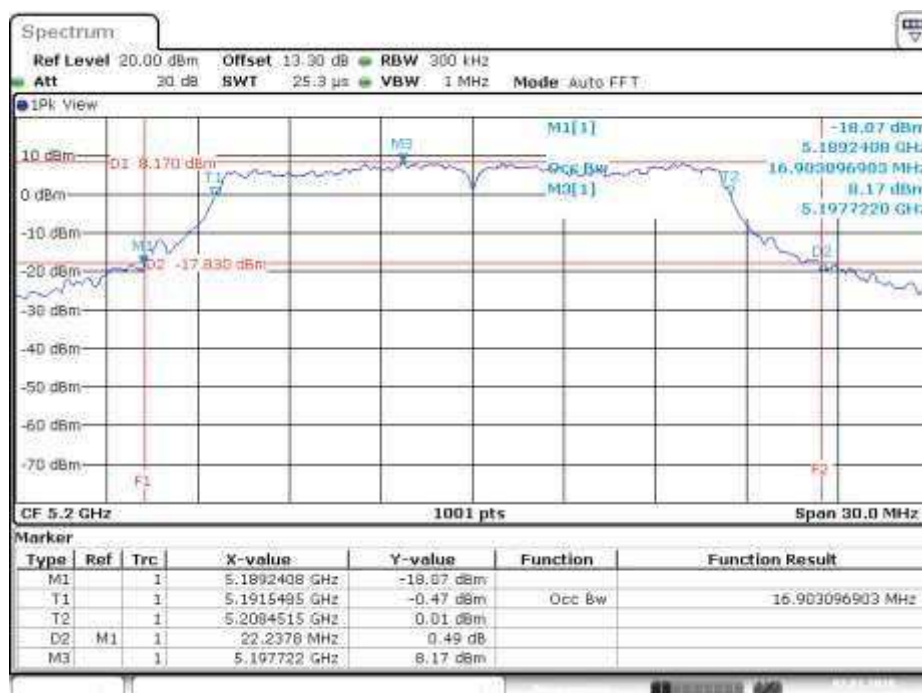
Date: 2.JAN.2020 13:25:52

Ant 2


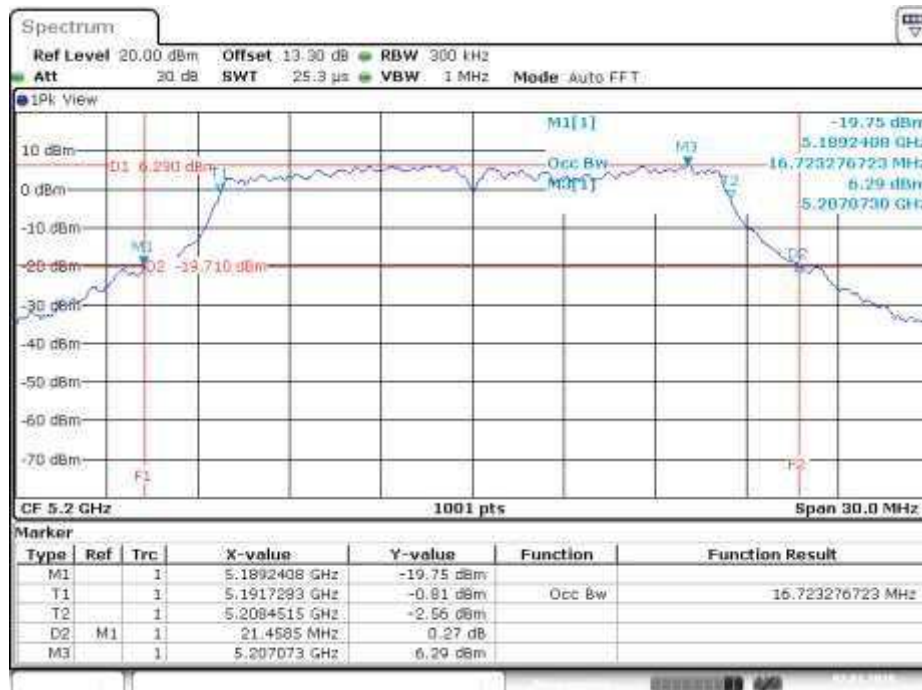
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Ant 3


