



<b>Prüfbericht-Nr.:</b> <i>Test report no.:</i>	<b>50335252 002</b>	<b>Auftrags-Nr.:</b> <i>Order no.:</i>	238106791	Seite 1 von 90 <i>Page 1 of 90</i>
<b>Kunden-Referenz-Nr.:</b> <i>Client reference no.:</i>	N/A	<b>Auftragsdatum:</b> <i>Order date:</i>	24-Jun-2019	
<b>Auftraggeber:</b> <i>Client:</i>	WatchGuard Technologies, Inc. 505 5th Avenue S, Suite 500, Seattle, WA 98104-3892, USA			
<b>Prüfgegenstand:</b> <i>Test item:</i>	Firebox			
<b>Bezeichnung / Typ-Nr.:</b> <i>Identification / Type no.:</i>	Firebox T20-W			
<b>Auftrags-Inhalt:</b> <i>Order content:</i>	FCC Part 15E Test report (Wifi 5GHz)			
<b>Prüfgrundlage:</b> <i>Test specification:</i>	FCC 47CFR Part 15: Subpart E Section 15.407(UNII)			
<b>Wareneingangsdatum:</b> <i>Date of sample receipt:</i>	15-Nov-2019			
<b>Prüfmuster-Nr.:</b> <i>Test sample no.:</i>	A001025332-002 A001025332-003			
<b>Prüfzeitraum:</b> <i>Testing period:</i>	07-Jan-2020 – 20-Jan-2020			
<b>Ort der Prüfung:</b> <i>Place of testing:</i>	EMC/RF Laboratory Taipei			
<b>Prüflaboratorium:</b> <i>Testing laboratory:</i>	TUV Rheinland Taiwan Ltd.			
<b>Prüfergebnis*:</b> <i>Test result*:</i>	Pass			
<b>überprüft von:</b> <i>reviewed by:</i>	<b>genehmigt von</b> <i>authorized by:</i>			
<b>Datum:</b> 04-May-2020 <i>Date:</i>	 <u>Jack H.C. Chang</u>	<b>Datum:</b> 04-May-2020 <i>Date:</i>	 <u>Arvin Ho</u>	
<b>Stellung / Position:</b>	Project Manager	<b>Stellung / Position:</b>	Vice General Manager	
<b>Sonstiges / Other:</b> The test report No. 50335252 001 is replaced by this new test report No. 50335252 002 for added RBW/VBW on page 83. Test report No. 50335252 001 becomes invalid since 2020-05-04.				
<b>Zustand des Prüfgegenstandes bei Anlieferung:</b> <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
<b>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.</b> <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*

## Contents

<b>1.</b>	<b>GENERAL REMARKS .....</b>	<b>5</b>
<b>1.1</b>	<b>COMPLEMENTARY MATERIALS.....</b>	<b>5</b>
<b>1.2</b>	<b>DECISION RULE OF CONFORMITY.....</b>	<b>5</b>
<b>2.</b>	<b>TEST SITES .....</b>	<b>6</b>
<b>2.1</b>	<b>TEST LABORATORY .....</b>	<b>6</b>
<b>2.2</b>	<b>TEST FACILITY.....</b>	<b>6</b>
<b>2.3</b>	<b>LIST OF TEST AND MEASUREMENT INSTRUMENTS.....</b>	<b>7</b>
<b>2.4</b>	<b>TRACEABILITY .....</b>	<b>8</b>
<b>2.5</b>	<b>CALIBRATION .....</b>	<b>8</b>
<b>2.6</b>	<b>MEASUREMENT UNCERTAINTY .....</b>	<b>8</b>
<b>3.</b>	<b>GENERAL PRODUCT INFORMATION.....</b>	<b>9</b>
<b>3.1</b>	<b>PRODUCT FUNCTION AND INTENDED USE .....</b>	<b>9</b>
<b>3.2</b>	<b>SYSTEM DETAILS AND RATINGS.....</b>	<b>9</b>
<b>3.3</b>	<b>INDEPENDENT OPERATION MODES.....</b>	<b>11</b>
<b>3.4</b>	<b>NOISE GENERATING AND NOISE SUPPRESSING PARTS .....</b>	<b>11</b>
<b>3.5</b>	<b>SUBMITTED DOCUMENTS.....</b>	<b>11</b>
<b>4.</b>	<b>TEST SET-UP AND OPERATION MODES.....</b>	<b>12</b>
<b>4.1</b>	<b>PRINCIPLE OF CONFIGURATION SELECTION .....</b>	<b>12</b>
<b>4.2</b>	<b>TEST OPERATION AND TEST SOFTWARE.....</b>	<b>13</b>
<b>4.3</b>	<b>SPECIAL ACCESSORIES AND AUXILIARY EQUIPMENT .....</b>	<b>13</b>
<b>4.4</b>	<b>COUNTERMEASURES TO ACHIEVE EMC COMPLIANCE.....</b>	<b>14</b>
<b>4.5</b>	<b>TEST SETUP DIAGRAM .....</b>	<b>14</b>
<b>5.</b>	<b>TEST RESULTS .....</b>	<b>16</b>
<b>5.1</b>	<b>TRANSMITTER REQUIREMENT &amp; TEST SUITES.....</b>	<b>16</b>
5.1.1	<i>Antenna Requirement .....</i>	<i>16</i>
5.1.2	<i>Duty Cycle .....</i>	<i>17</i>
5.1.3	<i>Maximum Conducted Average Output Power.....</i>	<i>20</i>
5.1.4	<i>26dB Bandwidth .....</i>	<i>22</i>
5.1.5	<i>6dB Bandwidth .....</i>	<i>37</i>
5.1.6	<i>Power Density .....</i>	<i>52</i>
5.1.7	<i>Frequency Stability Measurement .....</i>	<i>81</i>
5.1.8	<i>Spurious Emission .....</i>	<i>83</i>
<b>5.2</b>	<b>MAINS EMISSIONS.....</b>	<b>84</b>
5.2.1	<i>Mains Conducted Emissions.....</i>	<i>84</i>