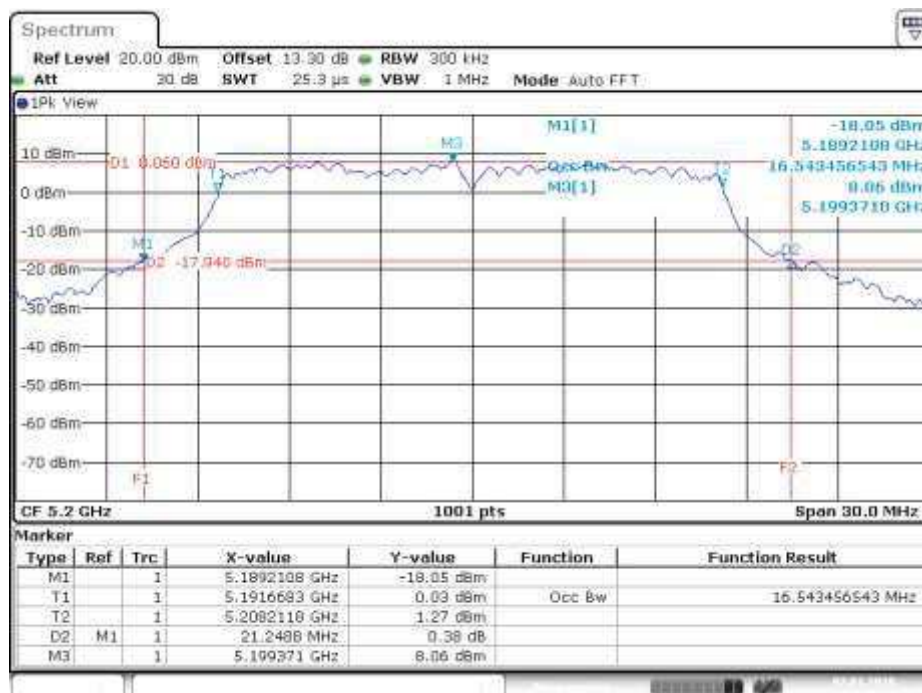
Date: 2.JAN.2020 13:30:56

802.11a 5200MHz
Ant 1


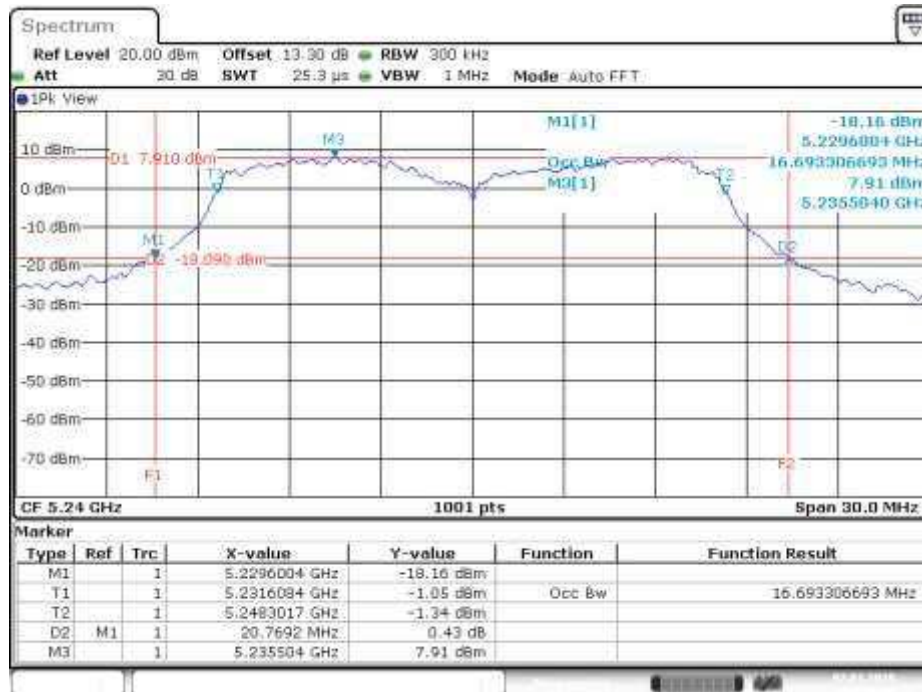
Date: 2.JAN.2020 13:50:35

Ant 2


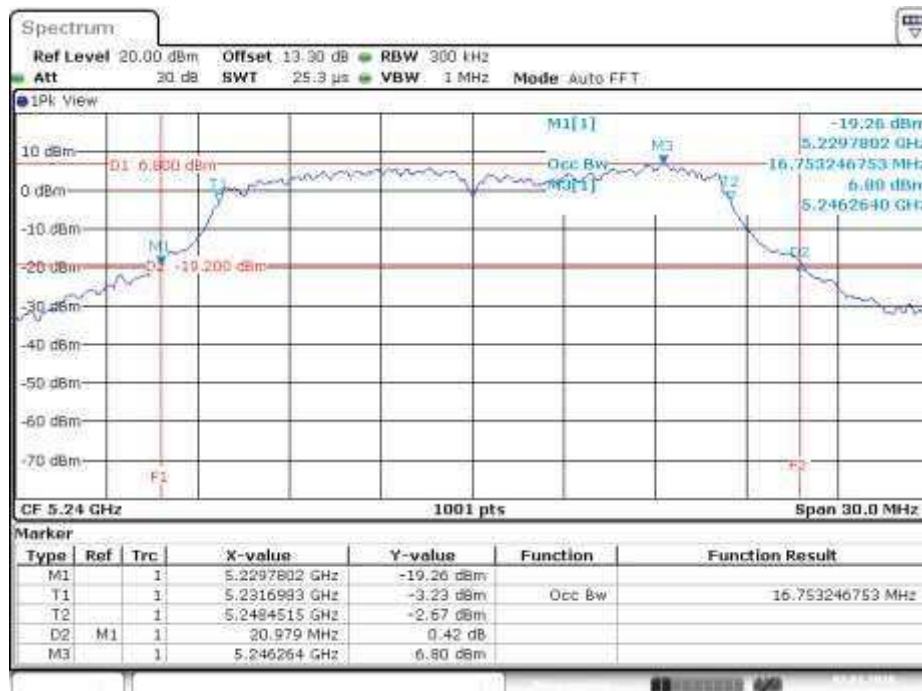
Date: 2.JAN.2020 13:49:46

Ant 3


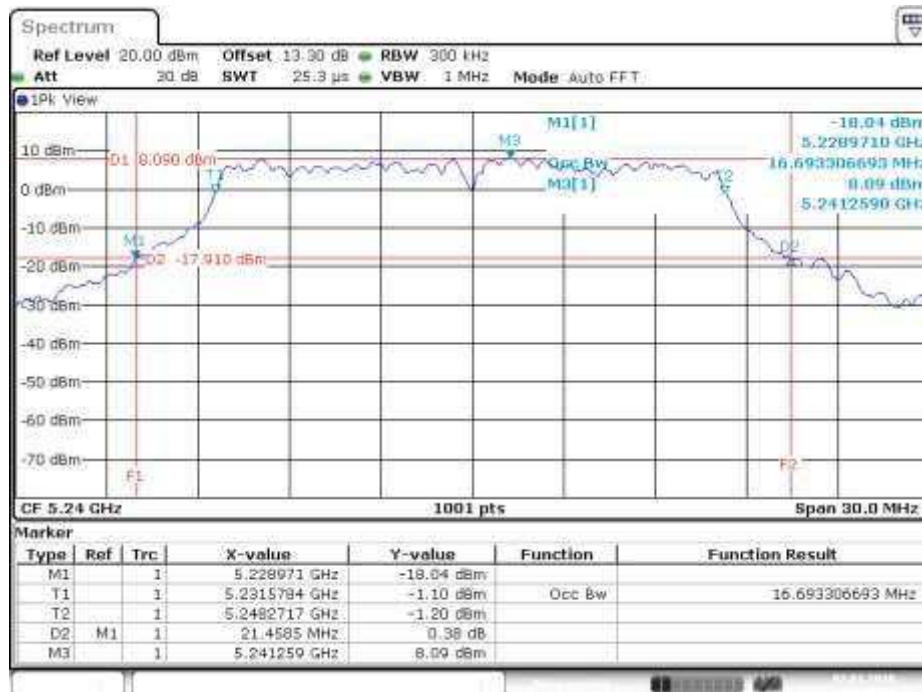
Date: 2.JAN.2020 13:40:03

802.11a 5240MHz
Ant 1


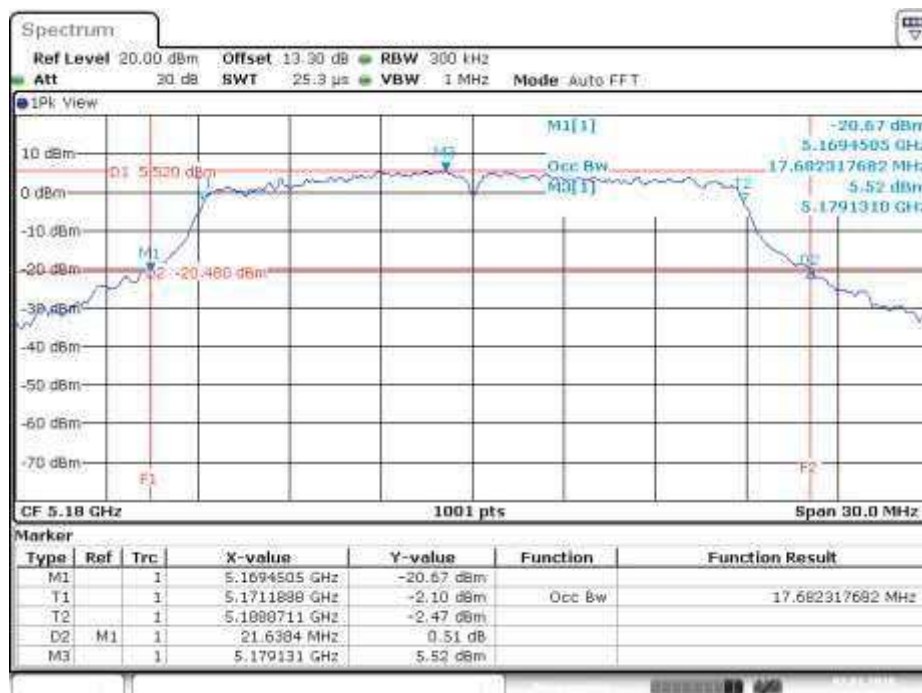
Date: 2.JAN.2020 13:53:47

Ant 2


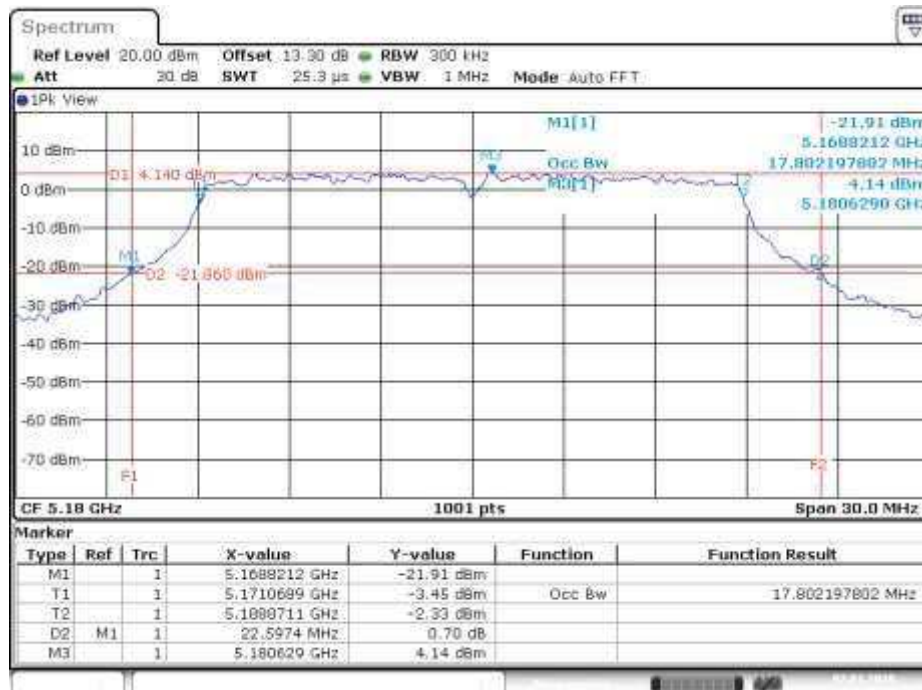
Date: 2.JAN.2020 14:05:23

Ant 3


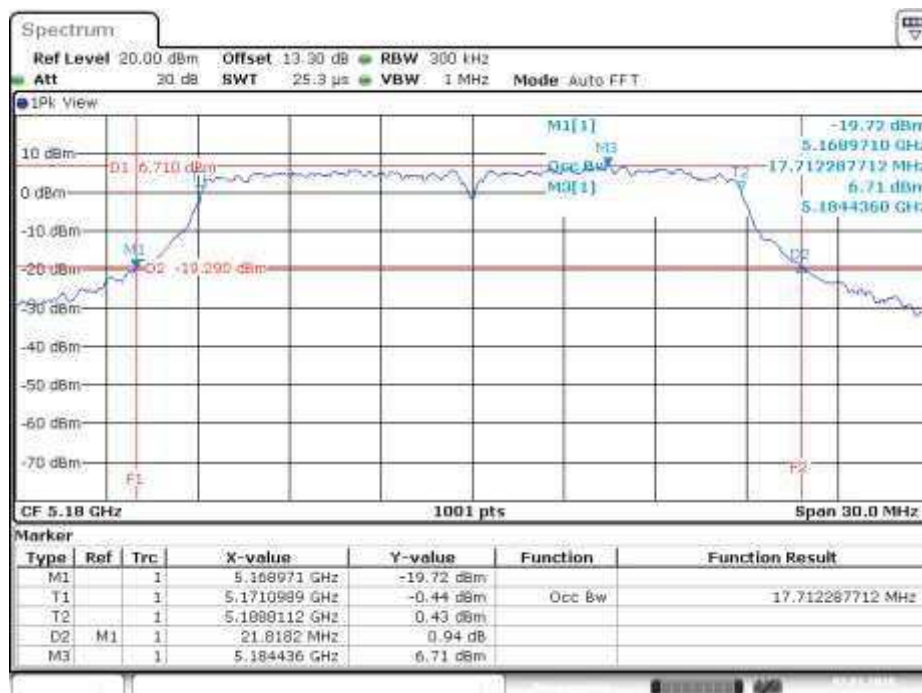
Date: 2.JAN.2020 14:06:23

802.11n HT20 5180MHz
Ant 1


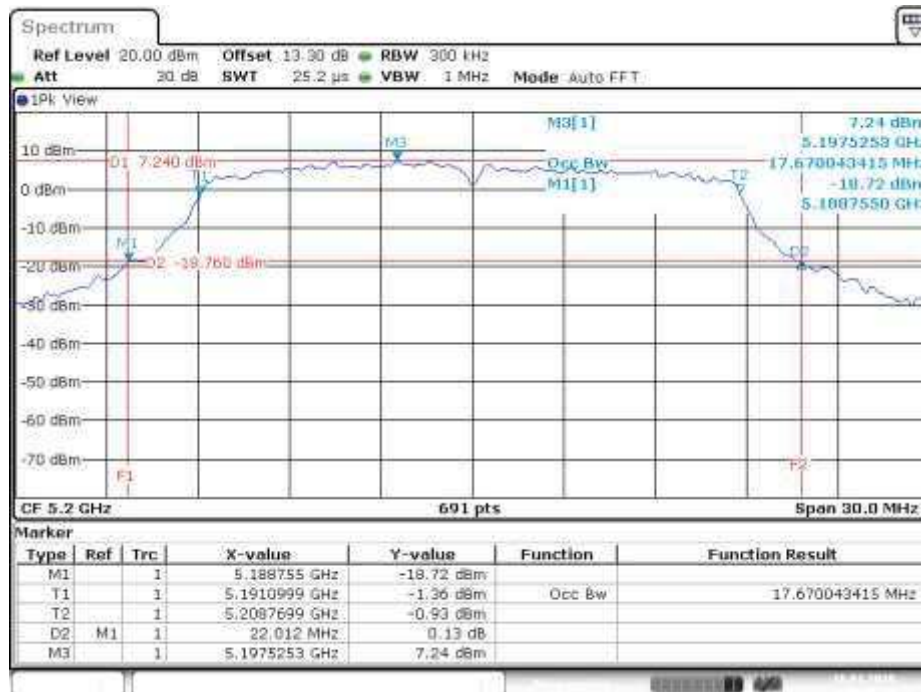
Date: 2.JAN.2020 14:16:13

Ant 2


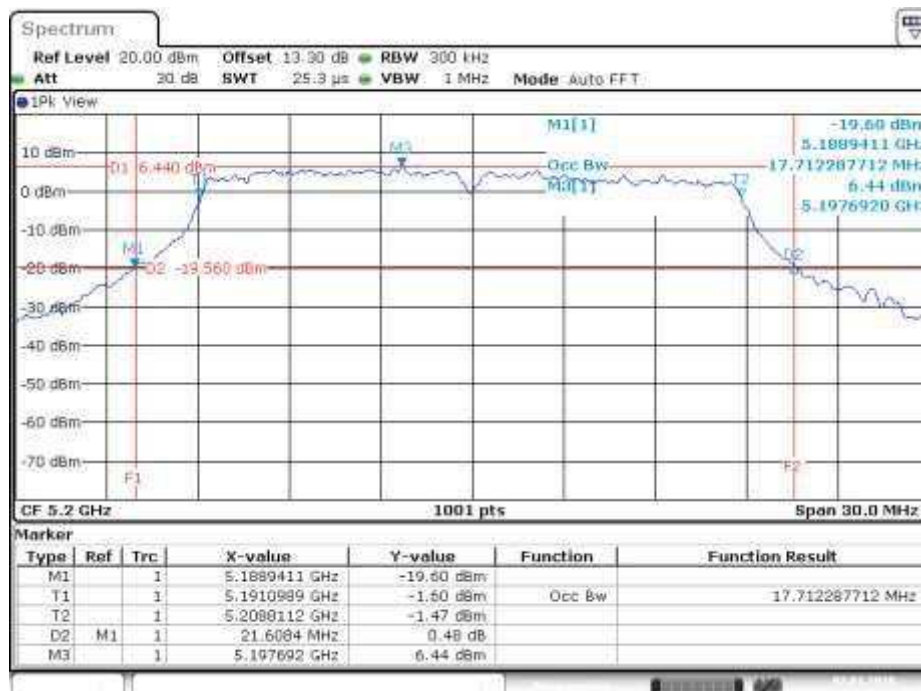
Date: 2.JAN.2020 14:15:20

Ant 3


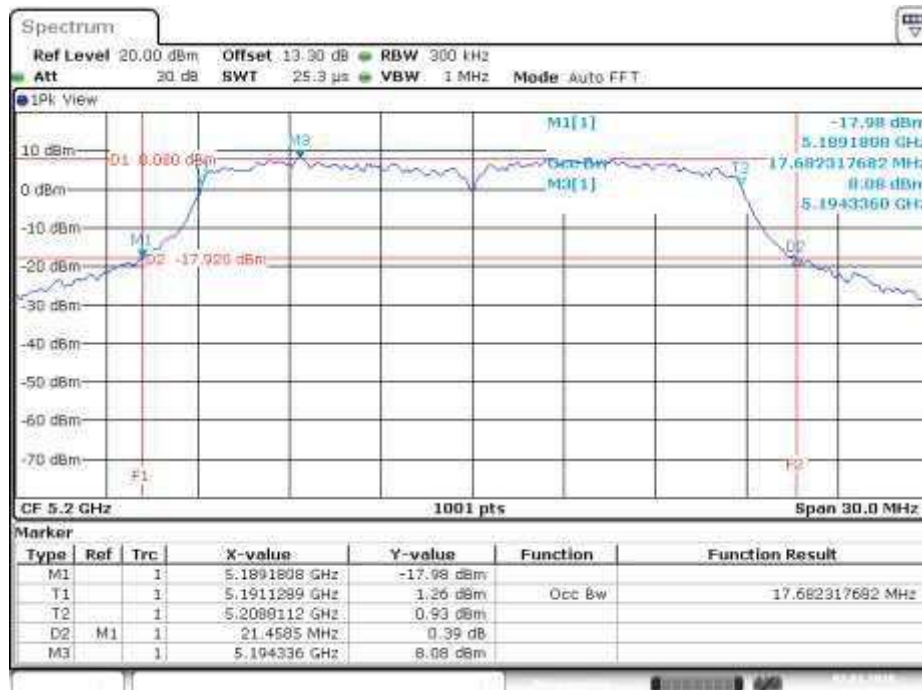
Date: 2.JAN.2020 14:12:50

802.11n HT20 5200MHz
Ant 1


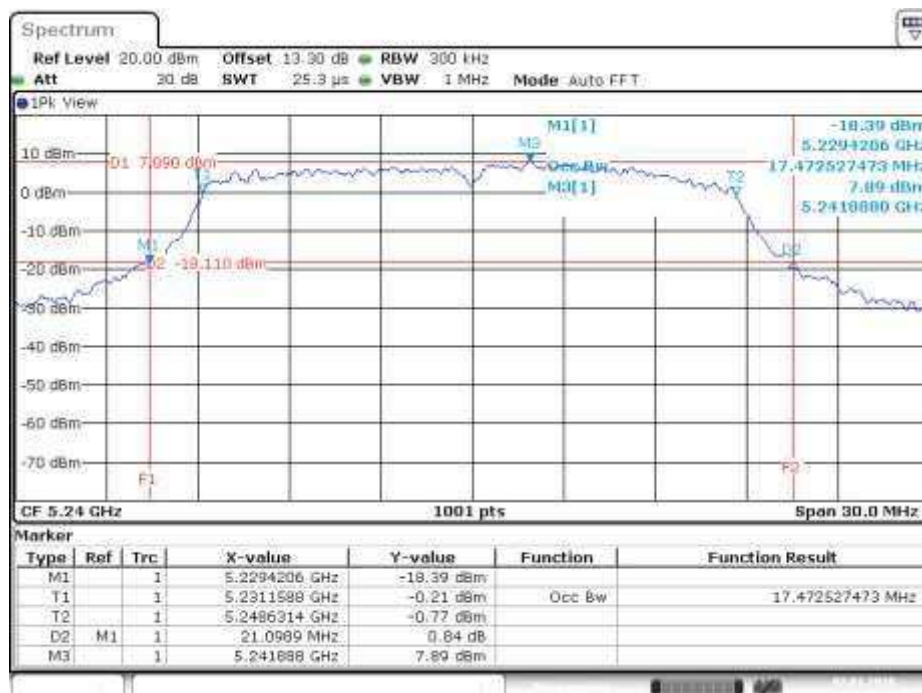
Date: 16.JAN.2020 09:57:53

Ant 2


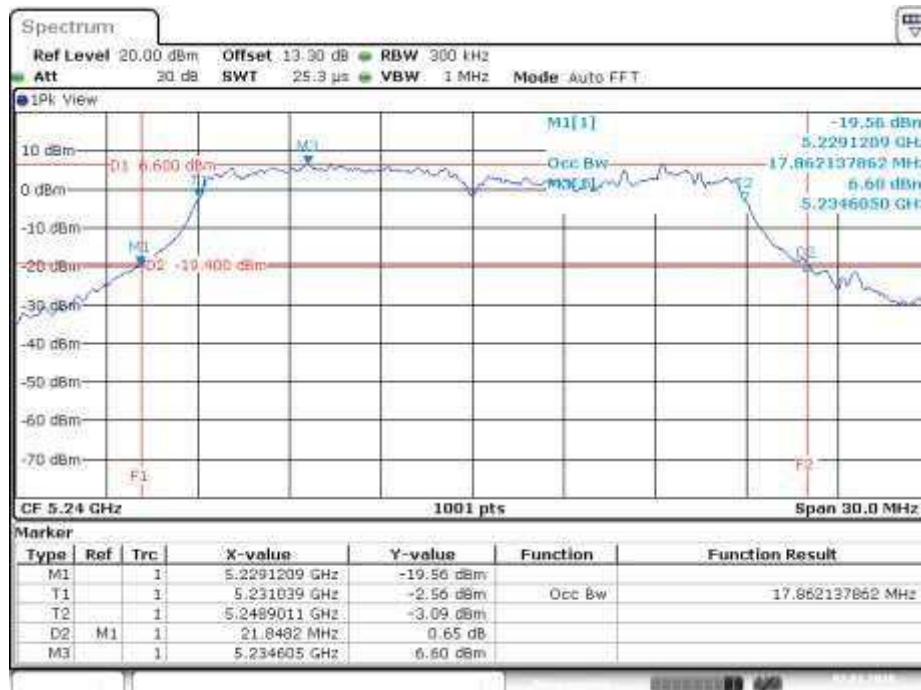
Date: 2.JAN.2020 14:18:04

Ant 3


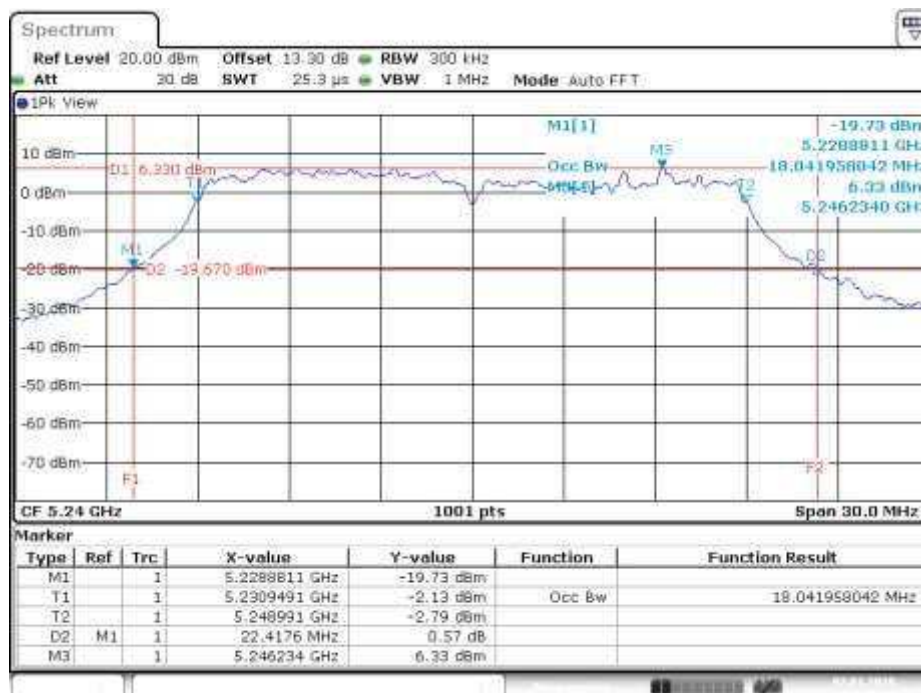
Date: 2.JAN.2020 14:18:53

802.11a 5240MHz
Ant 1


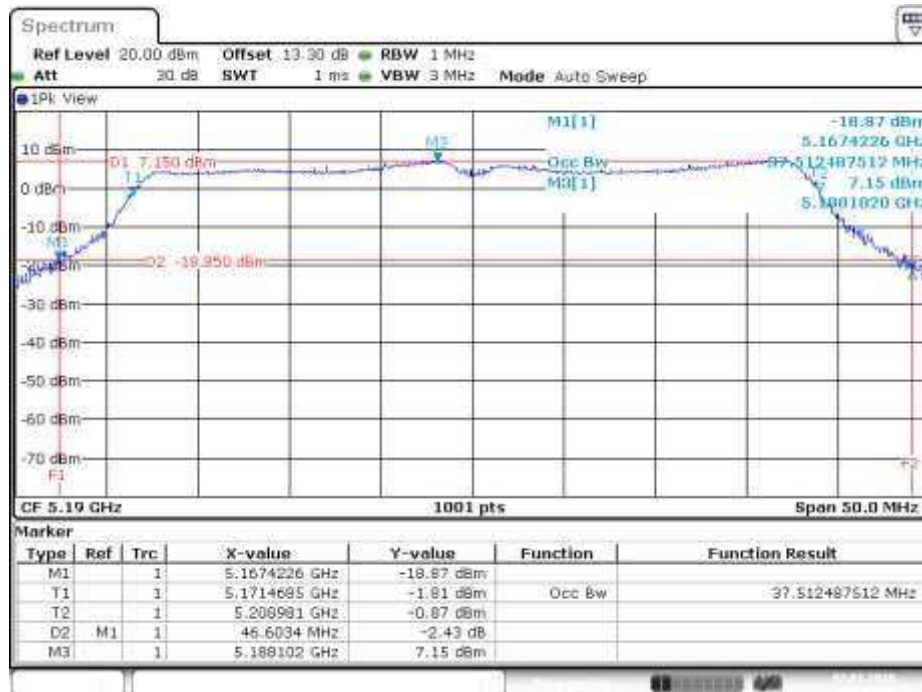
Date: 2.JAN.2020 14:23:24

Ant 2


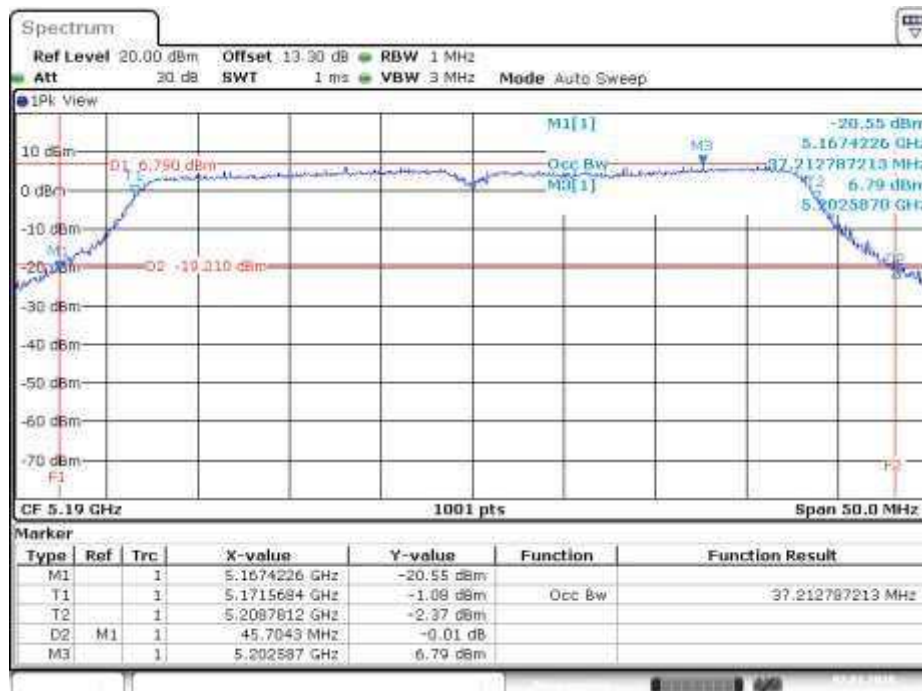
Date: 2.JAN.2020 14:21:50

Ant 3


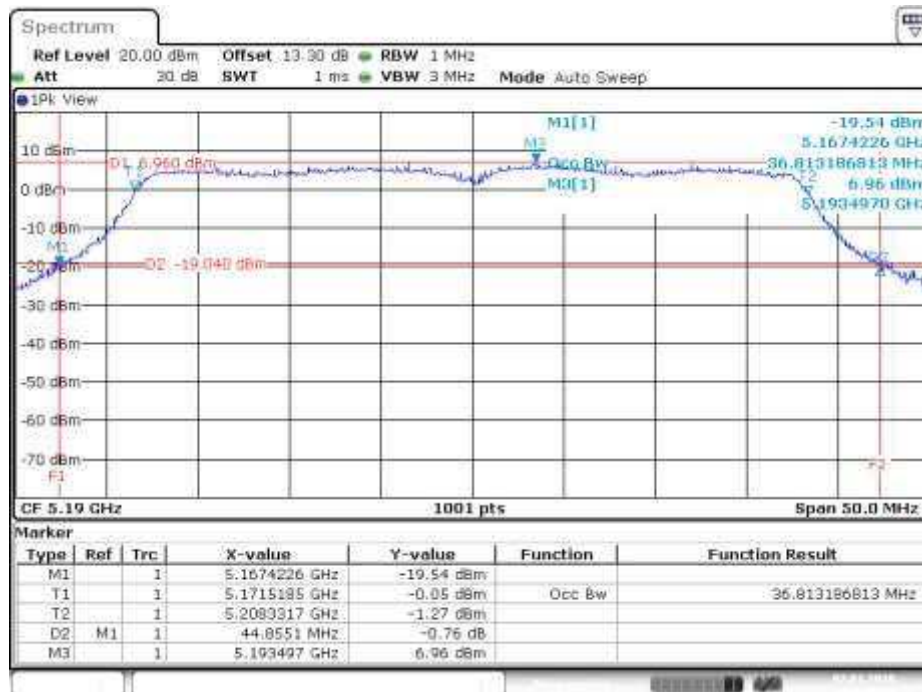
Date: 2.JAN.2020 14:20:48

802.11n HT40 5190MHz
Ant 1


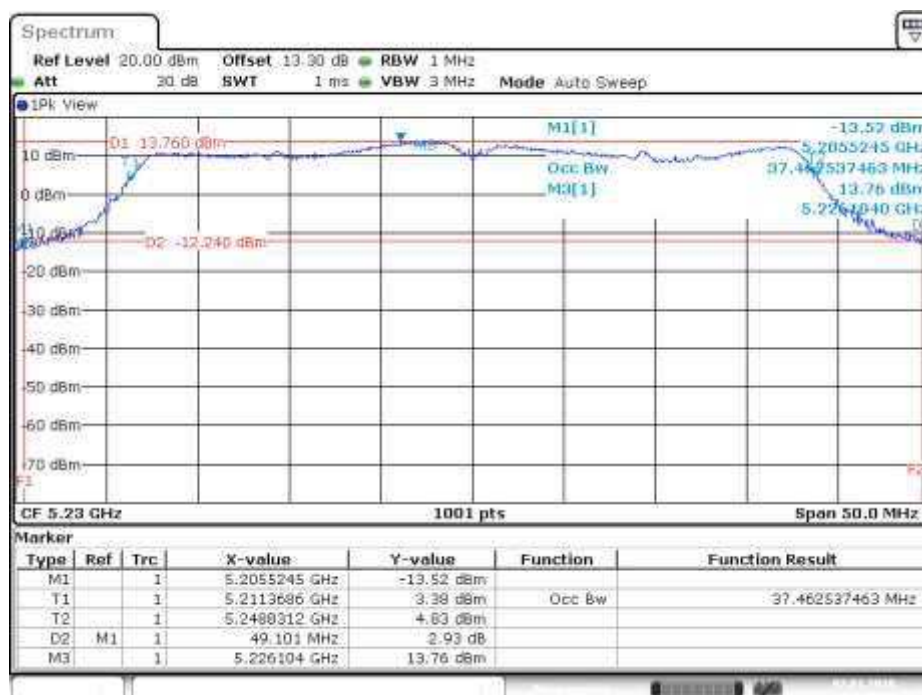
Date: 2.JAN.2020 14:25:06

Ant 2


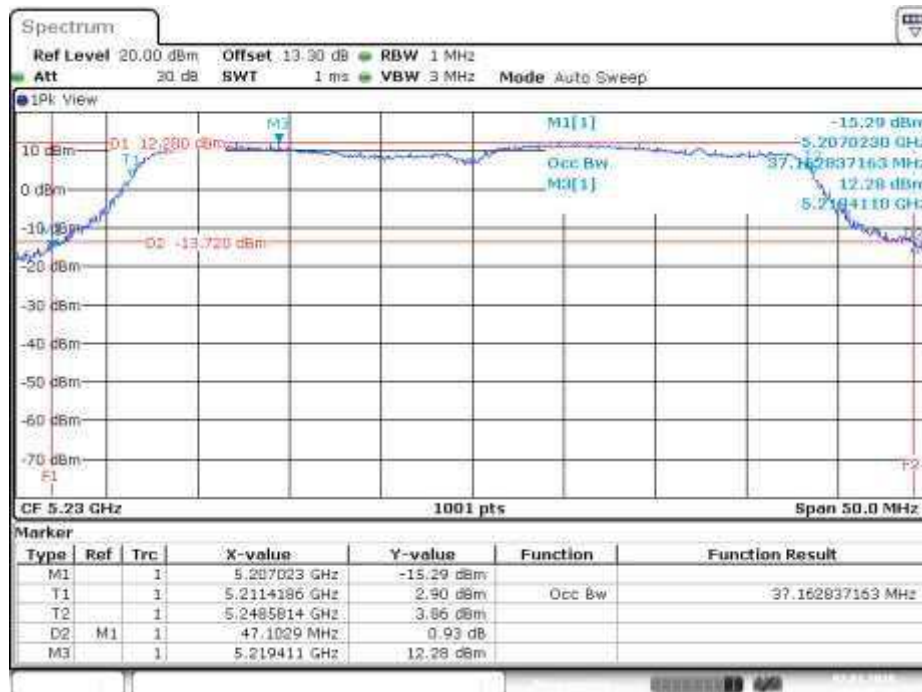
Date: 2.JAN.2020 14:25:57

Ant 3


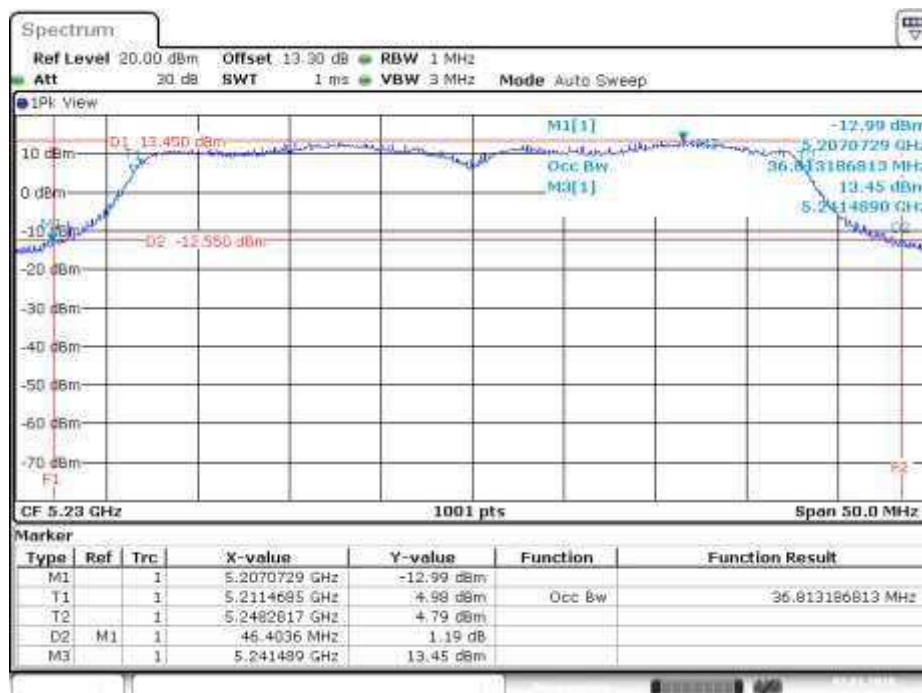
Date: 2.JAN.2020 14:26:50

802.11n HT40 5230MHz
Ant 1


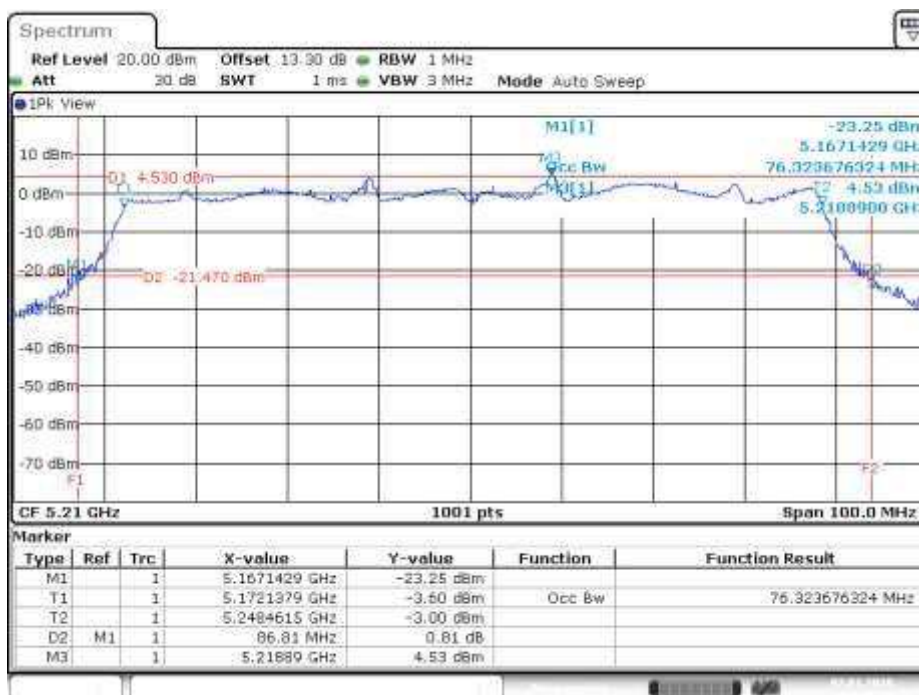
Date: 2.JAN.2020 14:43:26

Ant 2


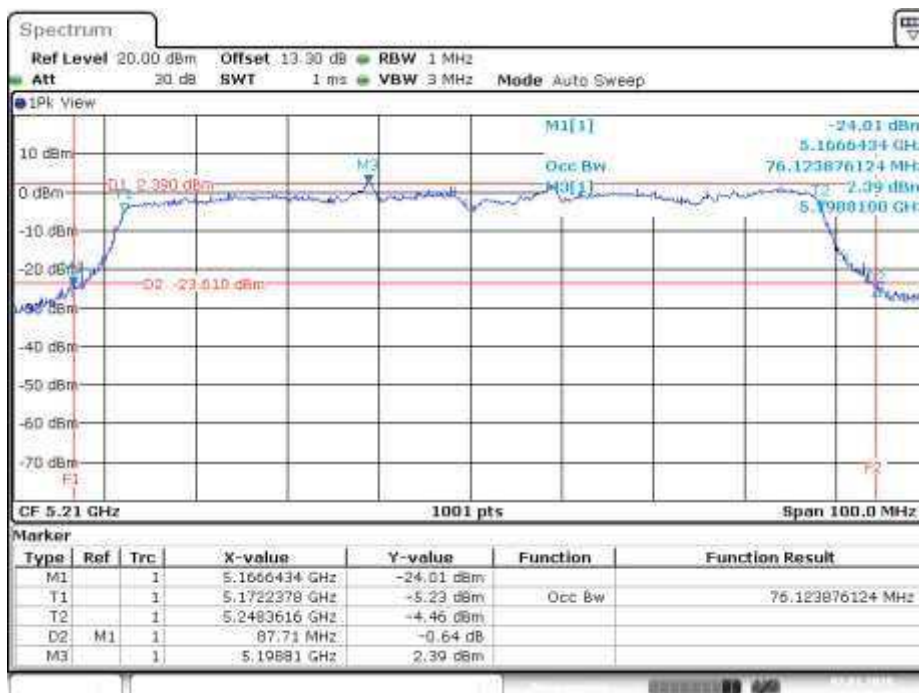
Date: 2.JAN.2020 14:28:57

Ant 3


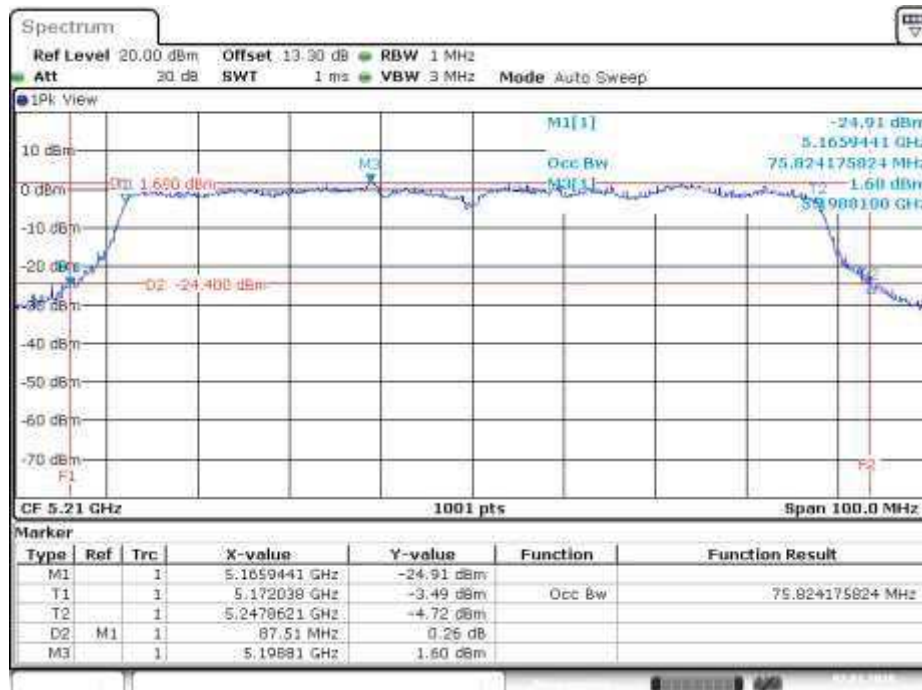
Date: 2.JAN.2020 14:30:02

802.11ac VHT80 5210MHz
Ant 1


Date: 2.JAN.2020 14:45:28

Ant 2


Date: 2.JAN.2020 14:46:09

Ant 3


Date: 2.JAN.2020 14:46:52

5.1.5 6dB Bandwidth

RESULT:
Passed

Test standard : FCC Part 15.407
 Limit : FCC Part 15.407
 Basic standard : ANSI C63.10:2013
 Kind of test site : Conducted room