<b>6.</b>	<b>RADIO FREQUENCY EXPOSURE COMPLIANCE .....</b>	<b>85</b>
6.1.1	<i>Electromagnetic Fields.....</i>	<i>85</i>
<b>7.</b>	<b>PHOTOGRAPHS OF THE TEST SET-UP.....</b>	<b>86</b>
<b>8.</b>	<b>LIST OF TABLES .....</b>	<b>90</b>
<b>9.</b>	<b>LIST OF PHOTOGRAPHS.....</b>	<b>90</b>

## 1. General Remarks

### 1.1 Complementary Materials

These attachments are integral parts of this test report:

**Appendix P: Photo Documentation**

(File Name: 50335252 002 APPENDIX P)

**Appendix D: Test Result of Radiated Emissions**

(File Name: 50335252 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**

<b>Radio</b>
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: 6<sup>th</sup>-May-2019 to 05<sup>th</sup>-May-2022



## 2.3 List of Test and Measurement Instruments

**Table 2: List of Test and Measurement Equipment**

<b>Equipment</b>	<b>Manufacturer</b>	<b>Model No.</b>	<b>Serial No.</b>	<b>Cal. Date</b>	<b>Cal. Due Date</b>
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 T20-W
FCC ID	Q6G-FS2AE5W

**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: 4.13dBi Band 4: 4.94dBi
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	<b>36</b>	13	13	<b>38</b>	12	<b>42</b>	11
	<b>40</b>	15	15	<b>46</b>	17		
	<b>48</b>	15	15				
Band 4	<b>149</b>	10	11	<b>151</b>	15	<b>155</b>	15
	<b>157</b>	12	13	<b>159</b>	13		
	<b>165</b>	13	12				

## 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: A001025332-002

Radiation: A001025332-003

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:

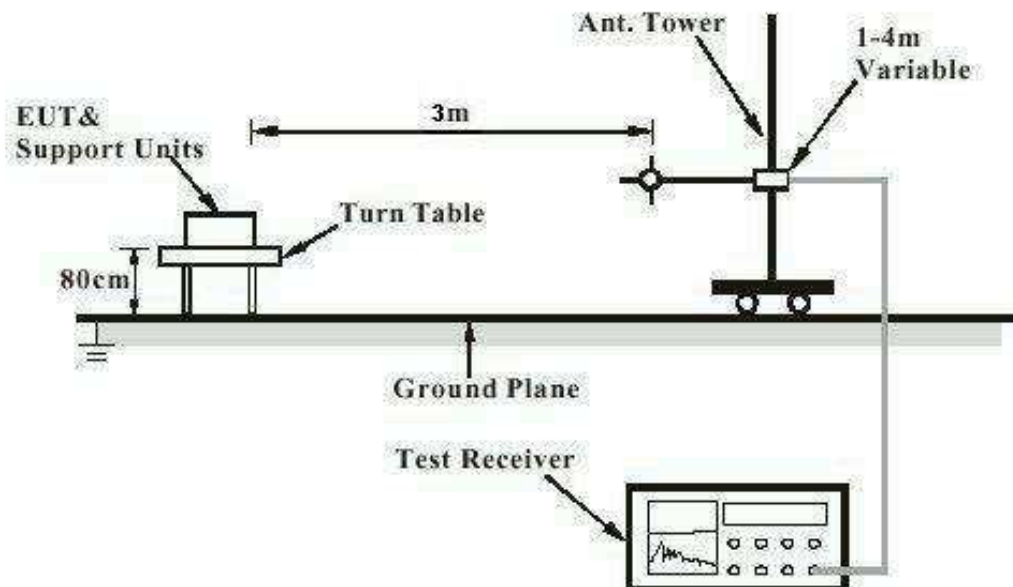
Kind of Equipment	Manufacturer	Model Name
Notebook	Lenovo	G580

## 4.4 Countermeasures to achieve EMC Compliance

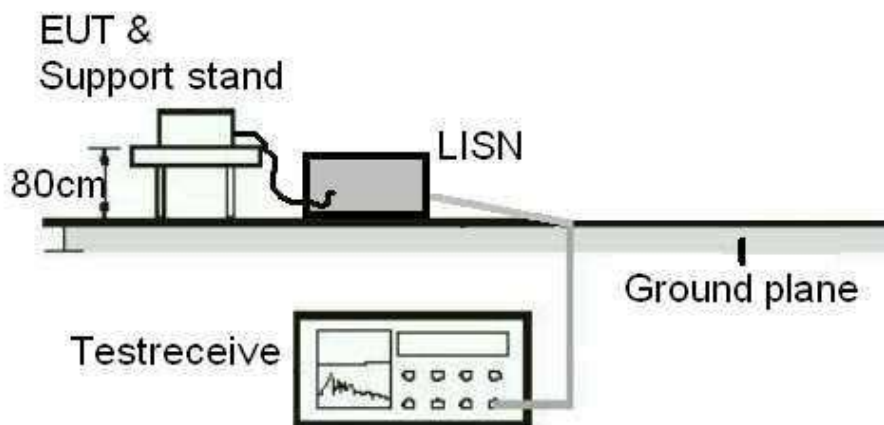
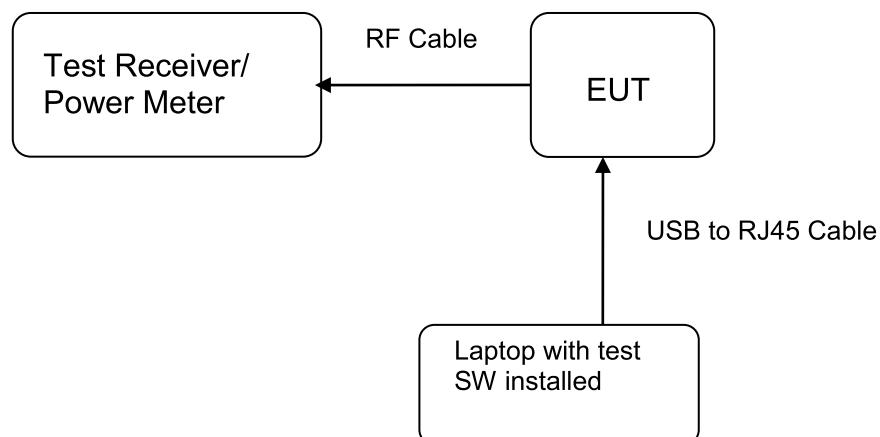
The test sample which has been tested contained the noise suppression parts as described in the Constructional Data Form or the Technical Construction File. No additional measures were employed to achieve compliance.

## 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 4.94 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**

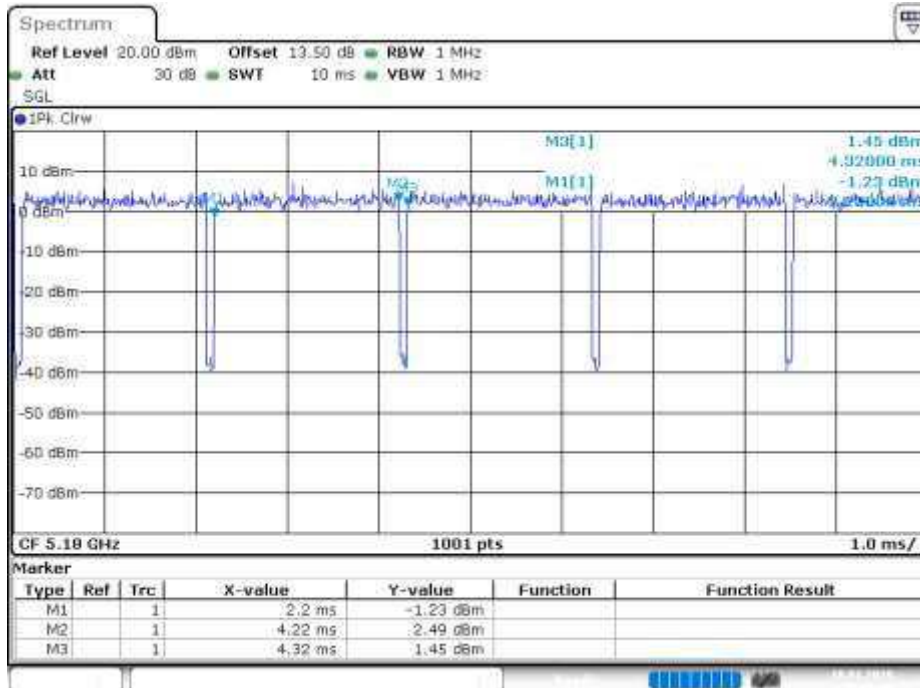
Operation Mode : A  
 Test Channel : Refer to the Table (Band 1 low channel)