Test setup

Test Channel : Refer to the Table 7
 Operation Mode : A

Table 11: Test result of 6dB Bandwidth

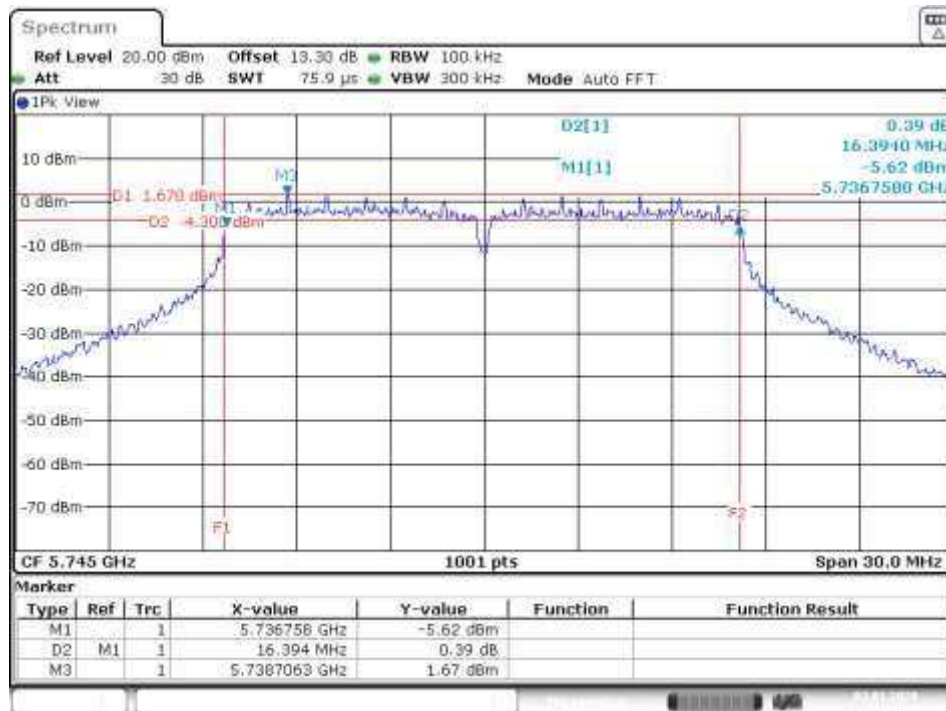
Mode	Channel Frequency (MHz)	6dB Bandwidth (MHz)			6dB Bandwidth Limit (kHz)	Result
		Ant 1	Ant 2	Ant 3		
802.11a	5745	16.39	16.39	16.36	>500	Pass
	5785	16.36	16.36	16.21	>500	Pass
	5825	16.39	16.39	16.39	>500	Pass
802.11n HT20	5745	17.74	17.80	17.80	>500	Pass
	5785	17.80	17.77	17.80	>500	Pass
	5825	17.80	17.80	17.77	>500	Pass
802.11n HT40	5755	36.32	36.38	36.32	>500	Pass
	5795	35.82	36.12	36.42	>500	Pass
802.11ac VHT80	5775	75.78	75.78	73.89	>500	Pass