**Table 8: Test result of Duty Cycle**

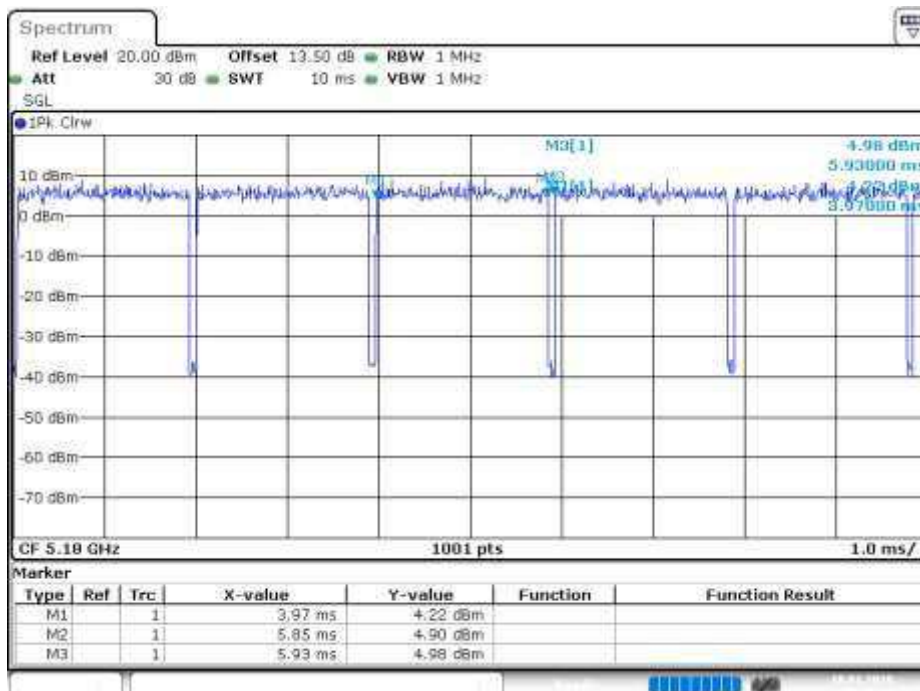
Mode	On Time(ms)	On+Off Time(ms)	Duty Cycle (%)	Duty Factor (dB)
802.11a	4.32	4.22	97.69	0.10
802.11ac VHT20	5.93	5.85	98.65	0.06
802.11ac VHT40	4.99	4.9	98.20	0.08
802.11ac VHT80	5.13	5.04	98.25	0.08