Test Plot of 6dB Bandwidth

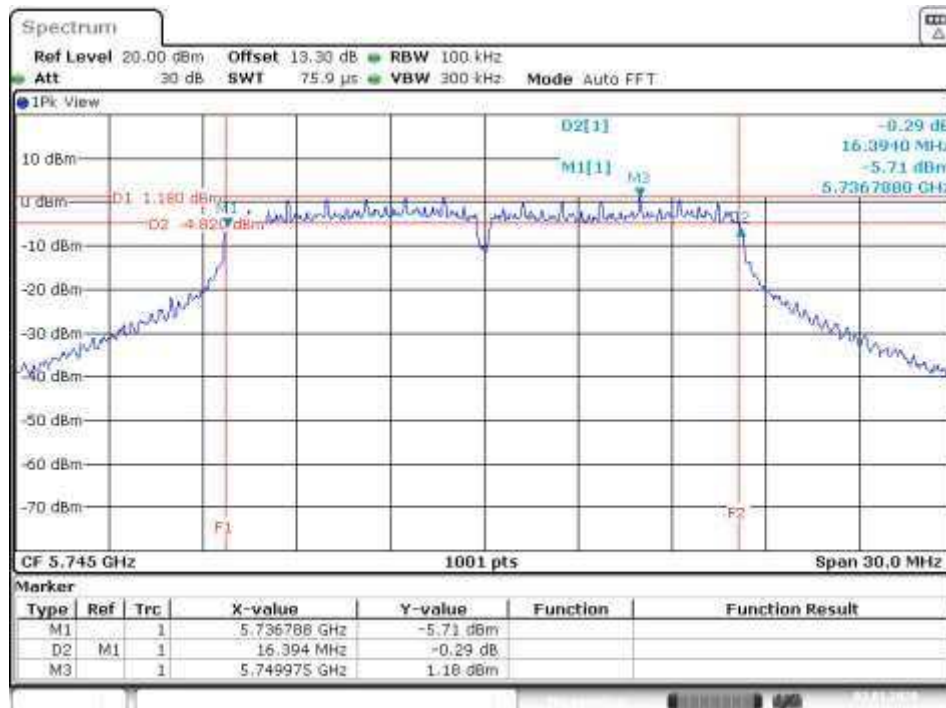
802.11a

5745MHz

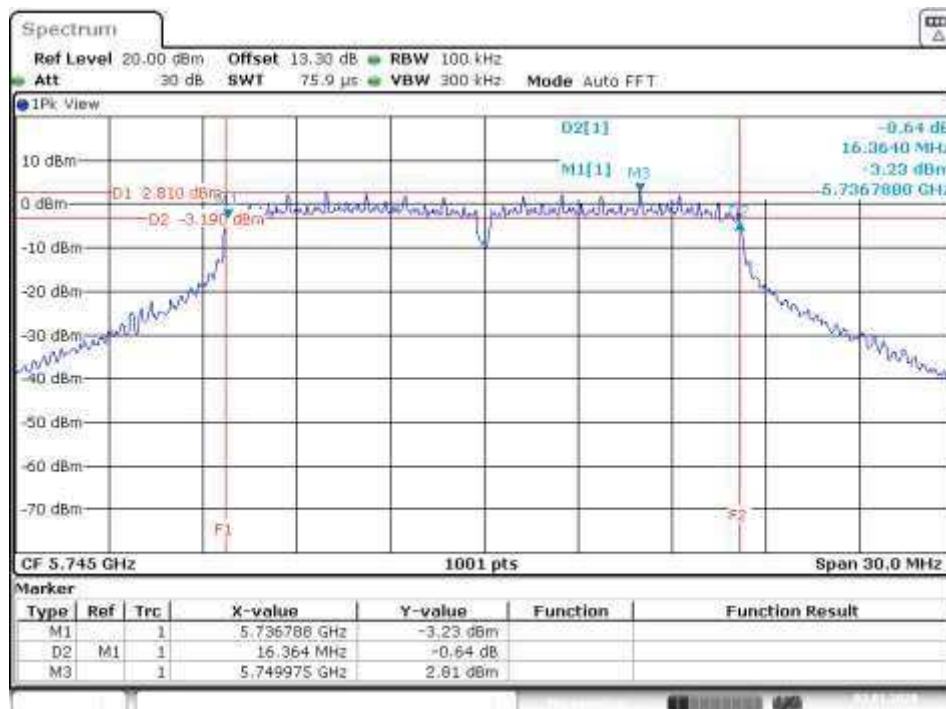
Ant 1



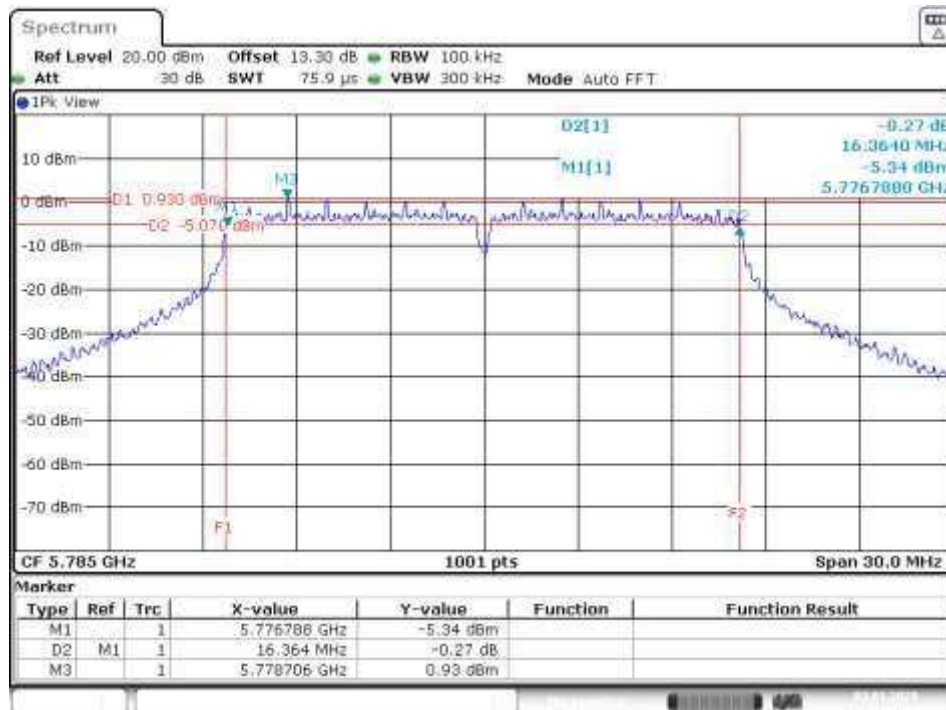
Date: 3.JAN.2020 21:19:36

Ant 2


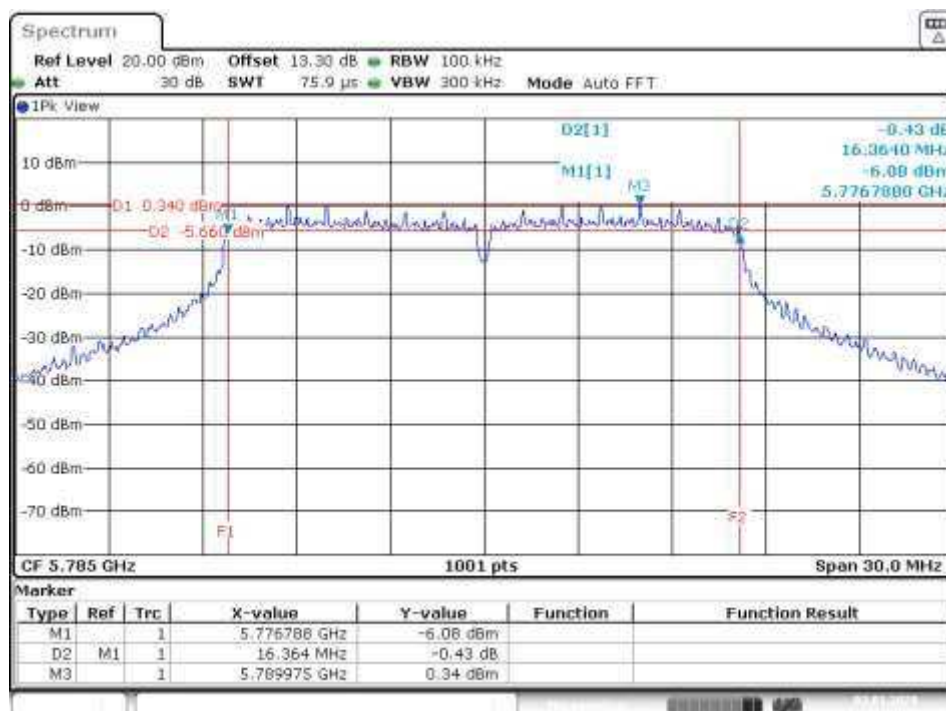
Date: 3.JAN.2020 21:21:22

Ant 3


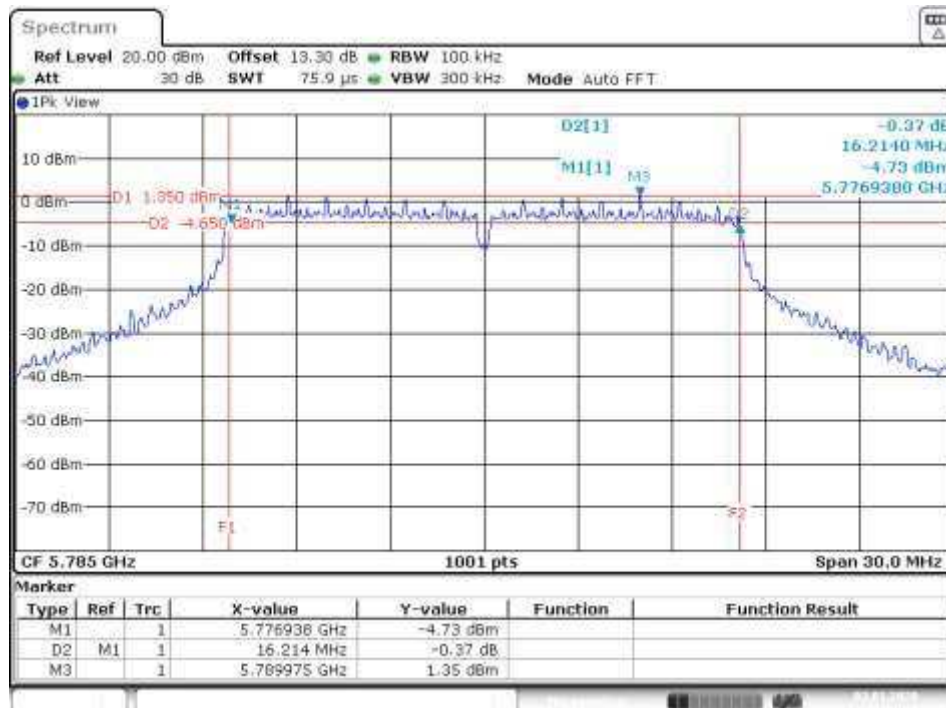
Date: 3.JAN.2020 21:23:00

5785MHz
Ant 1


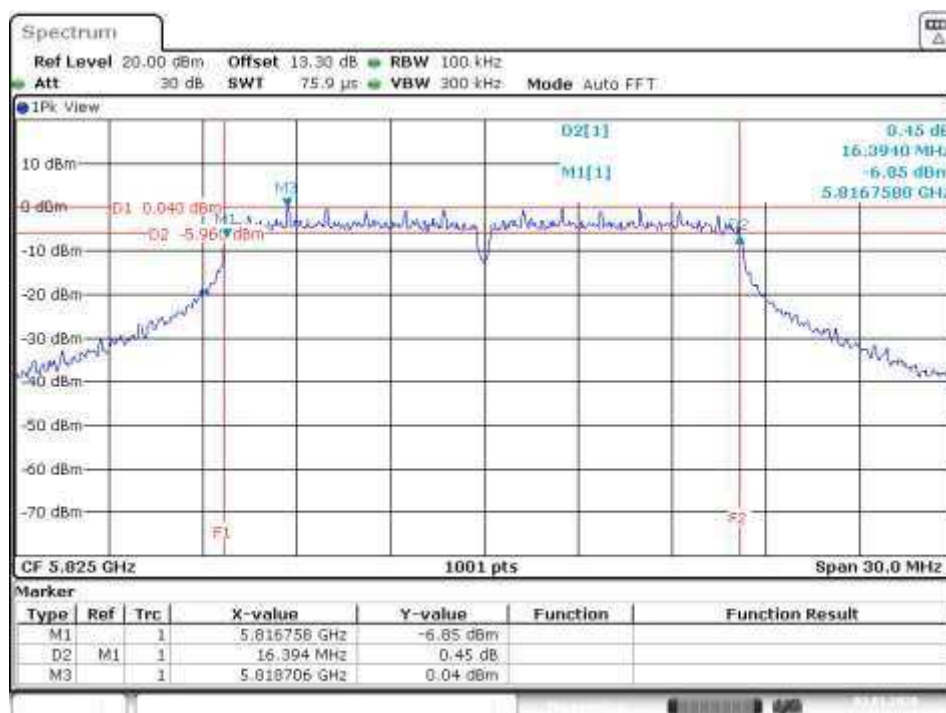
Date: 3.JAN.2020 21:34:04

Ant 2


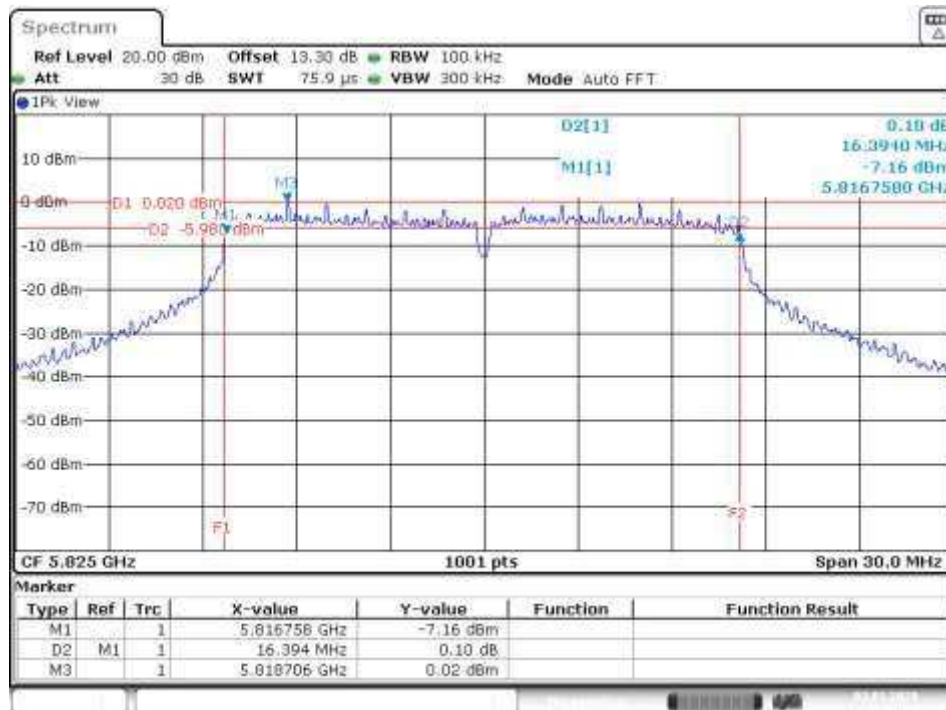
Date: 3.JAN.2020 21:32:05

Ant 3


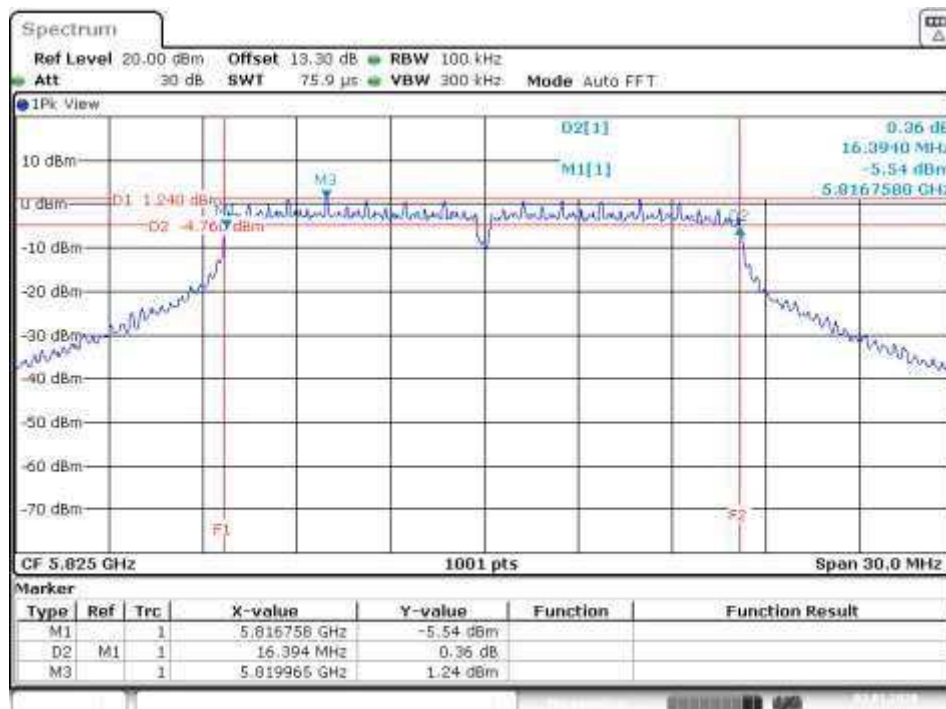
Date: 3.JAN.2020 21:27:22

5825MHz
Ant 1


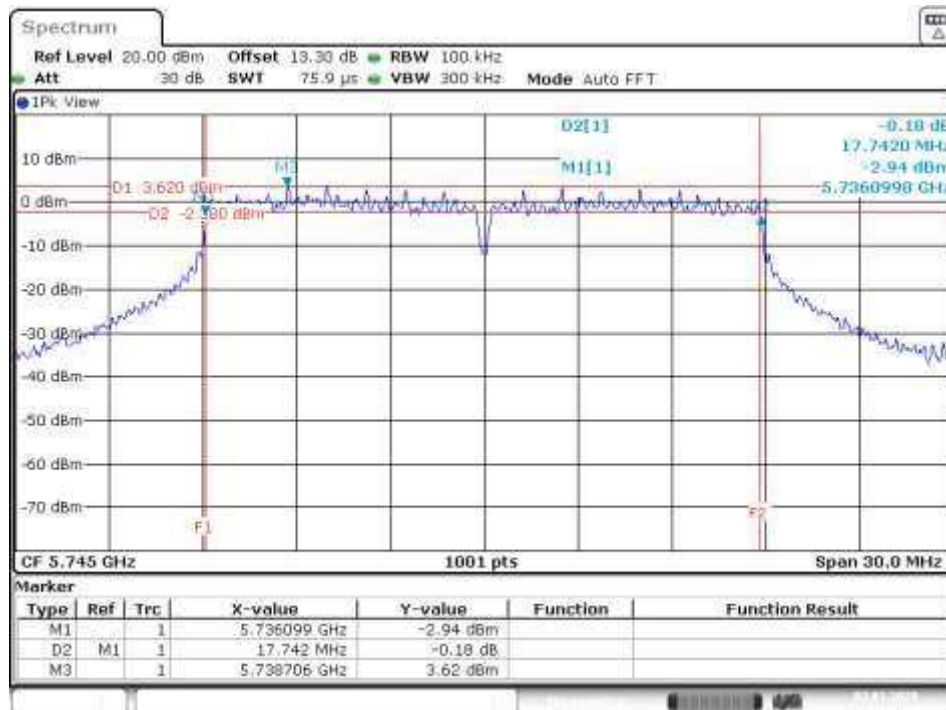
Date: 3.JAN.2020 21:37:16

Ant 2


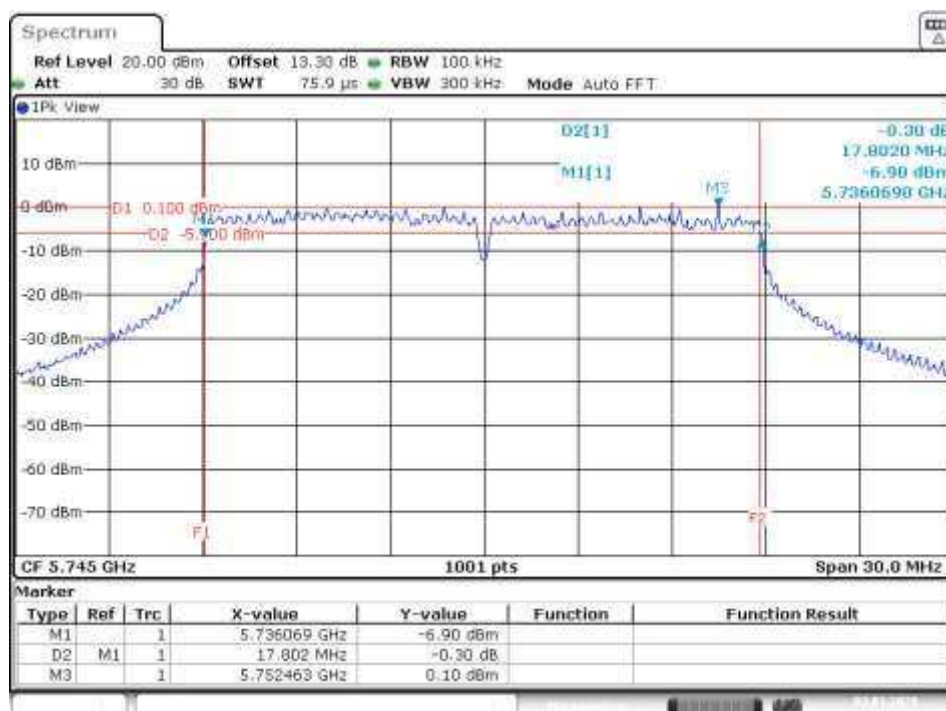
Date: 3.JAN.2020 21:45:54

Ant 3


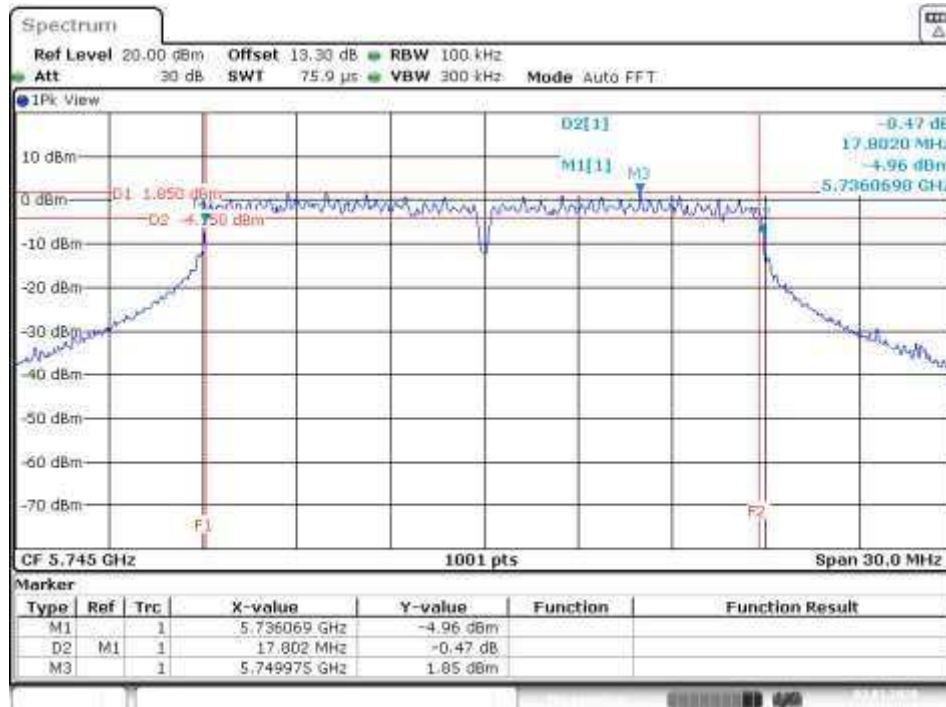
Date: 3.JAN.2020 21:58:43

802.11n HT20
5745MHz
Ant 1


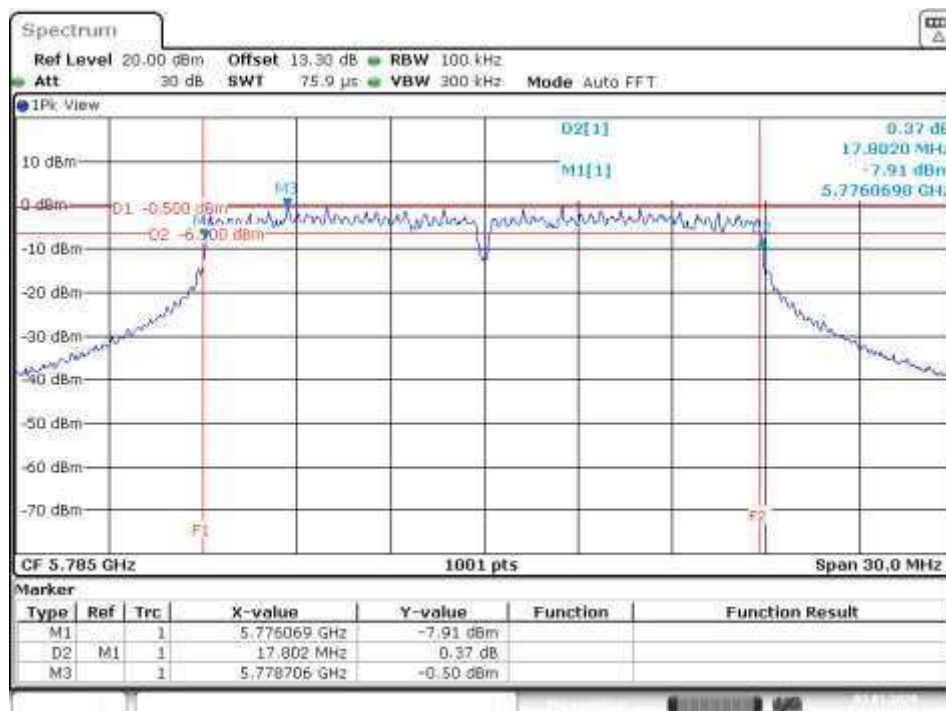
Date: 3.JAN.2020 22:18:04

Ant 2


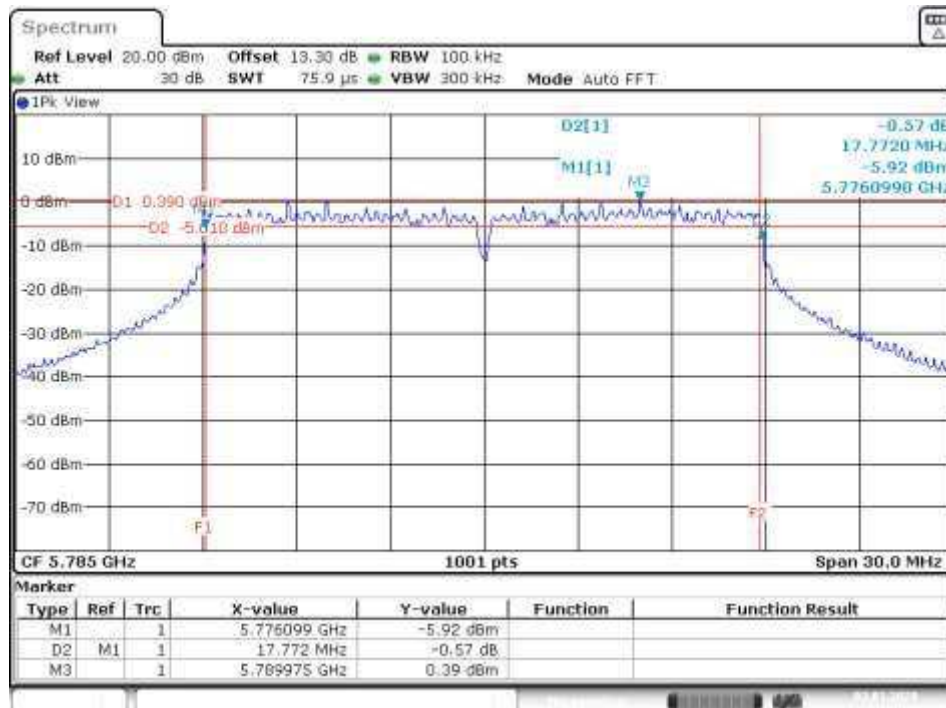
Date: 3.JAN.2020 22:25:56

Ant 3


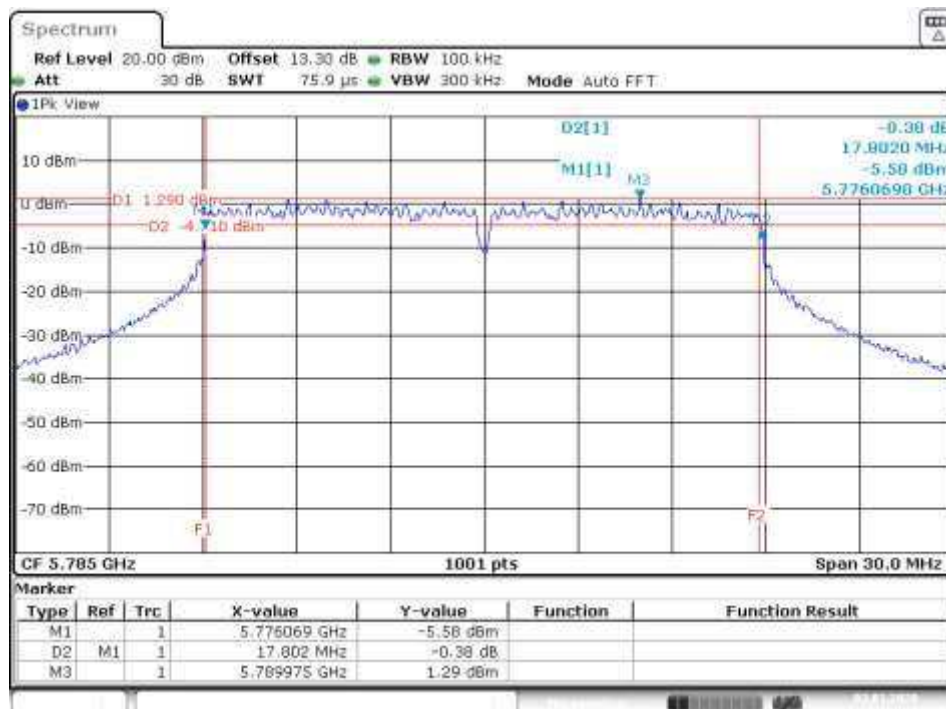
Date: 3.JAN.2020 22:27:23

5785MHz
Ant 1


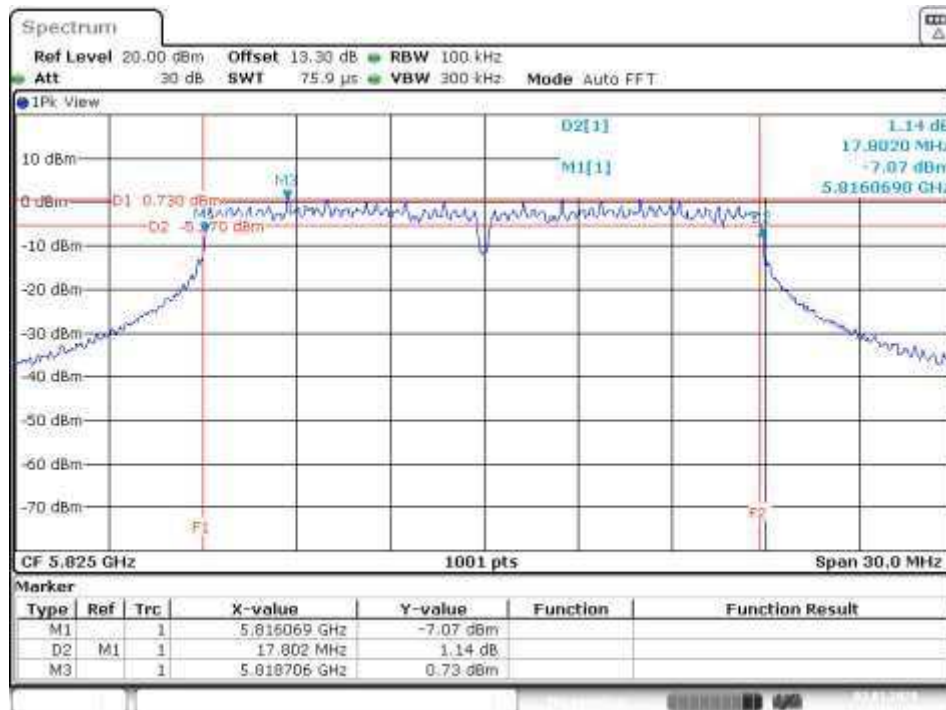
Date: 3.JAN.2020 22:29:53

Ant 2


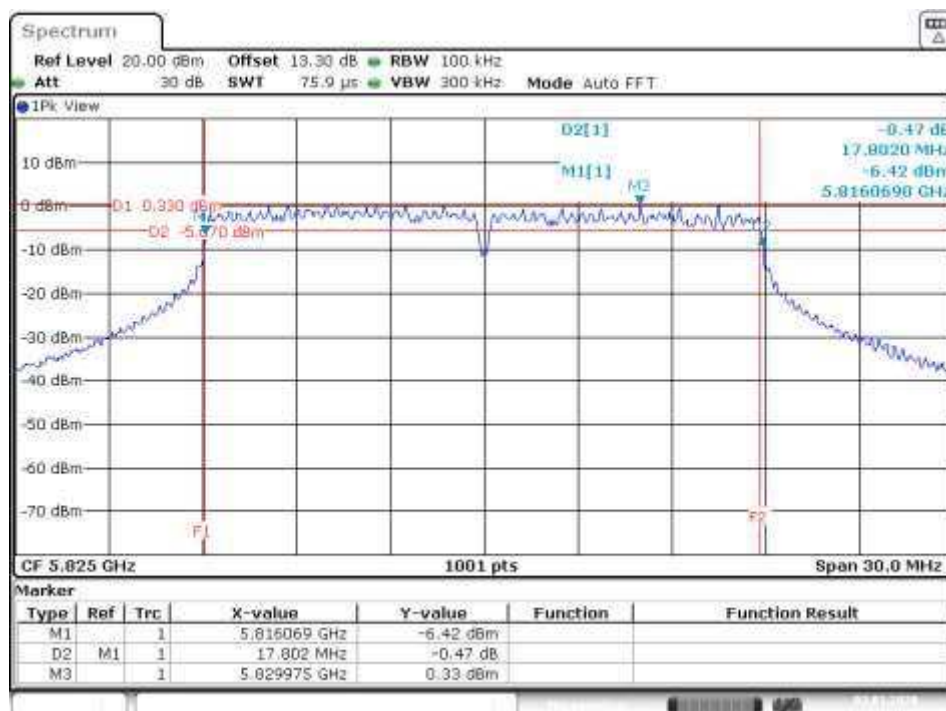
Date: 3.JAN.2020 22:32:03

Ant 3


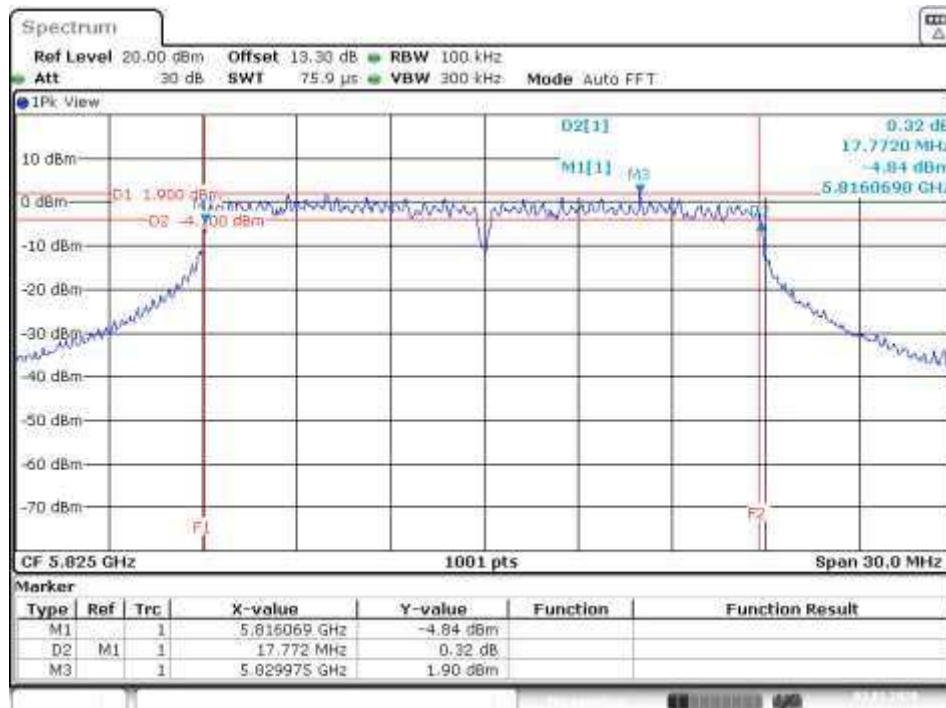
Date: 3.JAN.2020 22:33:27

5825MHz
Ant 1


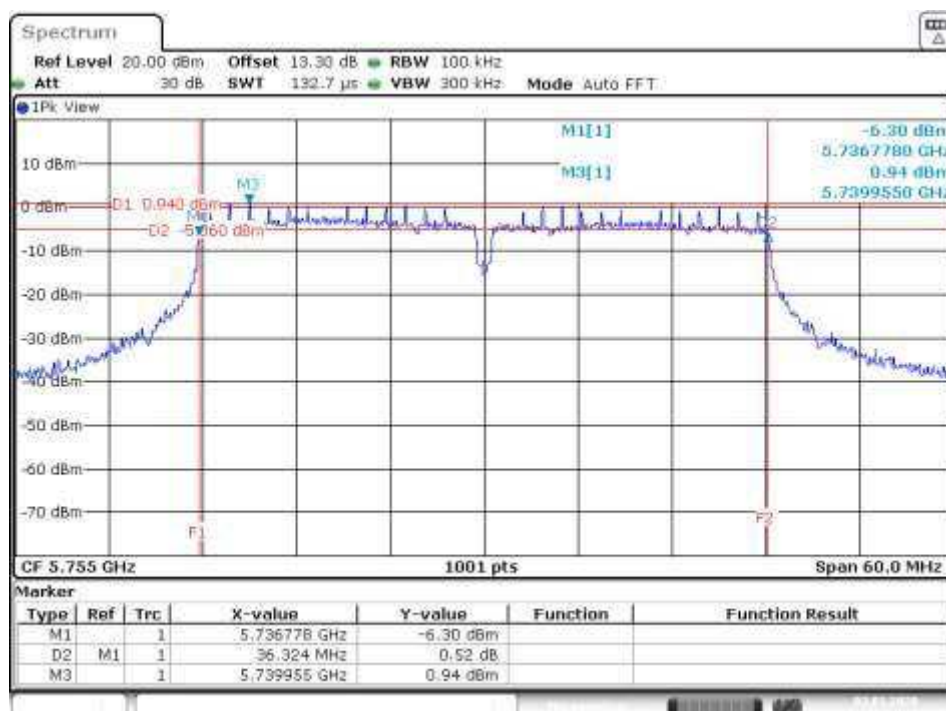
Date: 3.JAN.2020 22:36:35

Ant 2


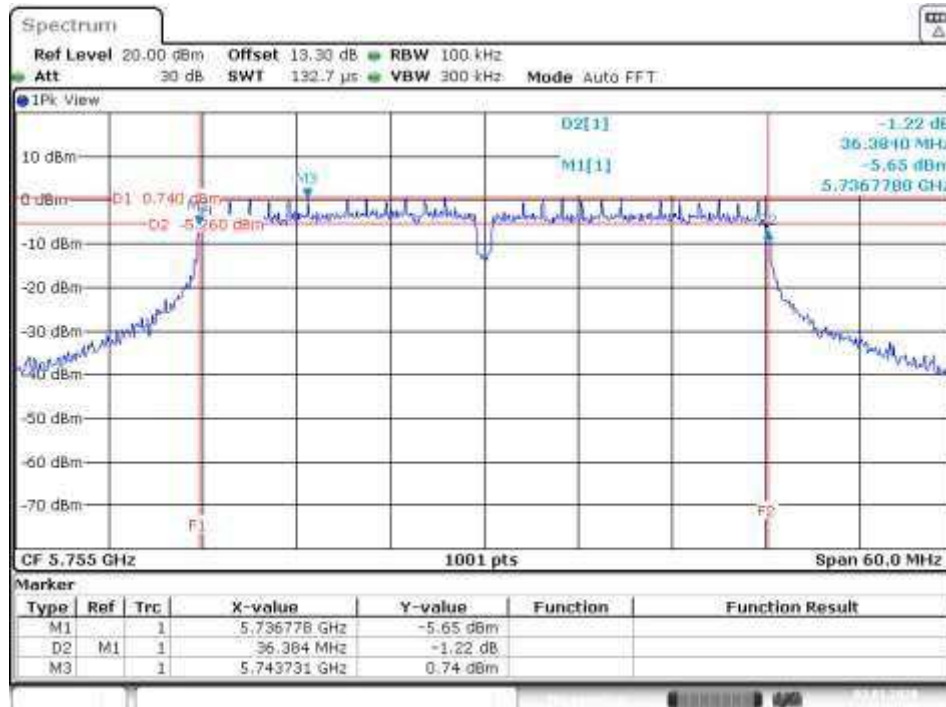
Date: 3.JAN.2020 22:39:46

Ant 3


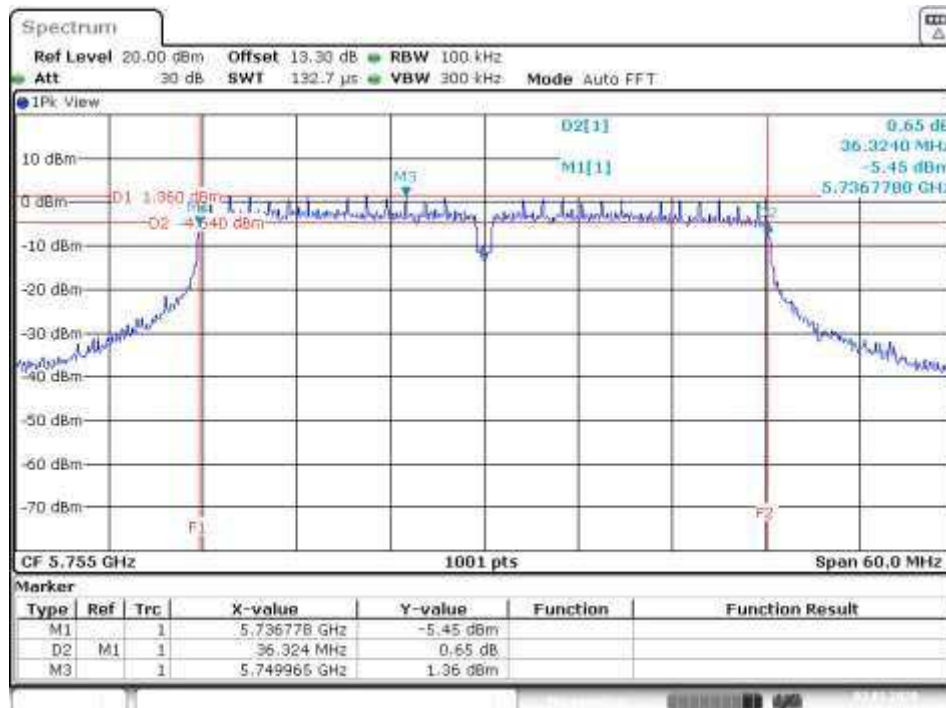
Date: 3.JAN.2020 22:41:16

802.11n HT40
5755MHz
Ant 1


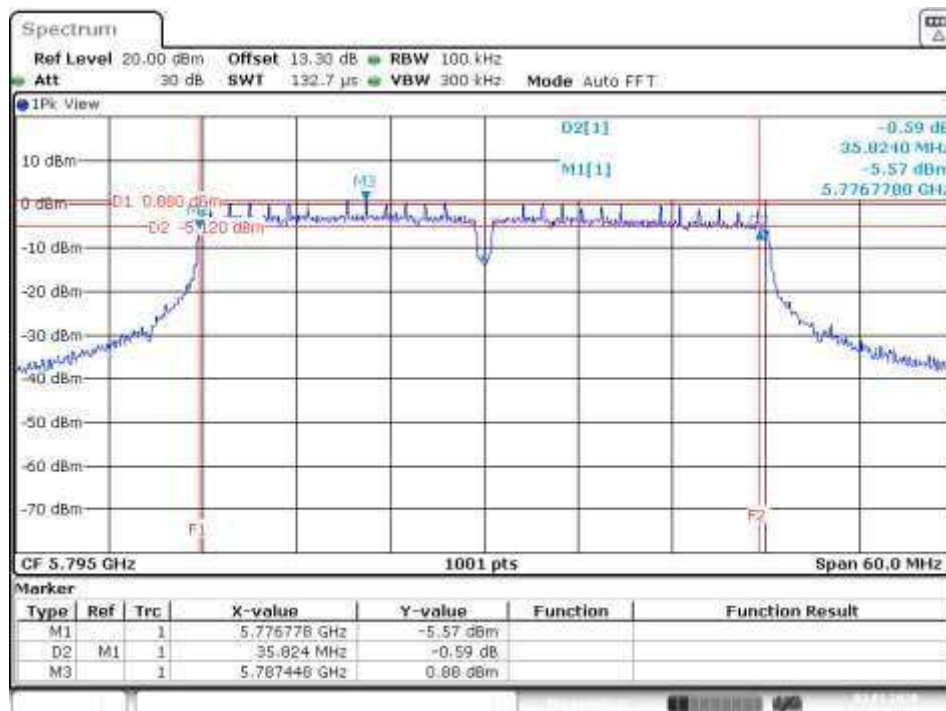
Date: 3.JAN.2020 23:01:27

Ant 2


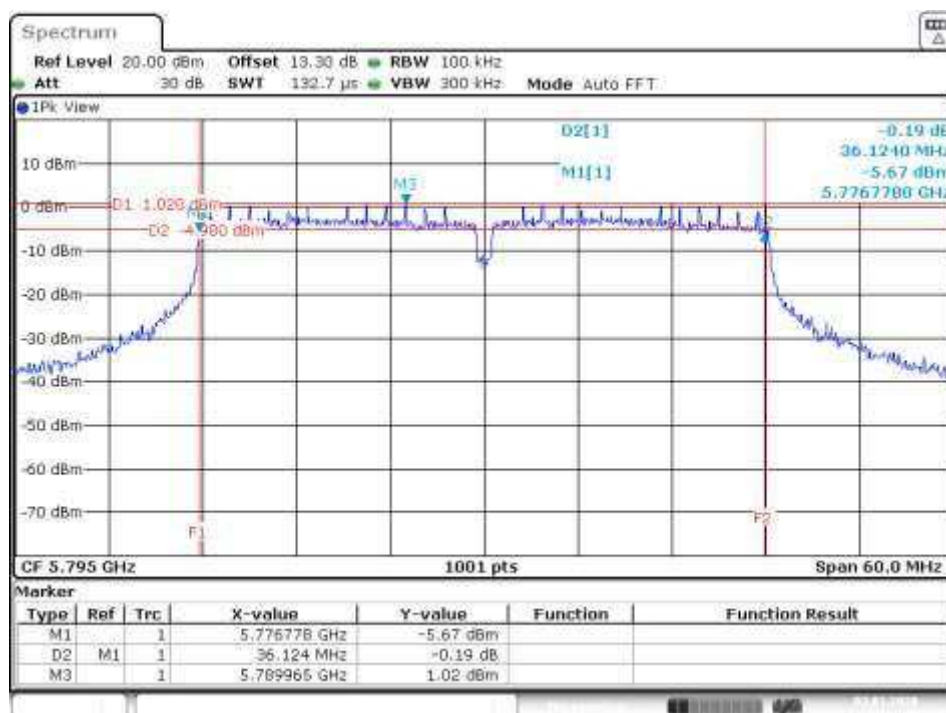
Date: 3.JAN.2020 22:59:50

Ant 3


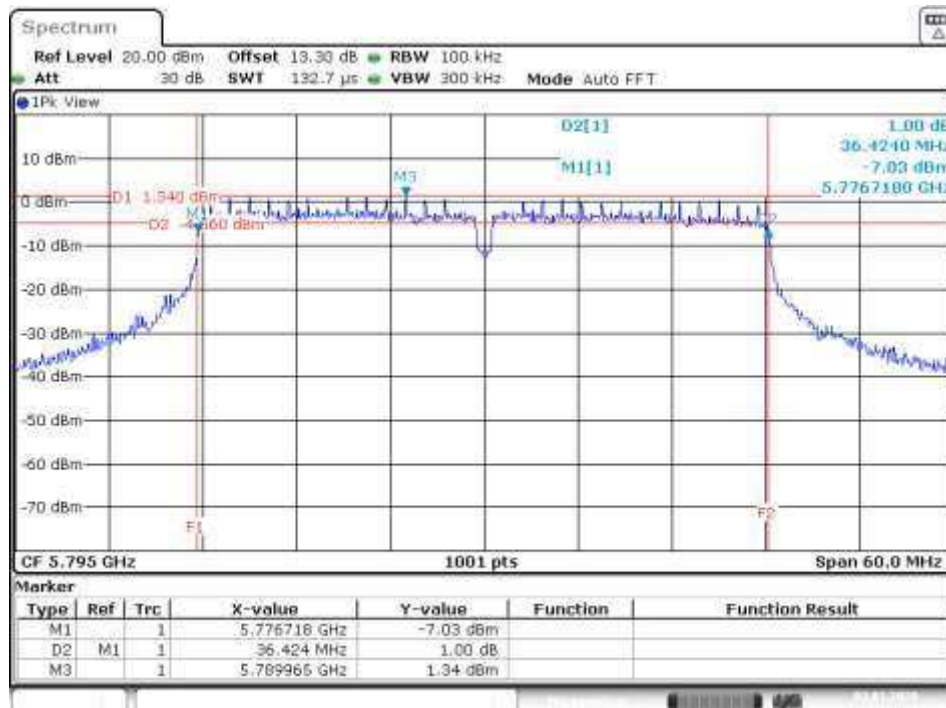
Date: 3.JAN.2020 22:49:17

5795MHz
Ant 1


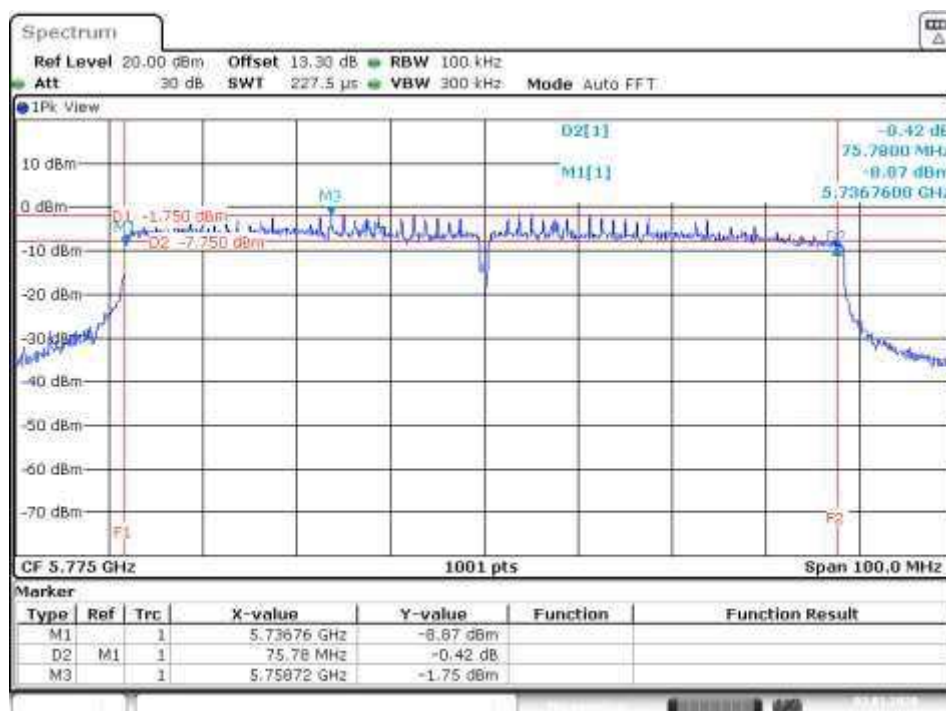
Date: 3.JAN.2020 23:08:10

Ant 2


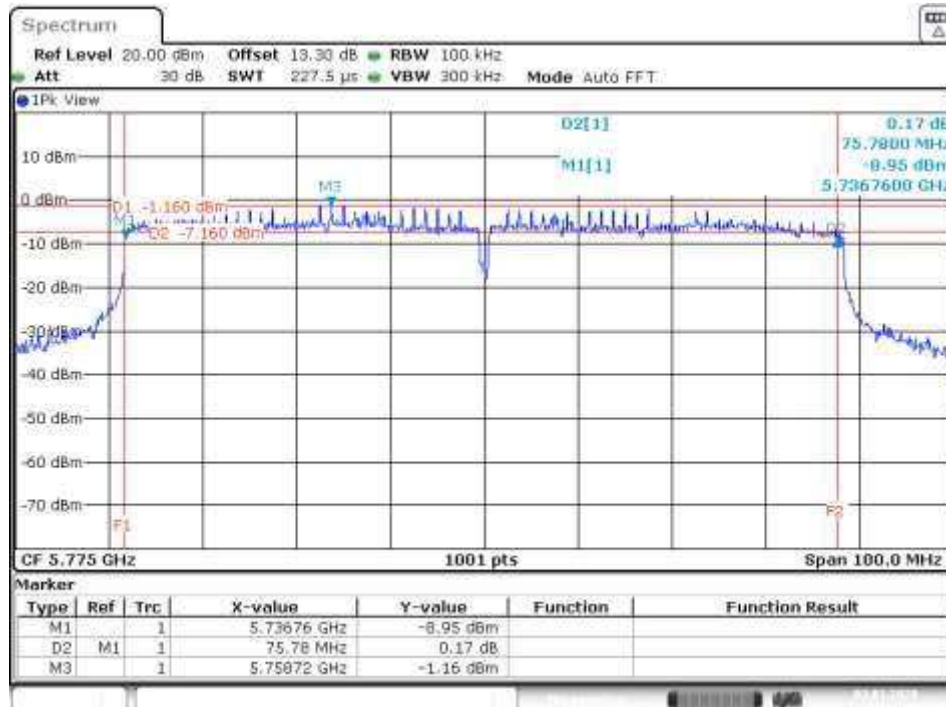
Date: 3.JAN.2020 23:12:48

Ant 3


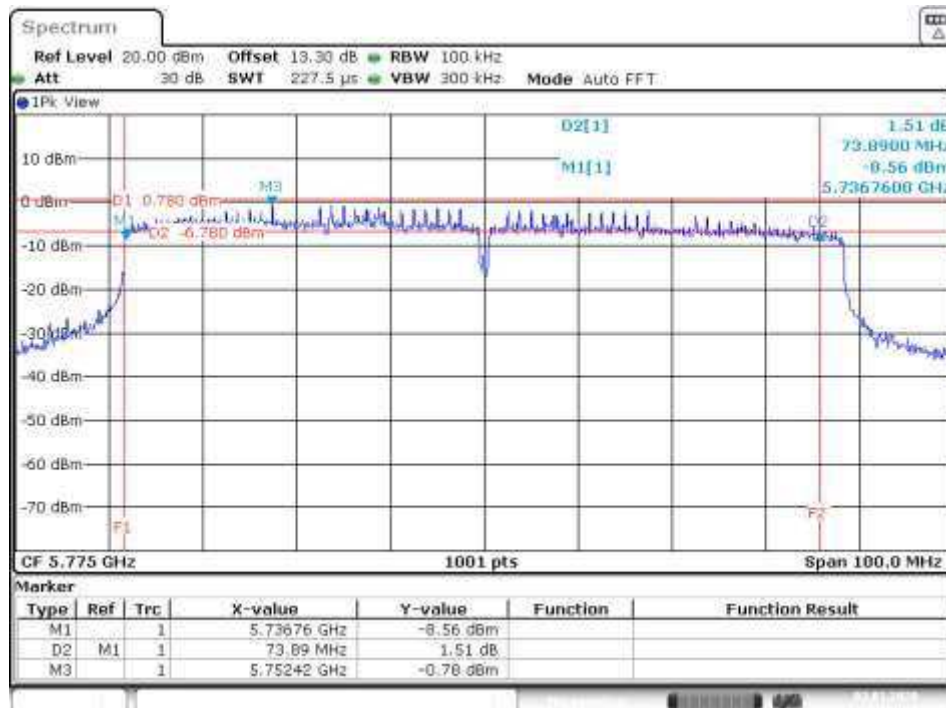
Date: 3.JAN.2020 23:15:22

802.11ac VHT80
5755MHz
Ant 1


Date: 3.JAN.2020 23:26:28

Ant 2


Date: 3.JAN.2020 23:28:43

Ant 3


Date: 3.JAN.2020 23:31:22

5.1.6 Power Density

RESULT:

Passed

Test standard	:	FCC Part 15.407(a)(1),(3)
Basic standard	:	ANSI C63.10:2013, KDB789033 D02
Kind of test site	:	Shielded room

Test setup

Test Channel	:	Refer to the table 7
Operation Mode	:	A

FCC Limit :

For client devices in the 5.15-5.25 GHz band, the maximum conducted power spectral density shall not exceed 17 dBm in any 1 megahertz band.

For the band 5.725-5.85 GHz, the maximum conducted power spectral density shall not exceed 30 dBm in any 500-kHz band.

Table 12: Test result of FCC Power Density

Mode	Channel Frequency (MHz)	Conducted Power Density (dBm/MHz)				Power Density Limit (dBm/MHz)
		Ant 1	Ant 2	Ant 3	Total	
802.11a	5180	4.14	2.66	4.37	8.74	14.45
	5200	6.27	4.48	5.58	10.46	14.45
	5240	6.12	2.45	3.44	9.24	14.45
802.11n HT20	5180	3.93	1.90	4.41	8.47	14.45
	5200	4.07	3.86	5.70	9.56	14.45
	5240	3.23	2.09	1.43	7.25	14.45
802.11n HT40	5190	-1.20	-2.72	-2.45	3.23	14.45
	5230	5.15	2.60	4.18	9.40	14.45
802.11ac VHT80	5210	-6.27	-8.26	-7.82	-1.63	14.45

Directional gain = 3.78 dBi + 10log(3) = 8.55 dBi > 6 dBi , so the power density limit shall be reduced to 17-(8.55-6) = 14.45 dBm.

Mode	Channel Frequency (MHz)	Conducted Power Density (dBm/500kHz)				Power Density Limit (dBm/500kHz)
		Ant 1	Ant 2	Ant 3	Total	
802.11a	5745	-1.8	-3.4	0.19	3.53	27.27
	5785	-2.24	-3.35	-1.64	2.60	27.27
	5825	-2.81	-3.21	-2.19	2.23	27.27
802.11n HT20	5745	-4.56	-3.83	-2.61	1.34	27.27
	5785	-4.49	-3.44	-2.29	1.62	27.27
	5825	-3.18	-2.8	-2.3	2.19	27.27
802.11n HT40	5755	-3.14	-2.23	-2.13	2.82	27.27
	5795	-2.96	-2.81	-1.94	2.75	27.27
802.11ac VHT80	5775	-5.52	-4.64	-4.32	0.93	27.27

Directional gain = 3.96 dBi + 10log(3) = 8.73 dBi > 6 dBi , so the power density limit shall be reduced to 30-(8.73-6) = 27.27 dBm.