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

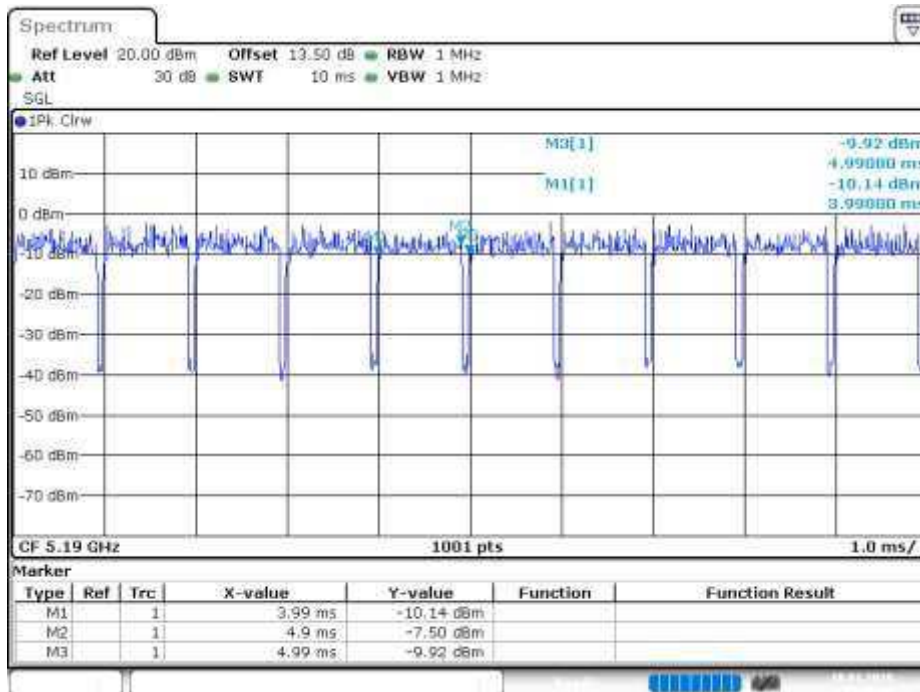
## Test Plot of Duty Cycle

**802.11a**


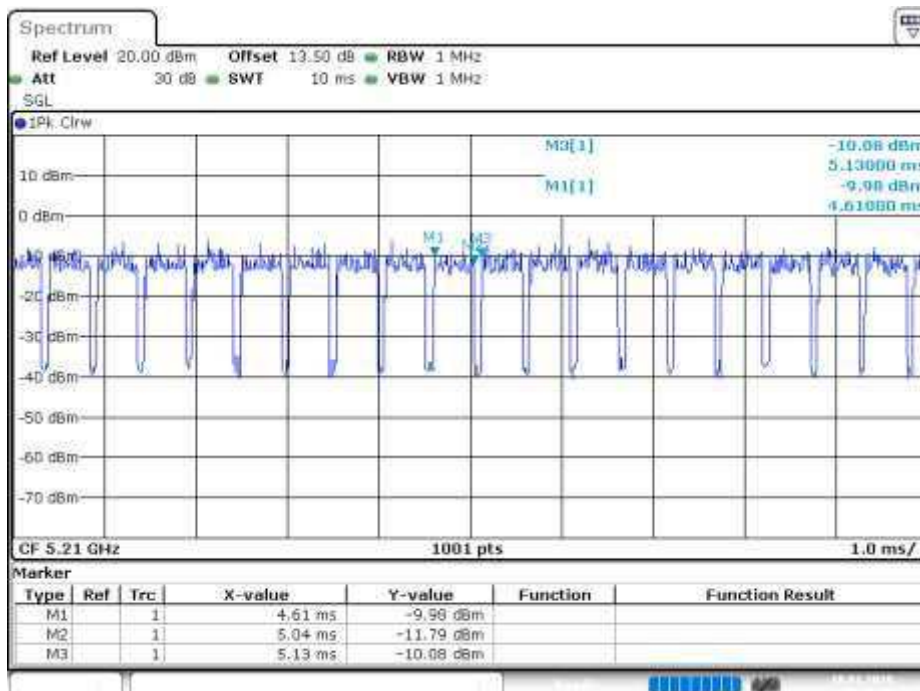
Date: 10.JAN.2020 18:25:46

**802.11n HT20**


Date: 10.JAN.2020 18:47:00

**802.11n HT40**


Date: 10.JAN.2020 19:00:07

**802.11ac VHT80**


Date: 10.JAN.2020 18:17:26

### 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 1W 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 1W.

**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	13.37	13.59	13.81	18.36	30.00
	5200	15.74	15.85	16.11	20.67	30.00
	5240	14.48	15.24	16.04	20.07	30.00
	5745	9.33	9.02	10.21	14.32	30.00
	5785	8.58	9.67	13.22	15.74	30.00
	5825	9.20	10.30	14.24	16.59	30.00
802.11n HT20	5180	13.32	13.51	13.75	18.30	30.00
	5200	15.32	15.62	17.14	20.87	30.00
	5240	14.84	15.35	15.75	20.10	30.00
	5745	10.27	9.78	12.02	15.57	30.00
	5785	11.37	11.03	15.03	17.65	30.00
	5825	10.46	10.12	14.84	17.15	30.00
802.11n HT40	5190	11.36	11.71	12.59	16.69	30.00
	5230	16.43	16.89	17.76	21.83	30.00
	5755	14.02	14.00	16.21	19.64	30.00
	5795	10.13	11.12	14.17	16.93	30.00
802.11ac VHT20	5180	12.82	13.33	13.63	18.04	30.00
	5200	15.19	15.65	16.67	20.65	30.00
	5240	15.21	15.03	15.51	20.03	30.00
	5745	9.60	10.45	11.98	15.56	30.00
	5785	11.35	7.57	15.12	17.15	30.00
	5825	10.44	7.85	14.91	16.82	30.00
802.11ac VHT40	5190	11.31	11.73	12.58	16.68	30.00
	5230	16.78	16.35	17.63	21.72	30.00
	5755	13.92	13.91	16.26	19.62	30.00
	5795	9.98	8.71	13.34	15.91	30.00
802.11ac VHT80	5210	10.29	10.10	11.31	15.37	30.00
	5775	12.05	13.01	15.36	18.47	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