Test Plot of FCC Power Density

802.11a 5180MHz

Ant 1



Date: 2.JAN.2020 13:29:14

Ant 2



Date: 2.JAN.2020 13:30:26

Ant 3


Date: 2.JAN.2020 13:31:19

802.11a 5200MHz
Ant 1


Date: 2.JAN.2020 13:50:58

Ant 2


Date: 2.JAN.2020 13:50:06

Ant 3

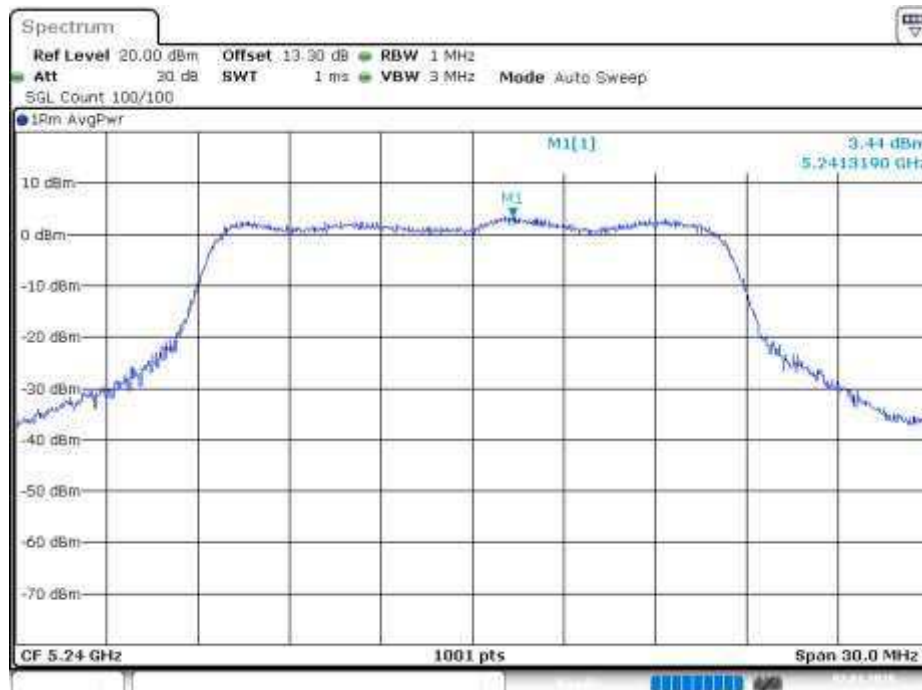

Date: 2.JAN.2020 13:42:00

802.11a 5240MHz
Ant 1

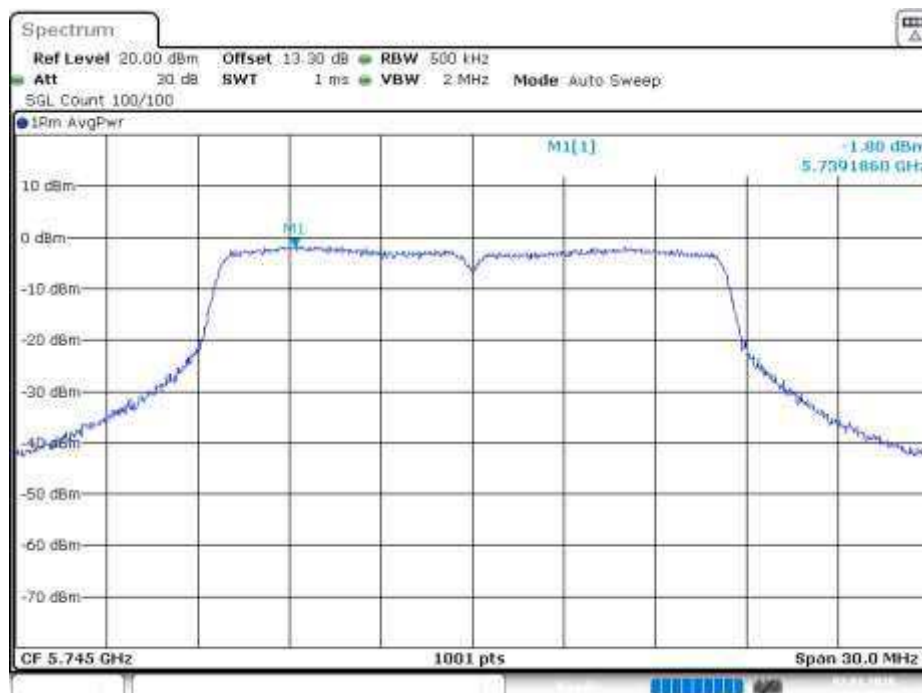

Date: 2.JAN.2020 13:52:03

Ant 2

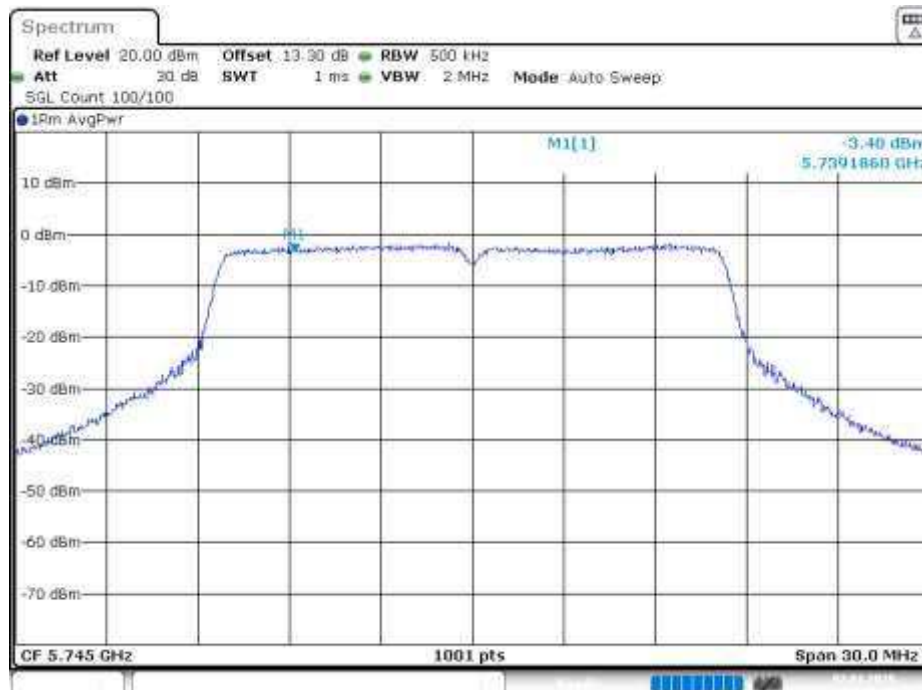

Date: 2.JAN.2020 14:05:44

Ant 3


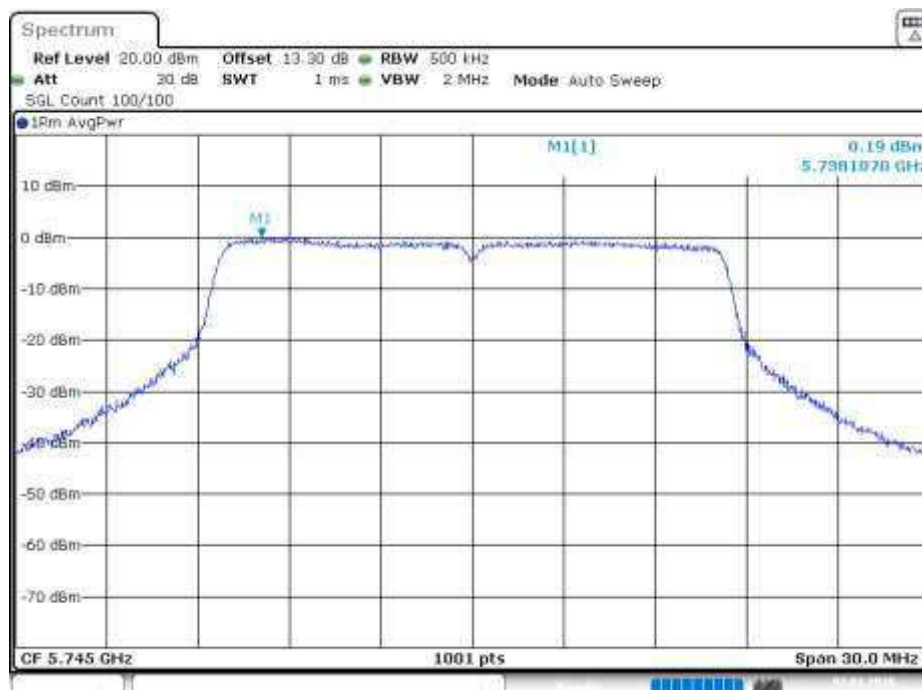
Date: 2.JAN.2020 14:06:44

802.11a 5745MHz
Ant 1


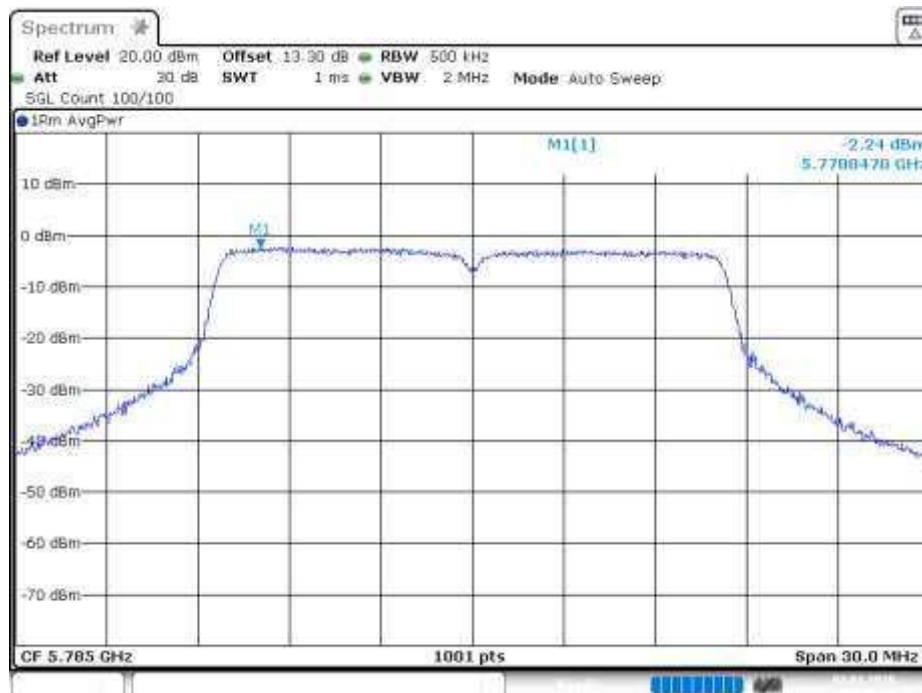
Date: 2.JAN.2020 18:28:52

Ant 2


Date: 2.JAN.2020 18:29:09

Ant 3


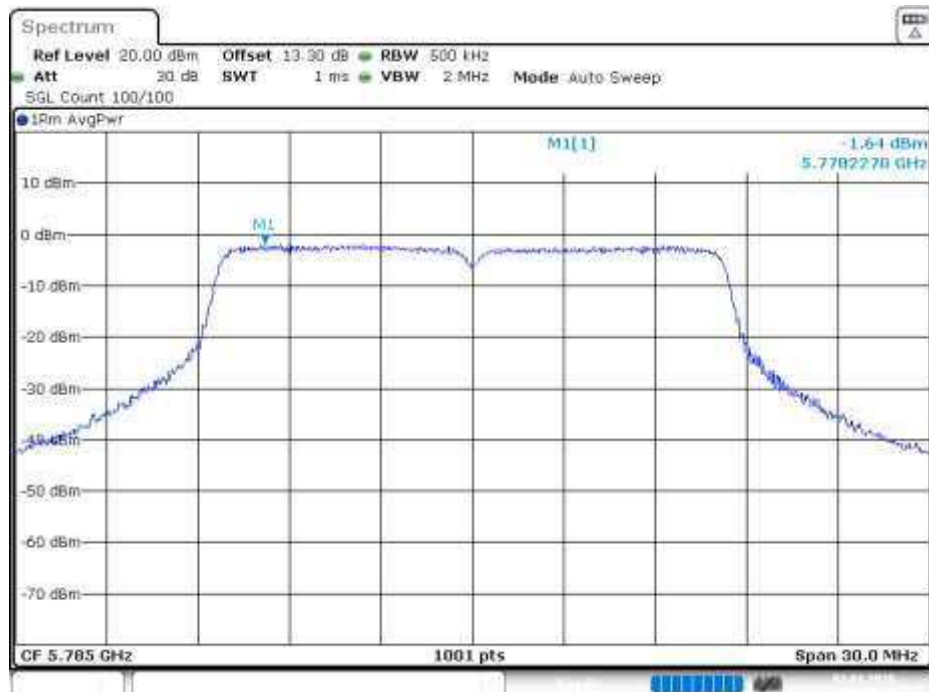
Date: 2.JAN.2020 18:29:35

802.11a 5785MHz
Ant 1


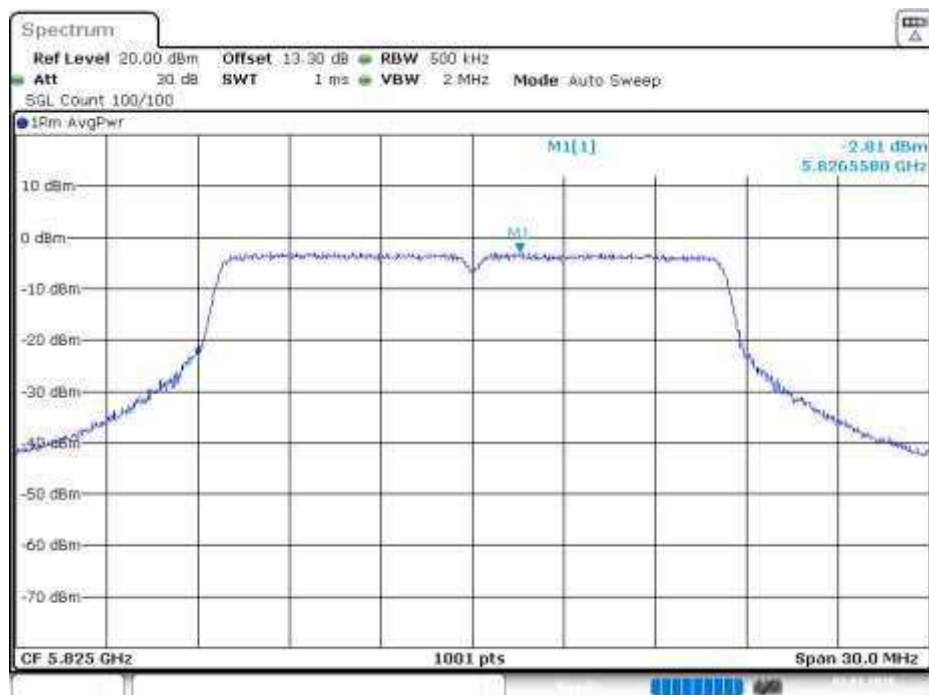
Date: 2.JAN.2020 18:33:54

Ant 2

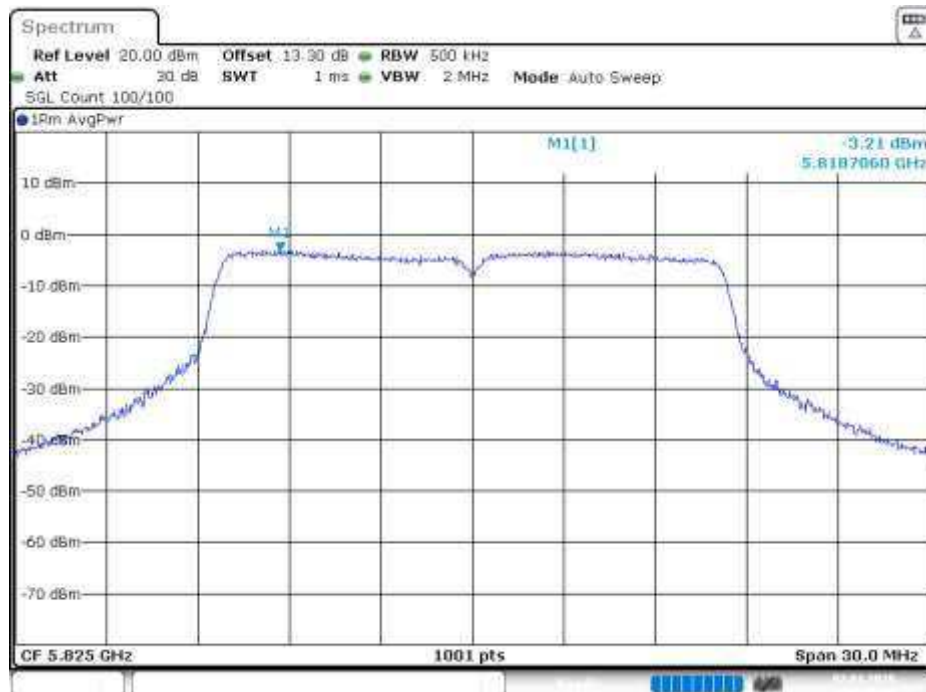

Date: 2.JAN.2020 18:34:05

Ant 3


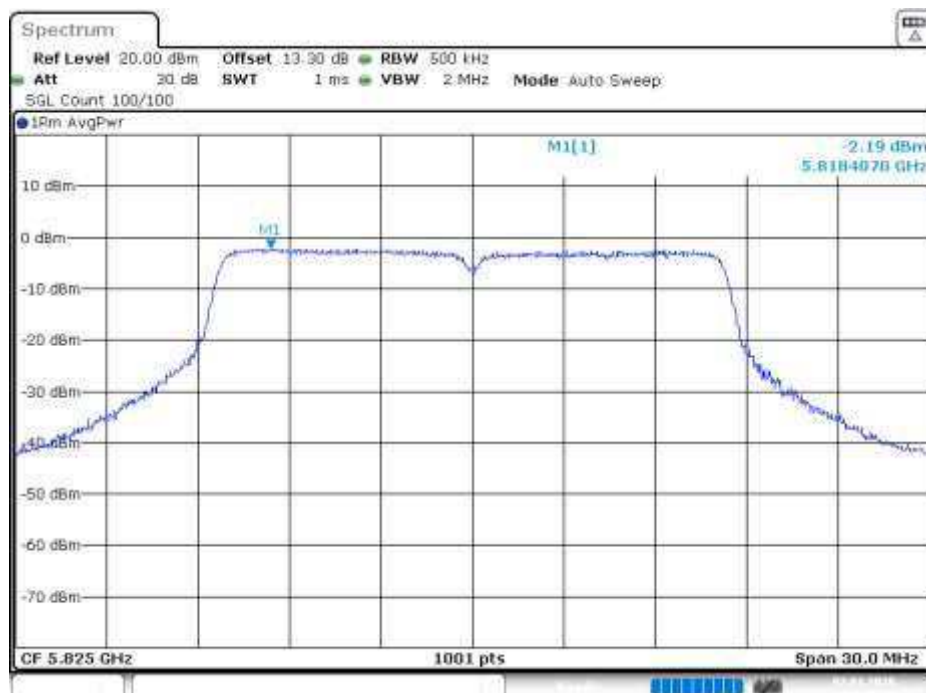
Date: 2.JAN.2020 18:34:24

802.11a 5825MHz
Ant 1


Date: 2.JAN.2020 18:36:40

Ant 2


Date: 2.JAN.2020 18:36:12

Ant 3


Date: 2.JAN.2020 18:36:57

802.11n HT20 5180MHz
Ant 1


Date: 2.JAN.2020 14:16:36

Ant 2


Date: 2.JAN.2020 14:15:40

Ant 3


Date: 2.JAN.2020 14:13:20

802.11n HT20 5200MHz
Ant 1

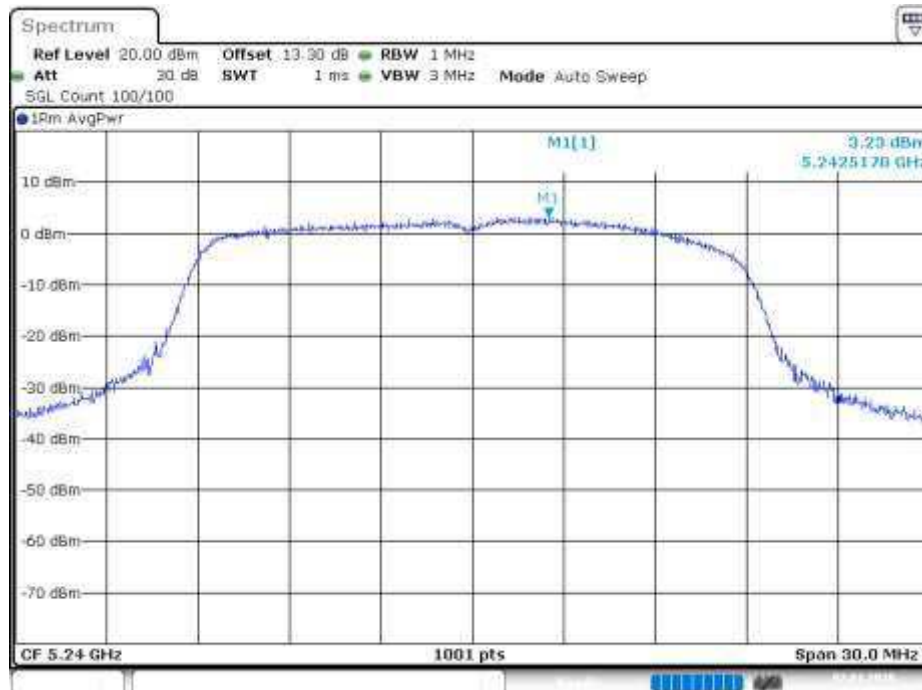

Date: 15.JAN.2020 17:03:57

Ant 2

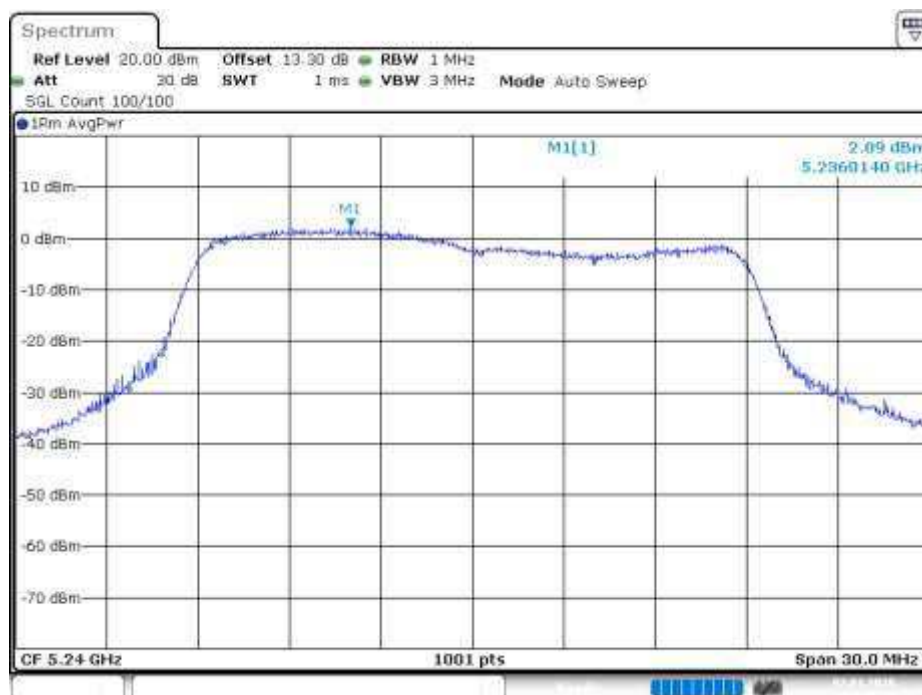

Date: 2.JAN.2020 14:18:25

Ant 3

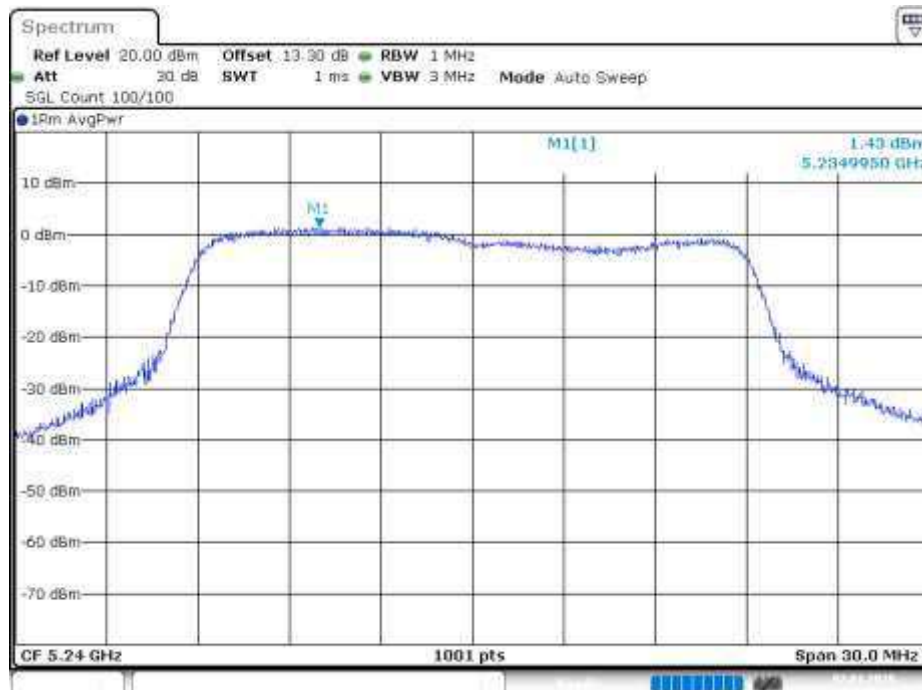

Date: 2.JAN.2020 14:19:16

802.11n HT20 5240MHz
Ant 1


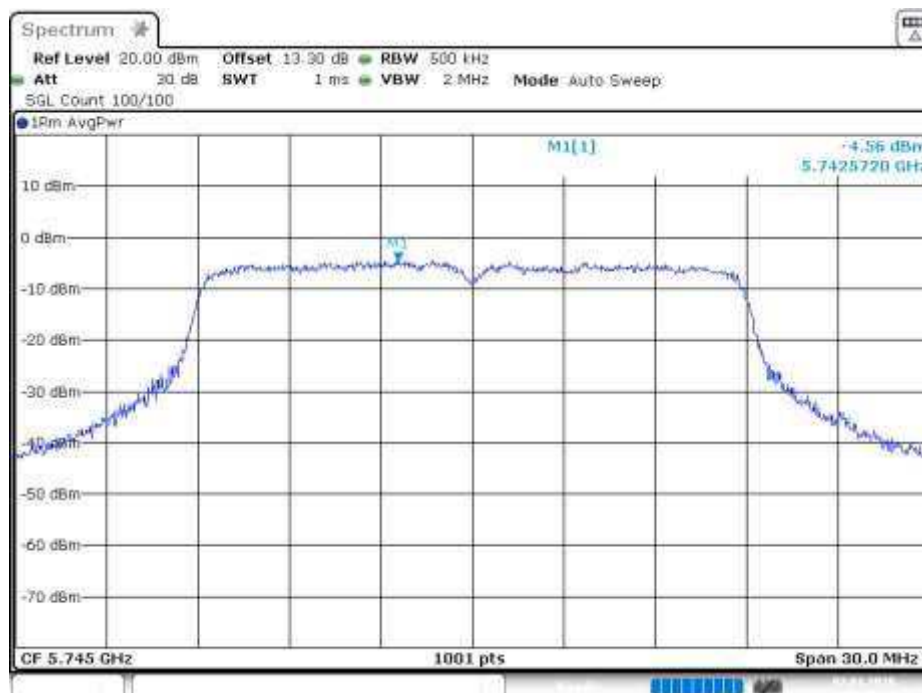
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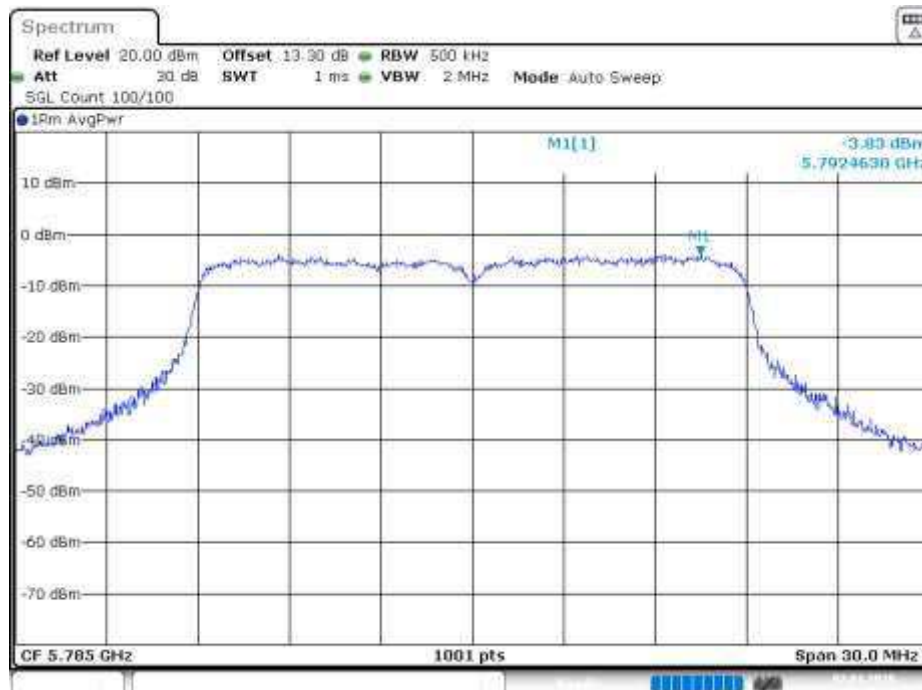
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Ant 3


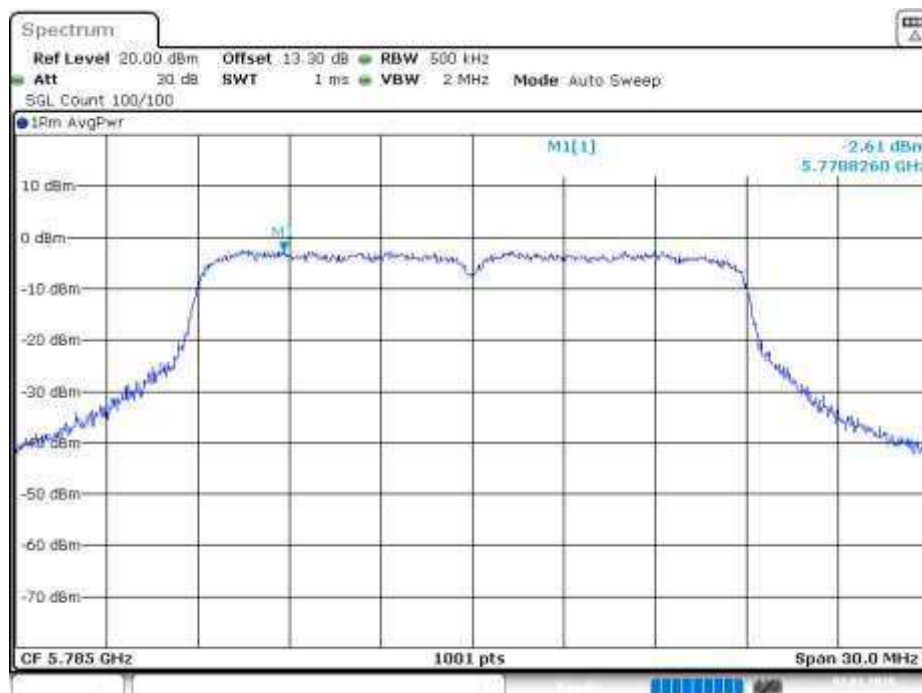
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802.11n HT20 5745MHz
Ant 1


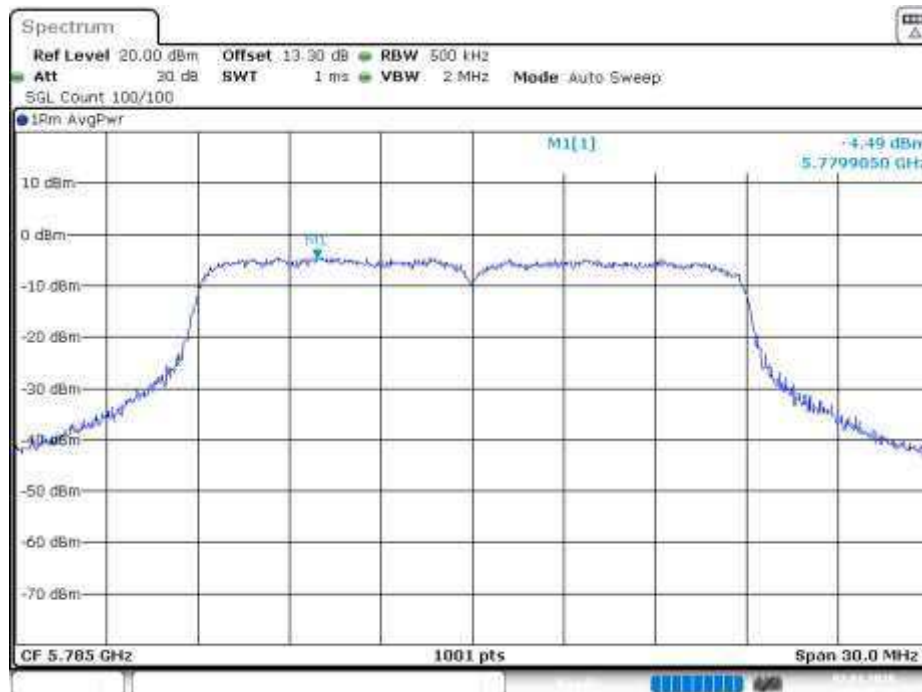
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Ant 2


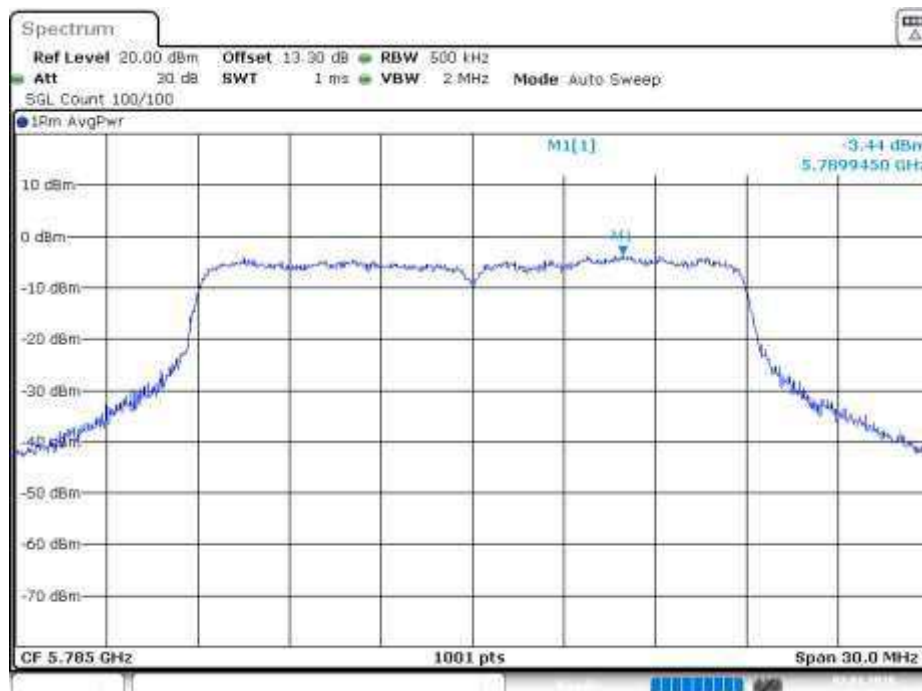
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Ant 3


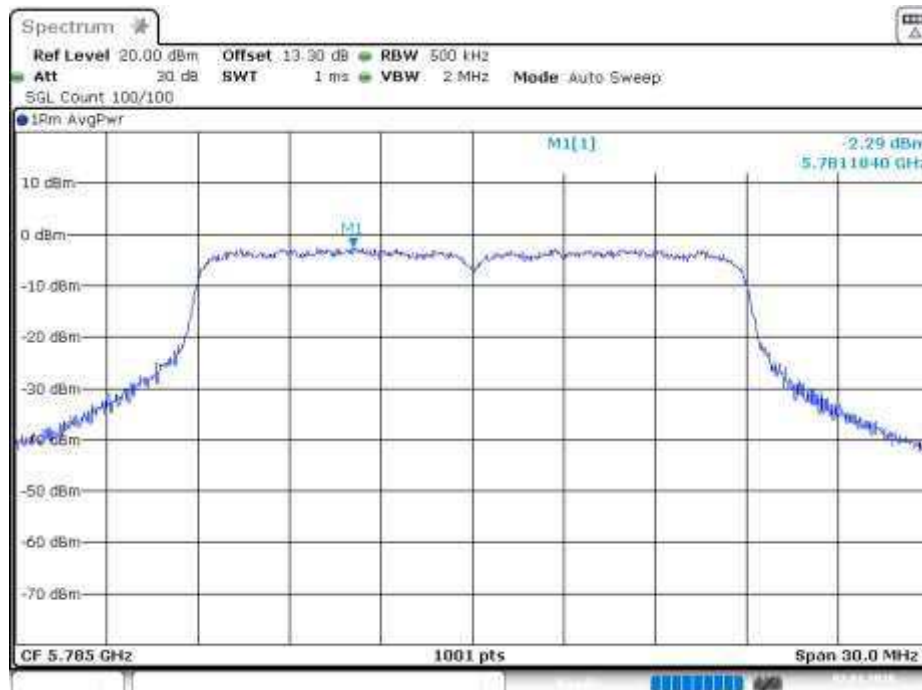
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802.11n HT20 5785MHz
Ant 1


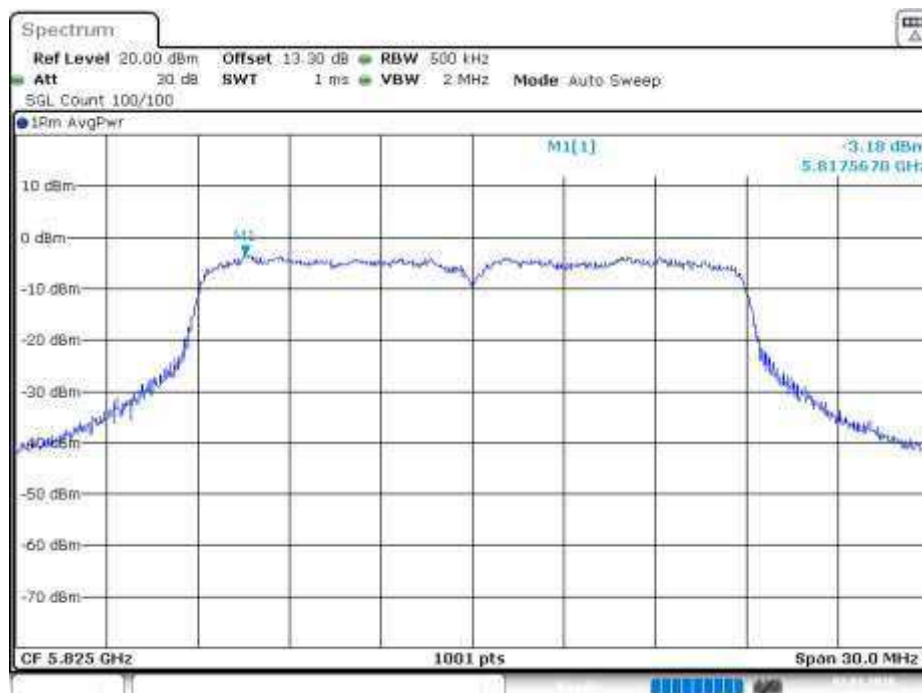
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Ant 2