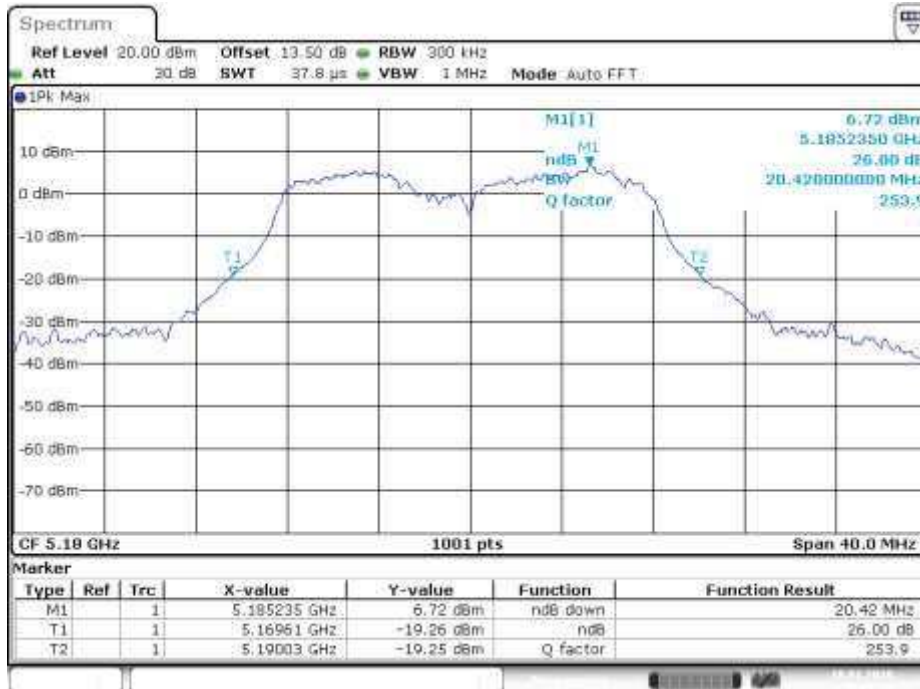
**Test setup**

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

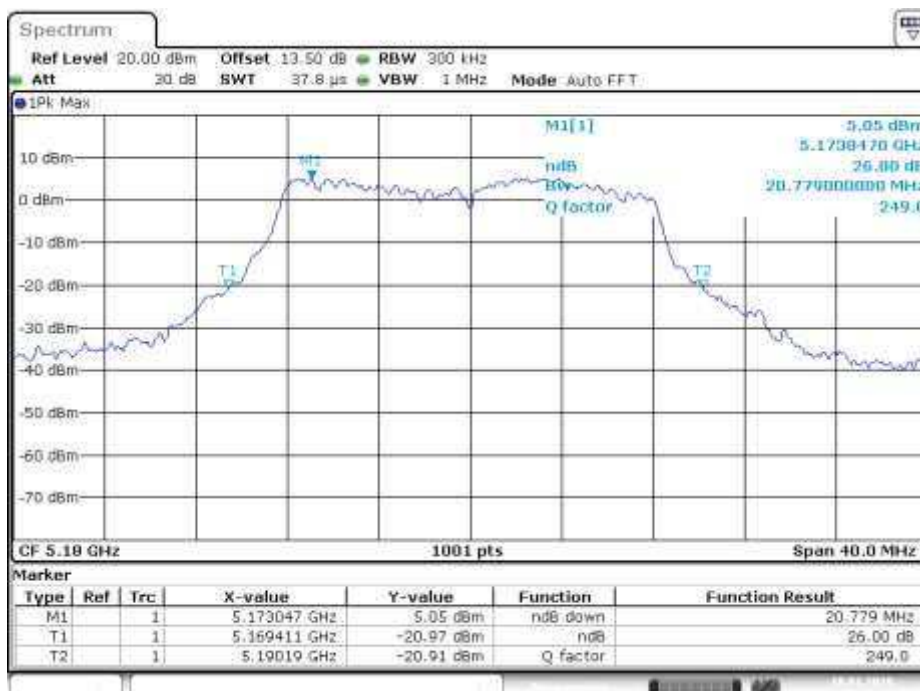
**Table 10: Test result of 26dB & 99% Bandwidth**

Mode	Channel Frequency (MHz)	26dB Bandwidth (MHz)		
		Ant 1	Ant 2	Ant 3
802.11a	5180	20.42	20.78	21.62
	5200	21.06	20.86	20.78
	5240	20.22	21.94	20.94
802.11n HT20	5180	20.58	22.30	20.78
	5200	20.70	22.18	22.34
	5240	22.66	21.54	22.98
802.11n HT40	5190	43.24	44.12	43.00
	5230	45.87	44.84	44.76
802.11ac VHT80	5210	86.79	88.07	84.08

## Test Plot of 26dB Bandwidth

**802.11a 5180MHz**
**Ant 1**


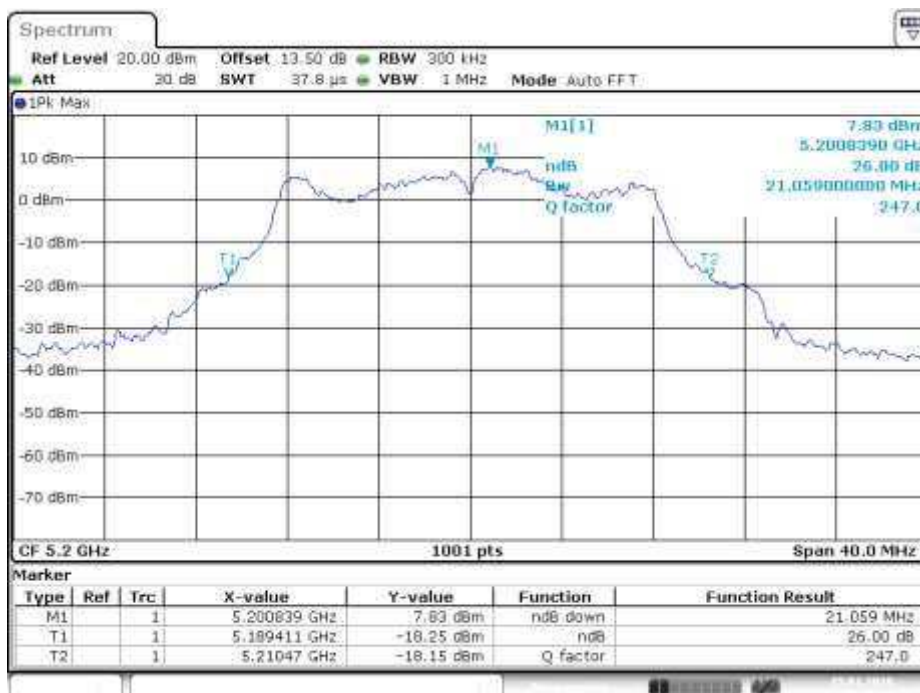
Date: 10. JAN. 2020 18:25:59

**Ant 2**


Date: 10. JAN. 2020 18:27:00

**Ant 3**


Date: 10.JAN.2020 18:28:24

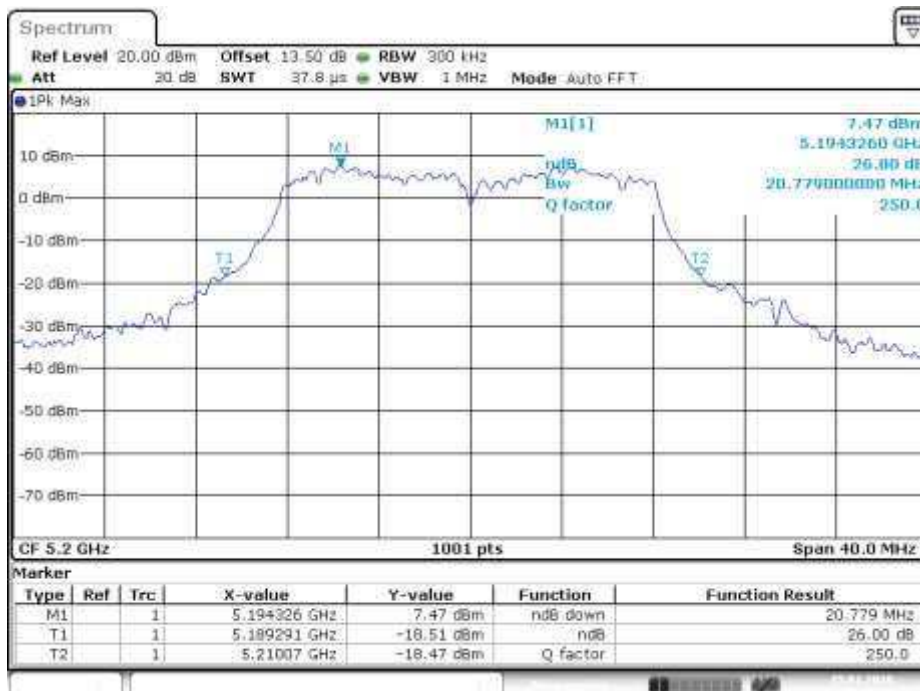