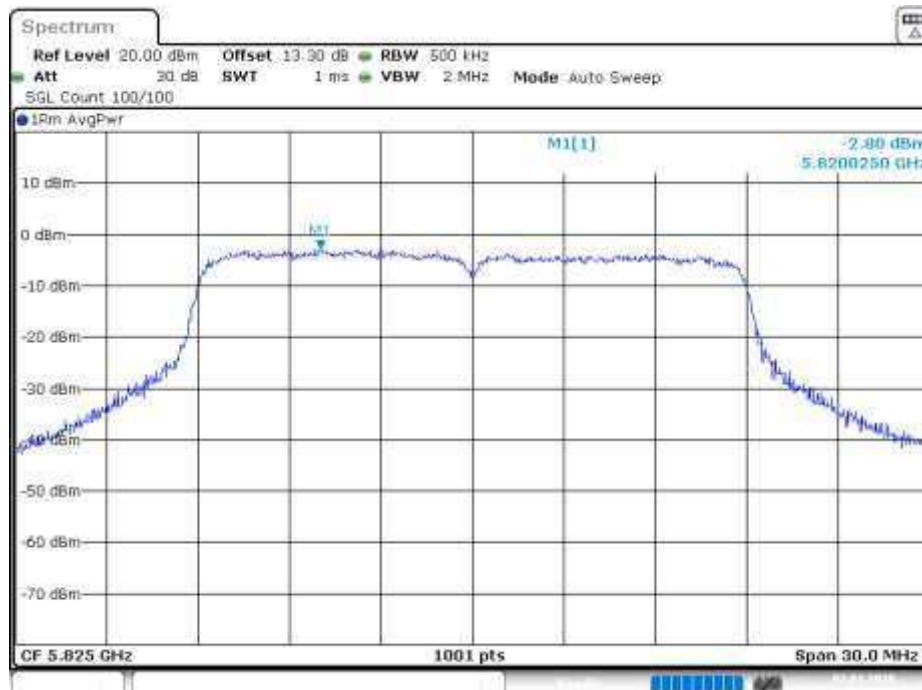
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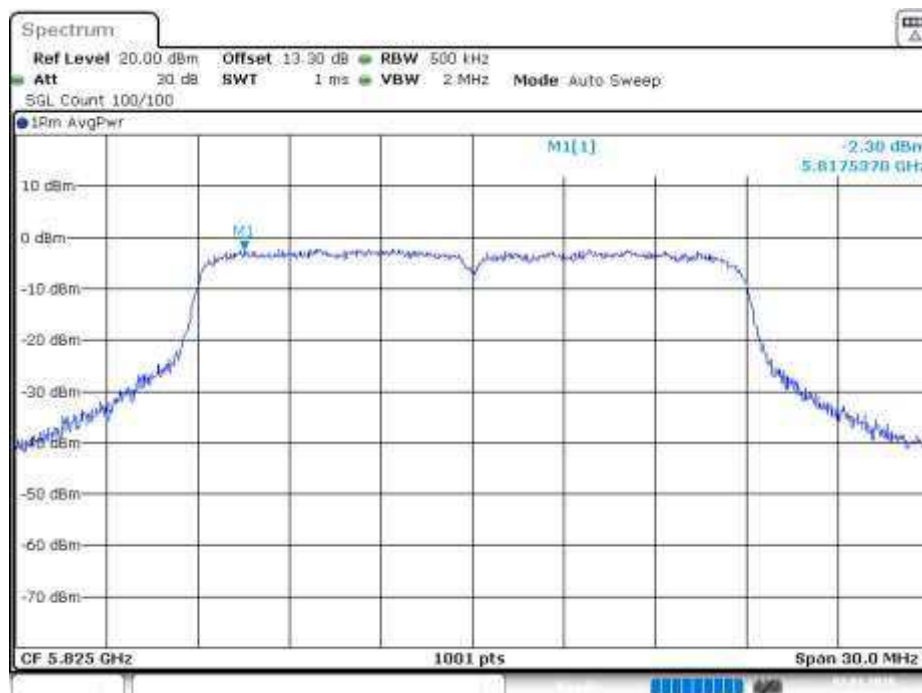
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802.11n HT20 5825MHz
Ant 1


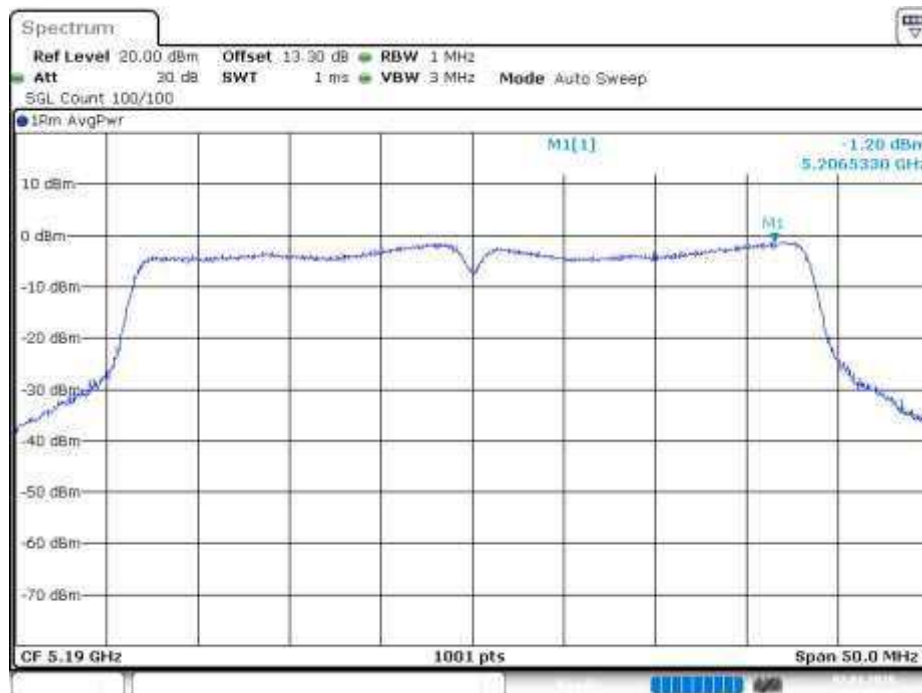
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Ant 2


Date: 2.JAN.2020 19:55:53

Ant 3


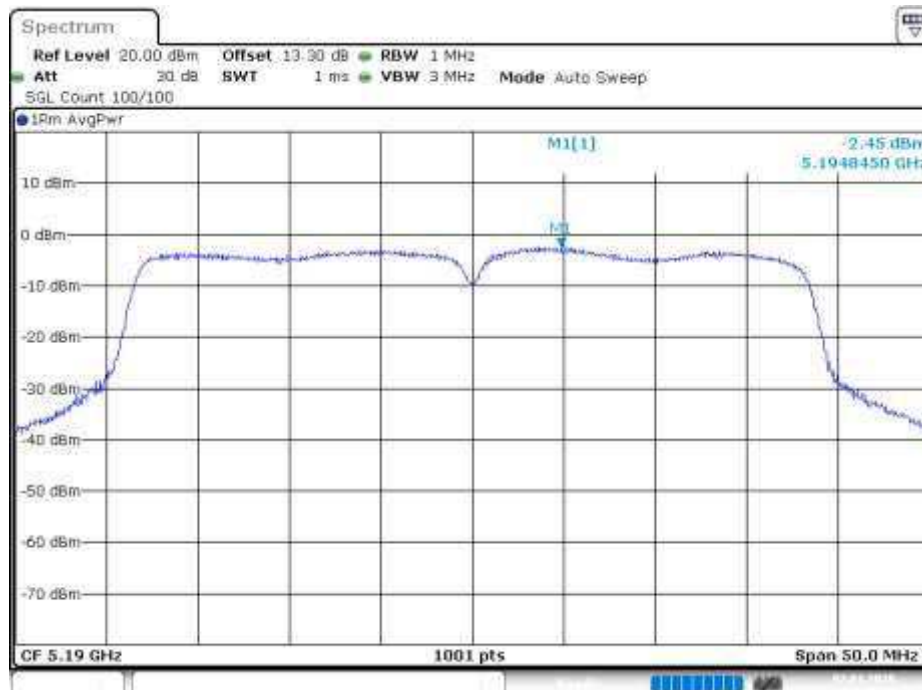
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802.11n HT40 5190MHz
Ant 1


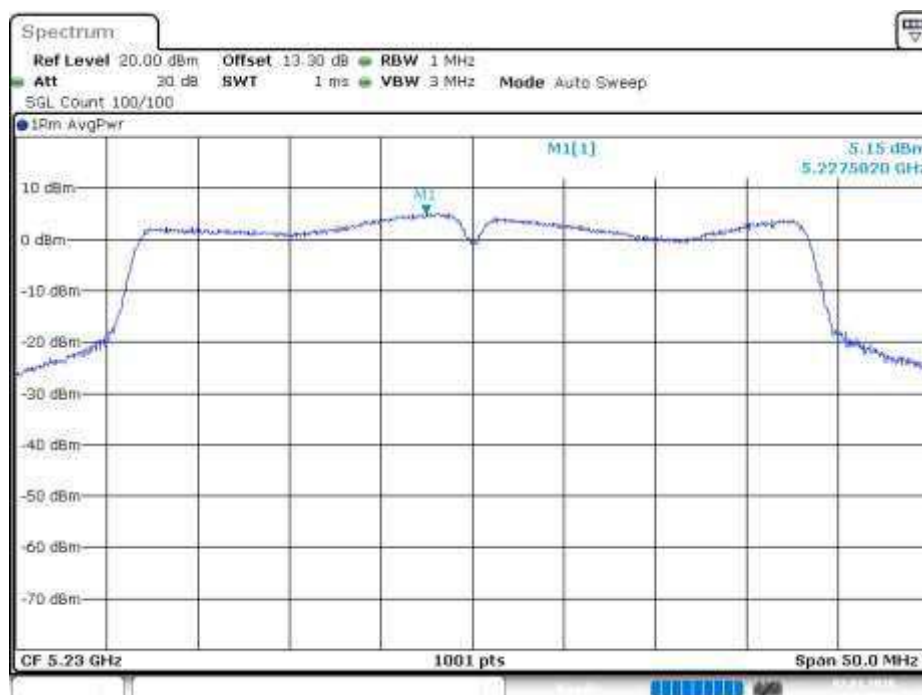
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Ant 2

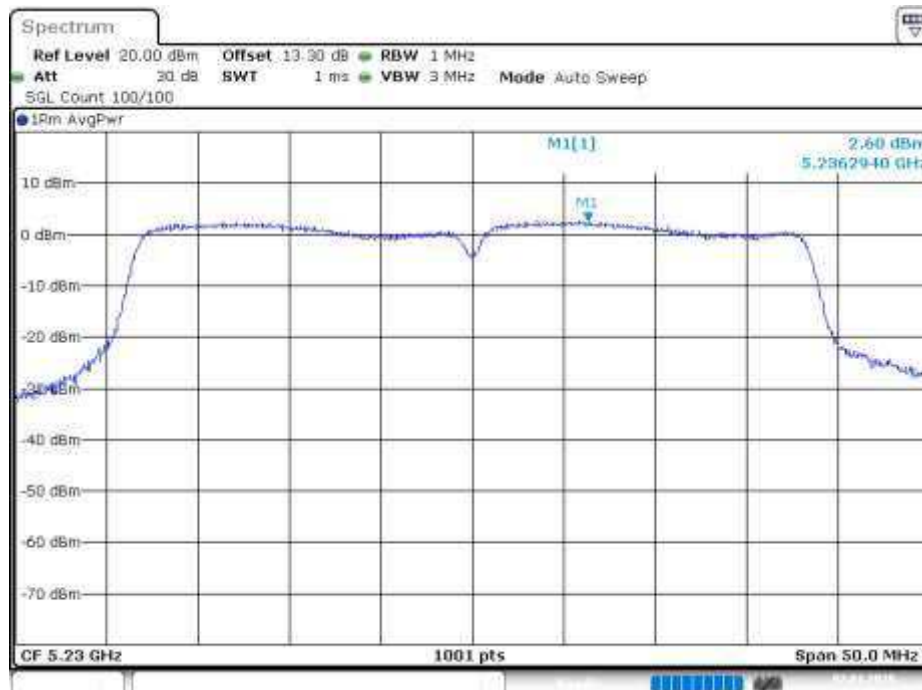

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Ant 3


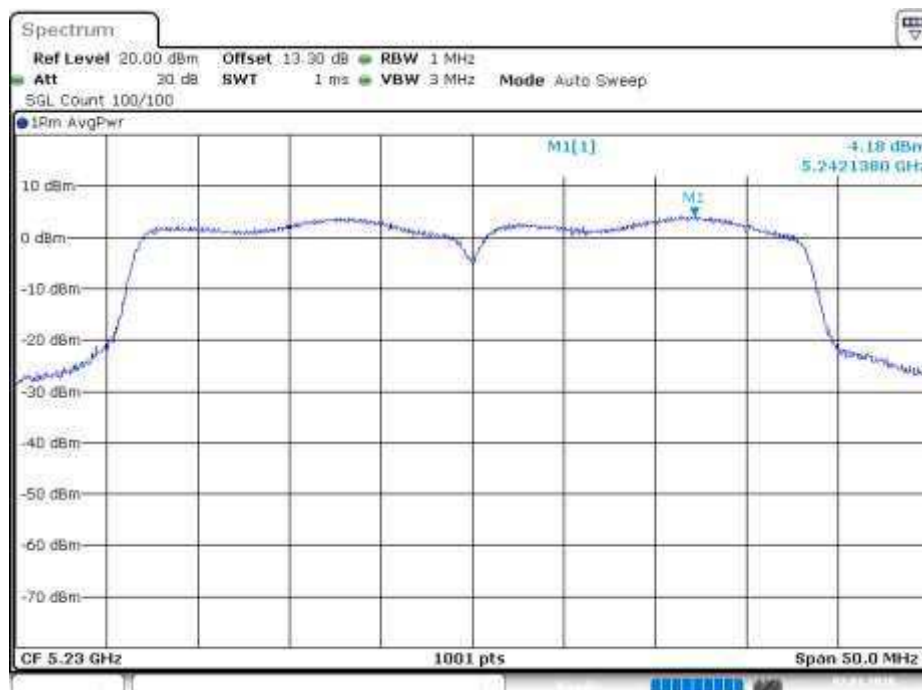
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802.11ac VHT40 5230MHz
Ant 1


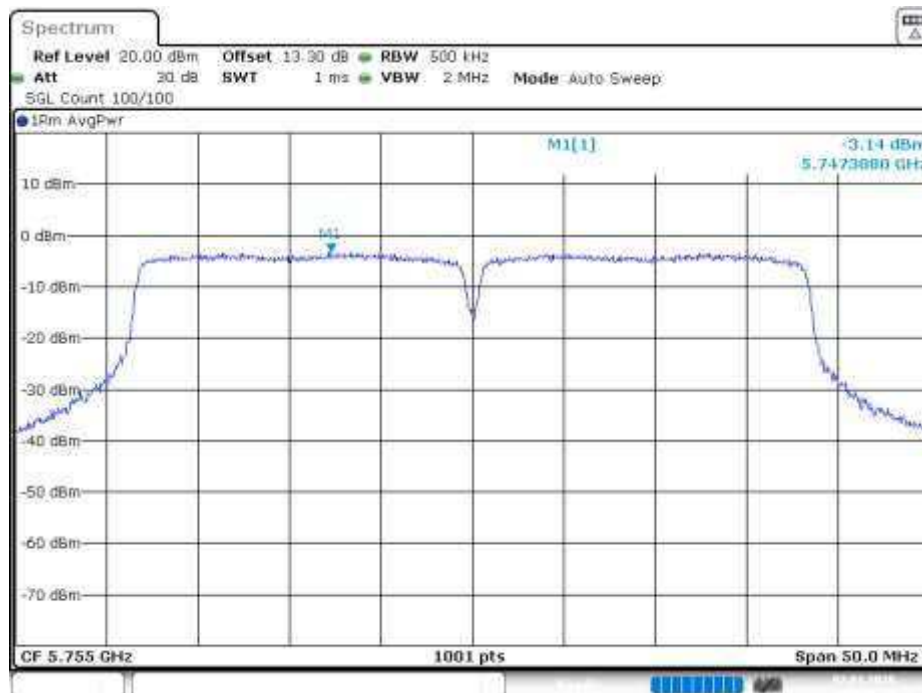
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Ant 2


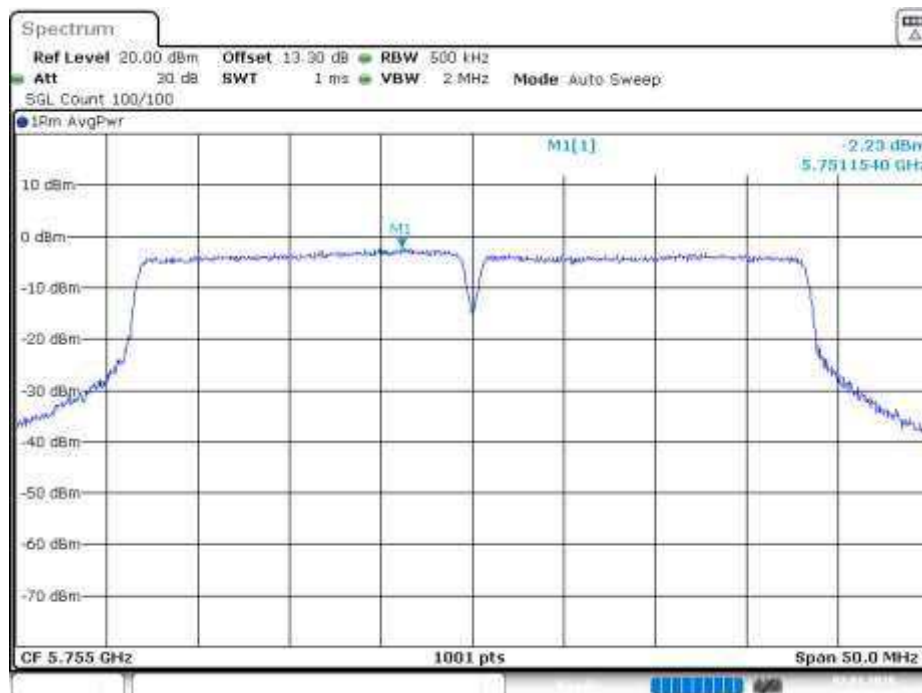
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Ant 3


Date: 2.JAN.2020 14:30:27

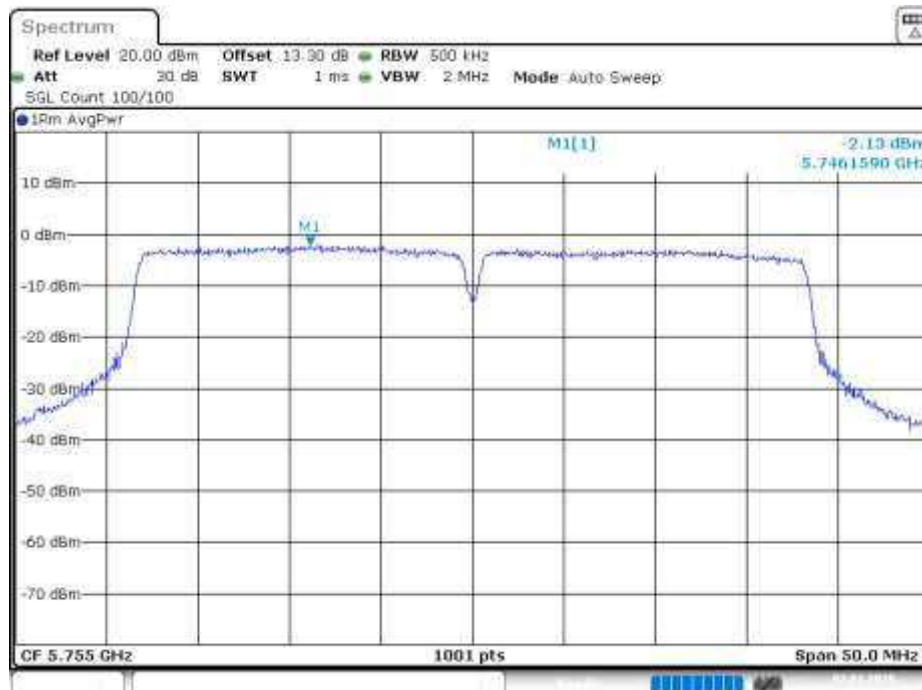
802.11n HT40 5755MHz
Ant 1


Date: 2.JAN.2020 19:58:26

Ant 2


Date: 2.JAN.2020 19:59:02

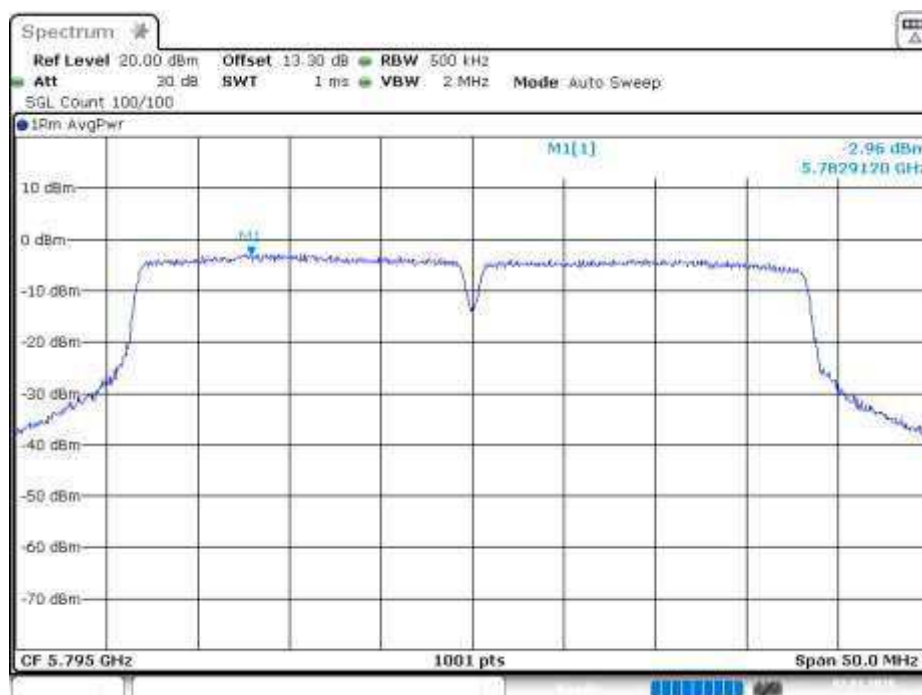
Ant 3



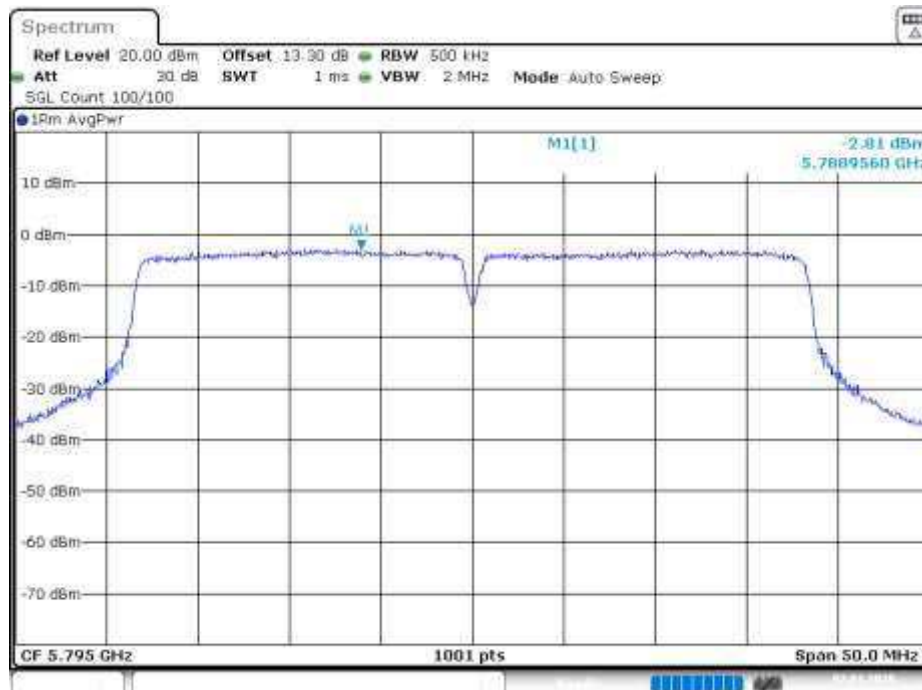
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802.11n HT40 5795MHz

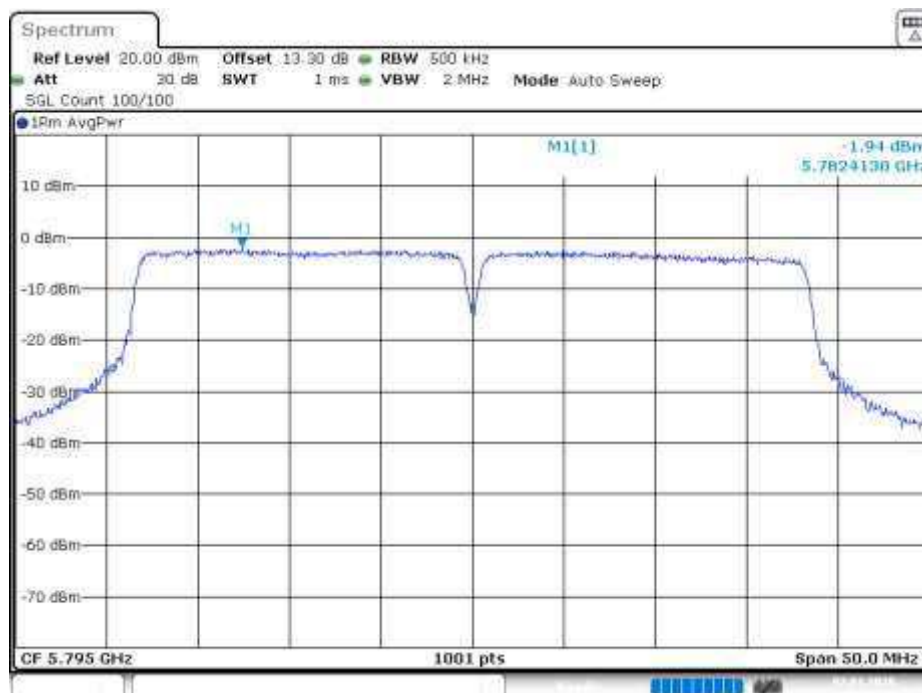
Ant 1



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Ant 2


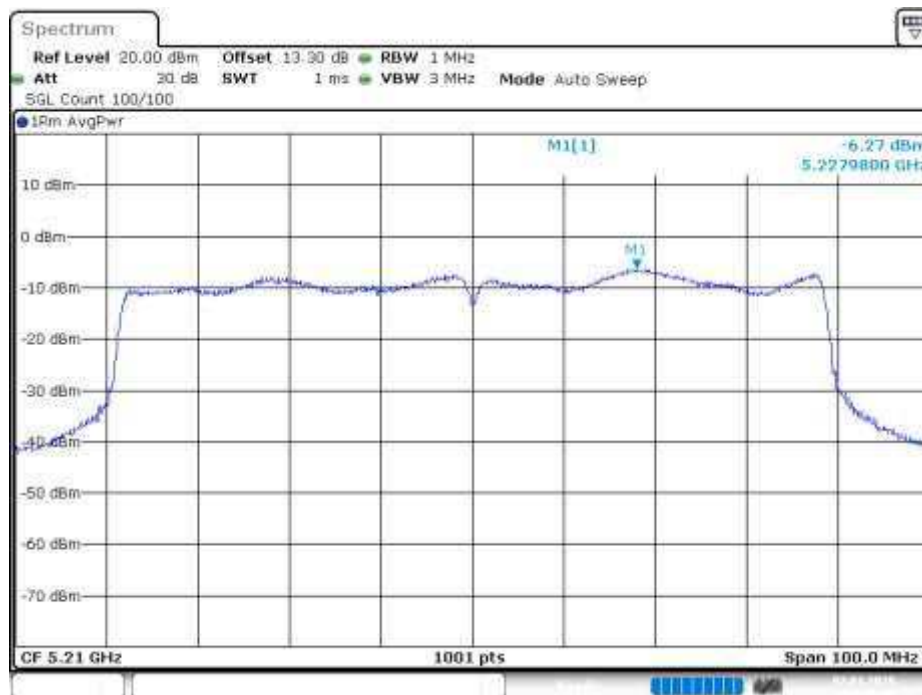
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Ant 3


Date: 2.JAN.2020 20:02:28

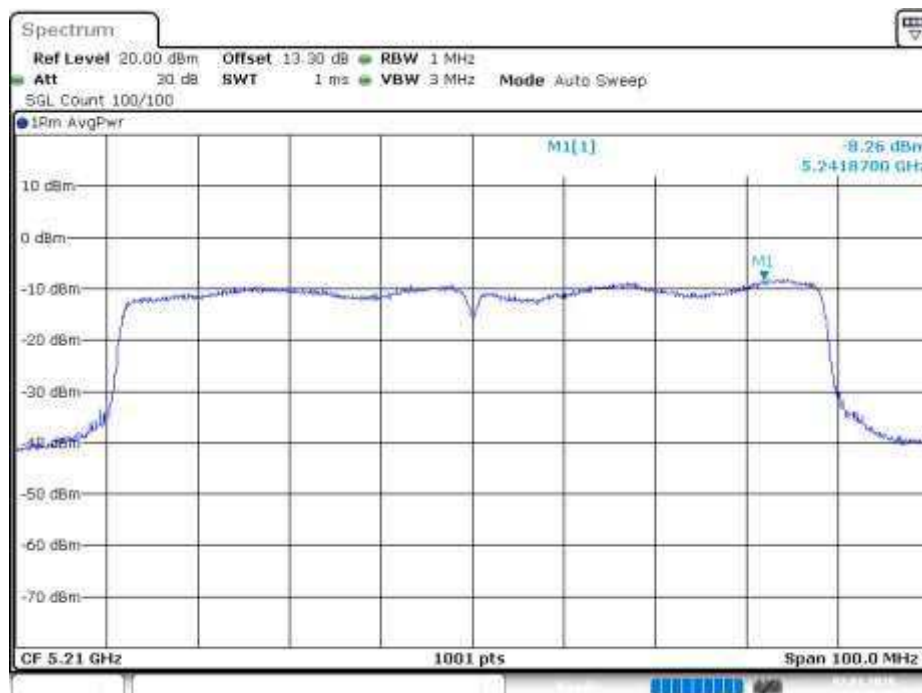
802.11ac VHT80 5210MHz

Ant 1

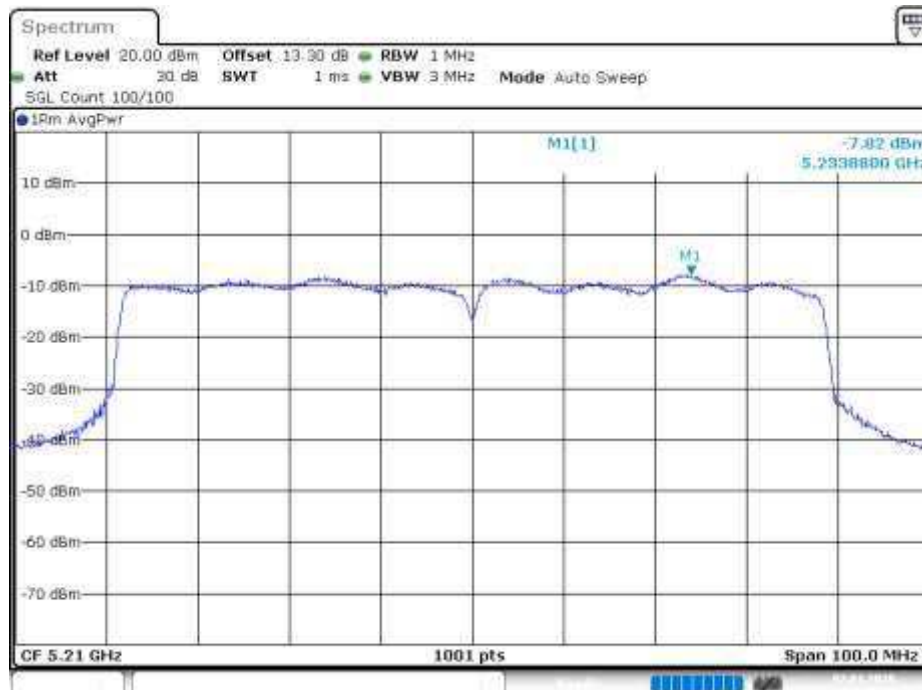


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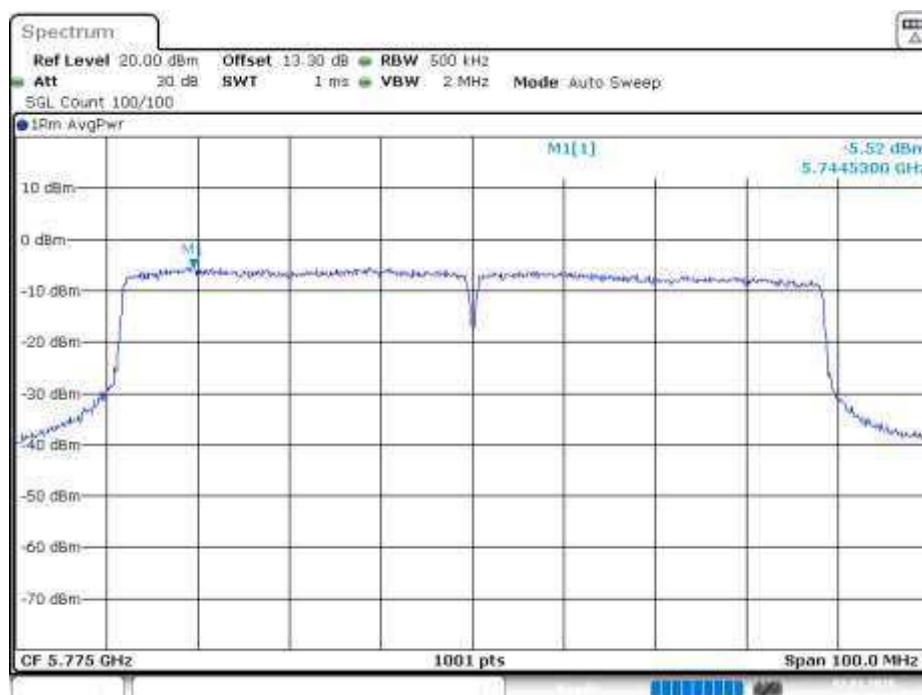
Ant 2



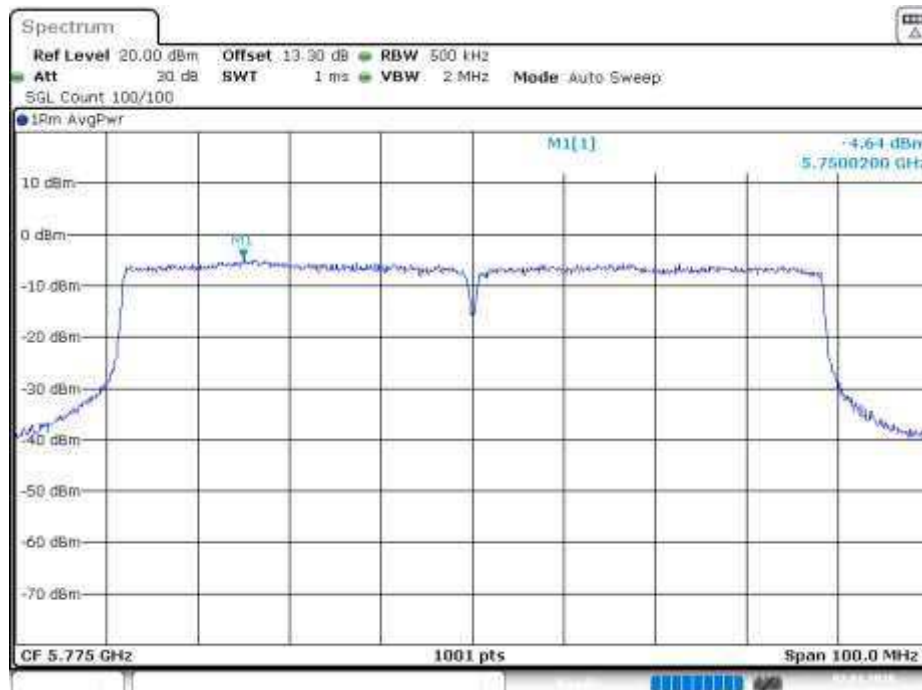
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Ant 3


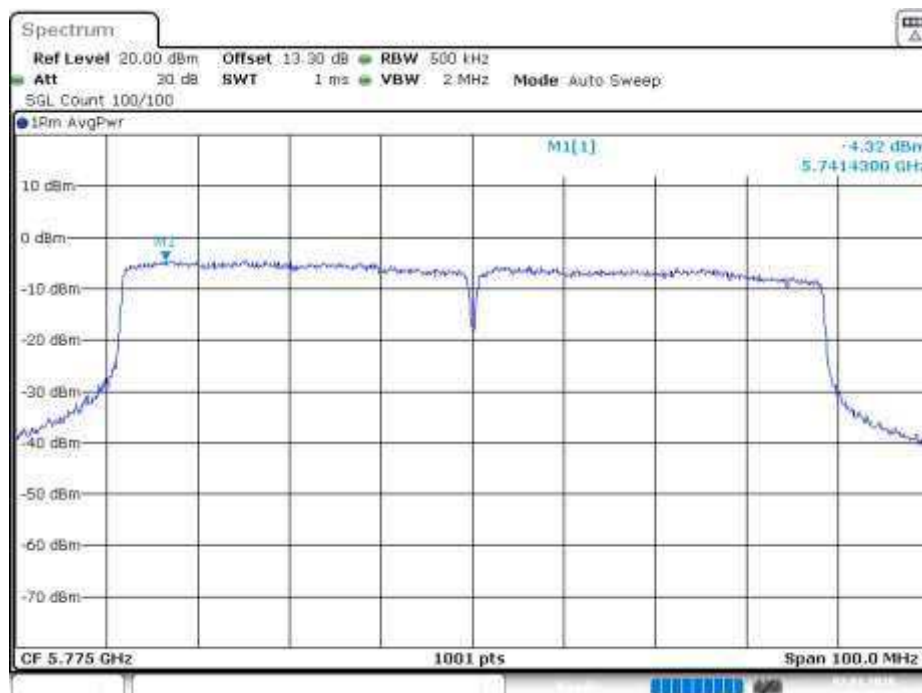
Date: 2.JAN.2020 14:47:16

802.11ac VHT80 5775MHz
Ant 1


Date: 2.JAN.2020 20:06:38

Ant 2


Date: 2.JAN.2020 20:06:51

Ant 3


Date: 2.JAN.2020 20:07:10

5.1.7 Frequency Stability Measurement

RESULT:
Passed

Test standard : FCC 15.407(g)
 Basic standard : ANSI C63.10: 2013
 Limits : ± 20 ppm
 Kind of test site : Shielded room

Test setup

Test Bandwidth : 20/40/80MHz
 Operation mode : A

Table 13: Test result of Frequency Stability

Frequency (MHz)	5200			
Voltage (V)	Measurement Frequency (MHz)			Max. Deviation (ppm)
132	5199.96035			7.625
120	5199.9664			6.462
108	5199.96035			7.625
Temp°C	Measurement Frequency (MHz)			
	0 Minute	2 Minute	5 Minute	10 Minute
50	5199.93517	5199.93488	5199.93488	5199.93488
40	5199.94559	5199.94443	5199.94414	5199.94385
30	5199.95716	5199.95716	5199.95745	5199.95716
20	5199.96064	5199.96093	5199.96035	5199.96035
10	5199.98958	5199.98958	5199.98958	5199.98958
0	5200.00232	5200.00203	5200.00203	5200.00203
-10	5200.01042	5200.00984	5200.00926	5200.00897
-20	5200.01158	5200.01158	5200.01158	5200.01158
-30	5200.00289	5200.00203	5200.00145	5200.00116
Limit (ppm)	± 20			
Max. Deviation (ppm)	12.467	12.523	12.523	12.523

Frequency (MHz)	5785			
Voltage (V)	Measurement Frequency (MHz)			Max. Deviation (ppm)
132	5784.95572			7.654
120	5784.95543			7.704
108	5784.95572			7.654
Temp°C	Measurement Frequency (MHz)			
	0 Minute	2 Minute	5 Minute	10 Minute
50	5784.92764	5784.92764	5784.92764	5784.92735
40	5784.93661	5784.93632	5784.93603	5784.93575
30	5784.95253	5784.95253	5784.95253	5784.95253
20	5784.95543	5784.95543	5784.95572	5784.95572
10	5784.98842	5784.98871	5784.98871	5784.98871
0	5785.00029	5785.00145	5785.00174	5785.00203
-10	5785.00926	5785.00897	5785.00868	5785.00868
-20	5785.01302	5785.01302	5785.01302	5785.01302
-30	5785.00029	5785	5784.99971	5784.99942
Limit (ppm)	±20			
Max. Deviation (ppm)	12.508	12.508	12.508	12.558

5.1.8 Spurious Emission

RESULT:
Passed

Test standard : FCC 15.205, FCC 15.209, FCC15.407
 Basic standard : ANSI C63.10: 2013
 Limits : Radiated emissions which fall in the restricted bands, as defined in FCC 15.205(a) and RSS-Gen i5, 8.10 (Table 7), must comply with the radiated emission limits specified in FCC 15.209(a) and RSS-Gen i5, 8.9 (Table 5 and 6).

Emission radiated outside the restricted and authorized frequency bands must either comply with the radiated emission limits specified for the restricted bands or in FCC15.407 and RSS-247 i2, 6.2

Kind of test site : 3m Semi-Anechoic Chamber

Test setup

Test Channel : Refer to Appendix D
 Operation mode : A

Ambient temperature : 20-24 °C
 Relative humidity : 50-65 %
 Atmospheric pressure : 100-103 kPa

	802.11a / n20	802.11n40	802.11ac80
Peak	RBW: 1MHz VBW: 3MHz	RBW: 1MHz VBW: 3MHz	RBW: 1MHz VBW: 3MHz
Average	RBW: 1MHz VBW: 1kHz	RBW: 1MHz VBW: 2kHz	RBW: 1MHz VBW: 3kHz

Factor (dB/m)=Antenna Factor(dB/m)+Cable loss (dB)

Level(dBuV/m)=Reading(dBuV)+ Factor(dB/m)

Testing was carried out within frequency range 9kHz to the tenth harmonic. For details refer to Appendix D. The Radiated Emissions testing was performed in the X, Y and Z axis orientation. The worst-case Axis orientation is recorded in this test report.

5.2 Mains Emissions

5.2.1 Mains Conducted Emissions

RESULT:**Passed**

Test standard : FCC Part 15.207, FCC Part 15.107
Limits : Mains Conducted emissions as defined in
above test standards must comply with the
mains conducted emission limits specified
Kind of test site : Shielded Room

Test setup

Operation mode : C
Ambient temperature : 20-24°C
Relative humidity : 50-65%
Atmospheric pressure : 100-103 kPa

Factor (dB/m)=Antenna Factor(dB/m)+Cable loss (dB)

Level(dBuV/m)=Reading(dBuV)+ Factor(dB/m)

Remark: For details refer to Appendix D.

6. Radio Frequency Exposure Compliance

6.1.1 Electromagnetic Fields

RESULT:**Passed**

Test standard : FCC CFR 47 Part 2 Subpart J Section 2.1091

Separation distance is more than 20 cm, thus mobile device exposure limits can be applied.

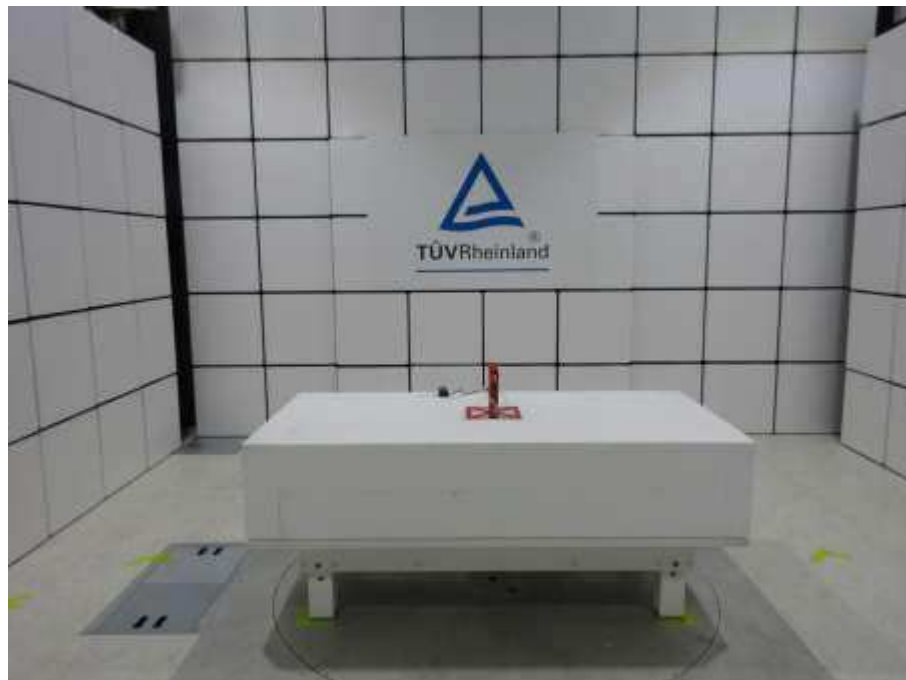
FCC Maximum Exposure:**Maximum Exposure:**

Power to Antenna (mW)	167.11 mW
Power to Antenna (dBm)	22.2 dBm
Antenna Gain	3.78 dBi
Power+Ant Gain	399.0 mW
Distance	20 cm
S=	0.079 mW/cm ²

Limit FCC: 1500-100,000 MHz 1.0 mW/cm²

7. Photographs of the Test Set-Up

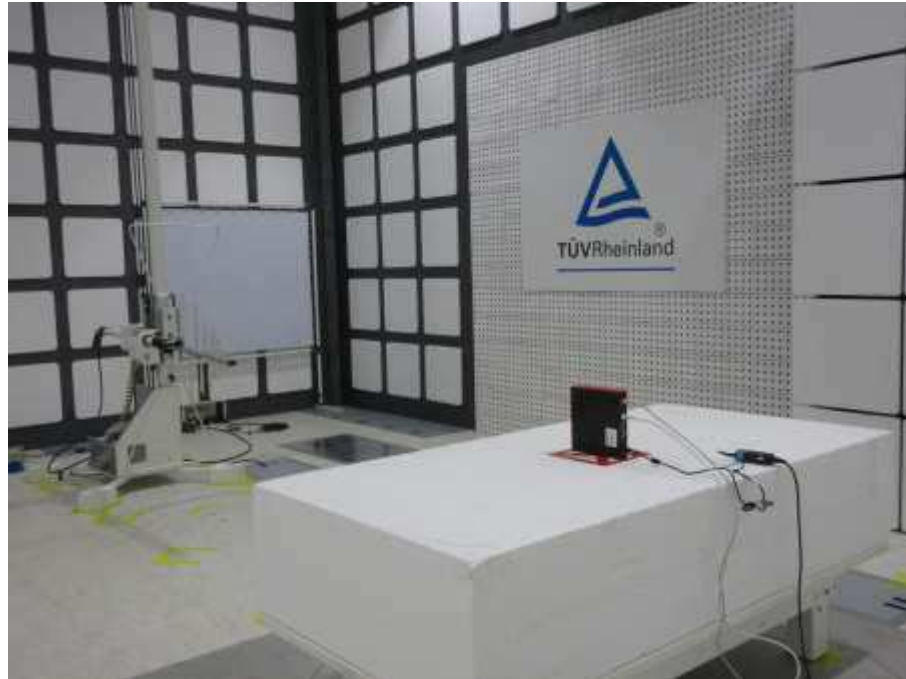
Photograph 1: Set-up for Spurious Emissions (Front View 1)



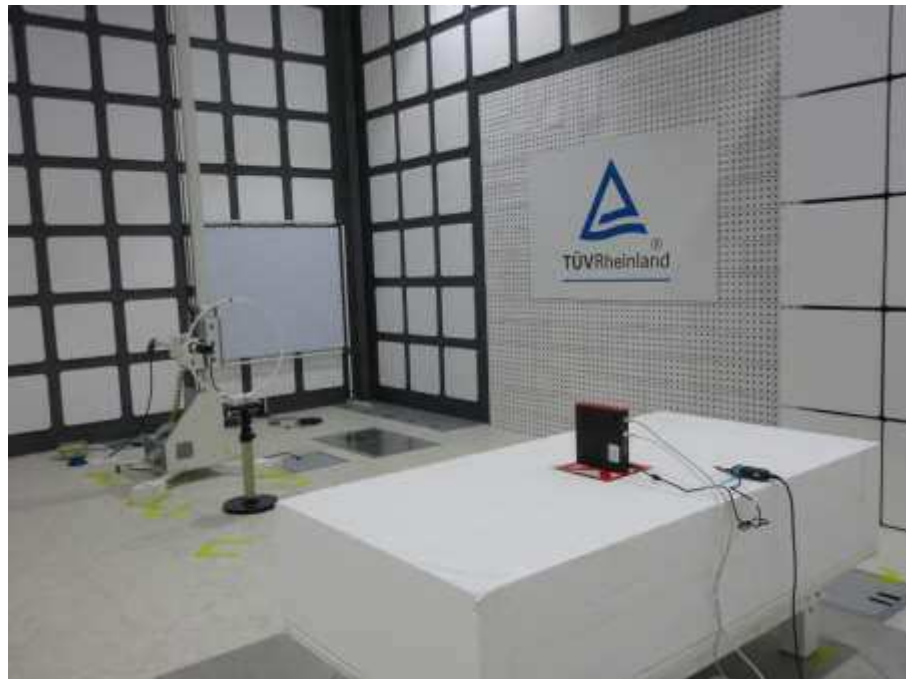
Photograph 2: Set-up for Spurious Emissions (Front View 2)



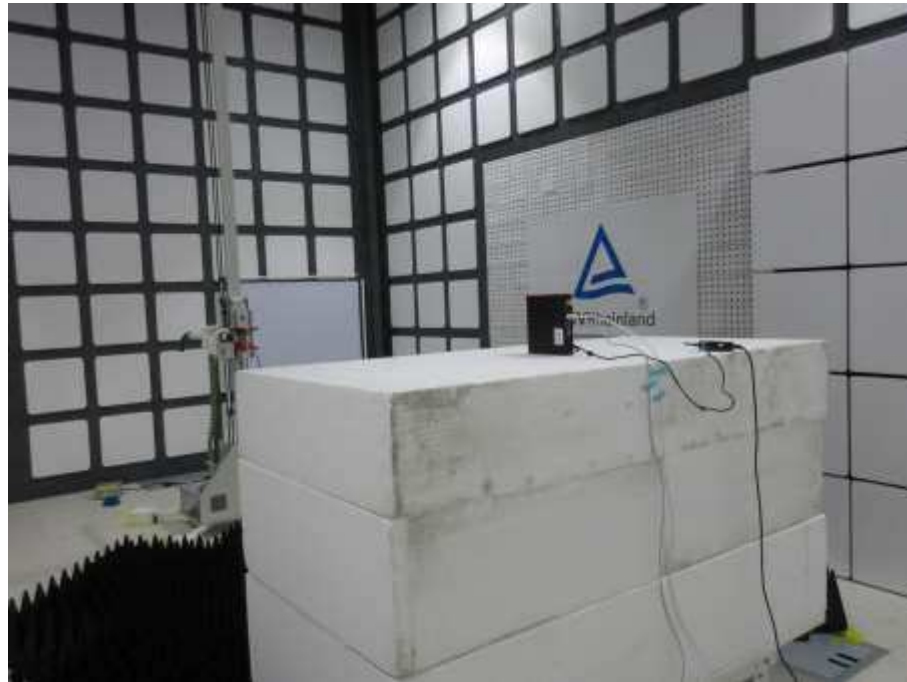
Photograph 3: Set-up for Spurious Emissions (Back View 1)



Photograph 4: Set-up for Spurious Emissions (Back View 2)



Photograph 5: Set-up for Spurious Emissions (Back View 3)



Photograph 6: Set-up for Mains Conducted testing (Front View)



Photograph 7: Set-up for Mains Conducted testing (Back View)



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