**802.11a 5200MHz**
**Ant 1**


Date: 15.JAN.2020 18:33:41

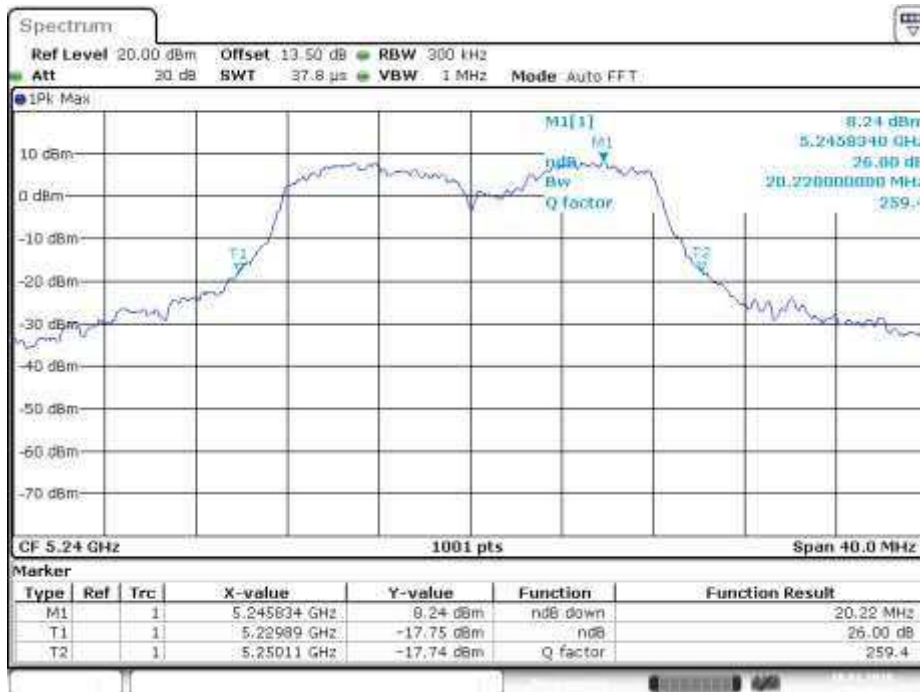


**Ant 2**

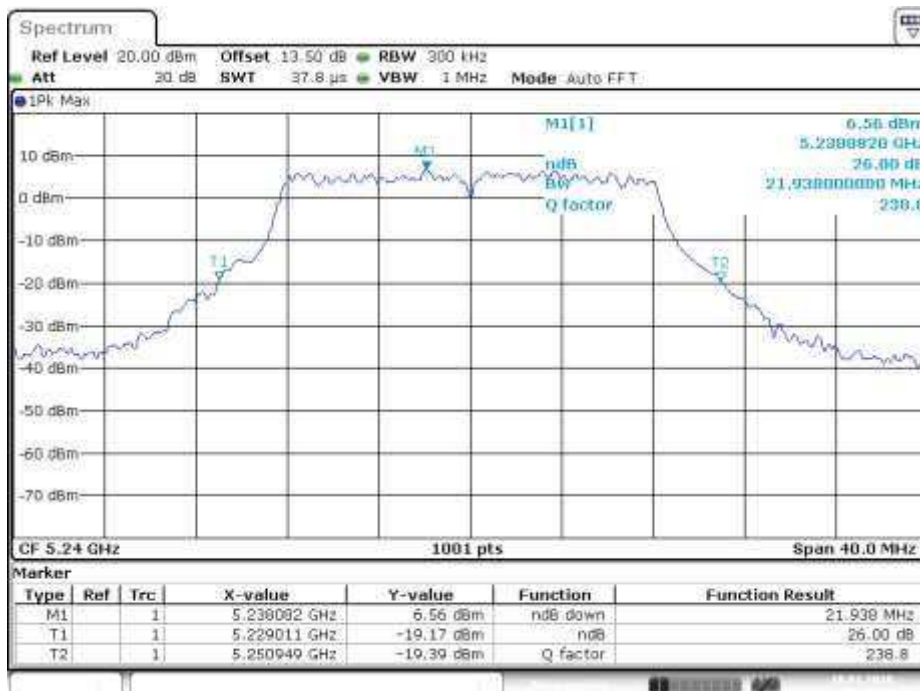

Date: 15.JAN.2020 18:28:58

**Ant 3**


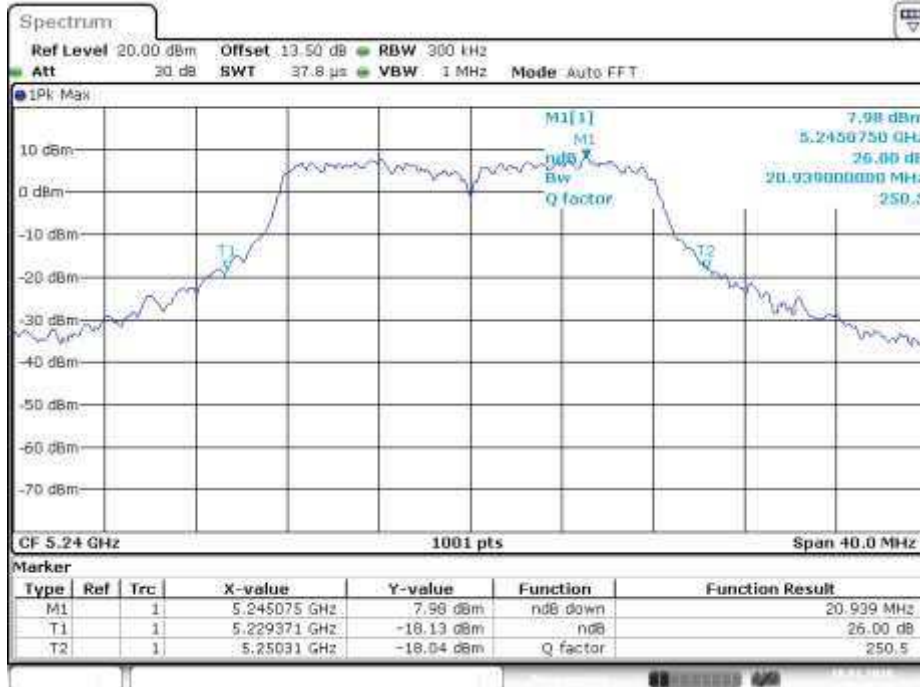
Date: 15.JAN.2020 18:21:52

**802.11a 5240MHz**
**Ant 1**


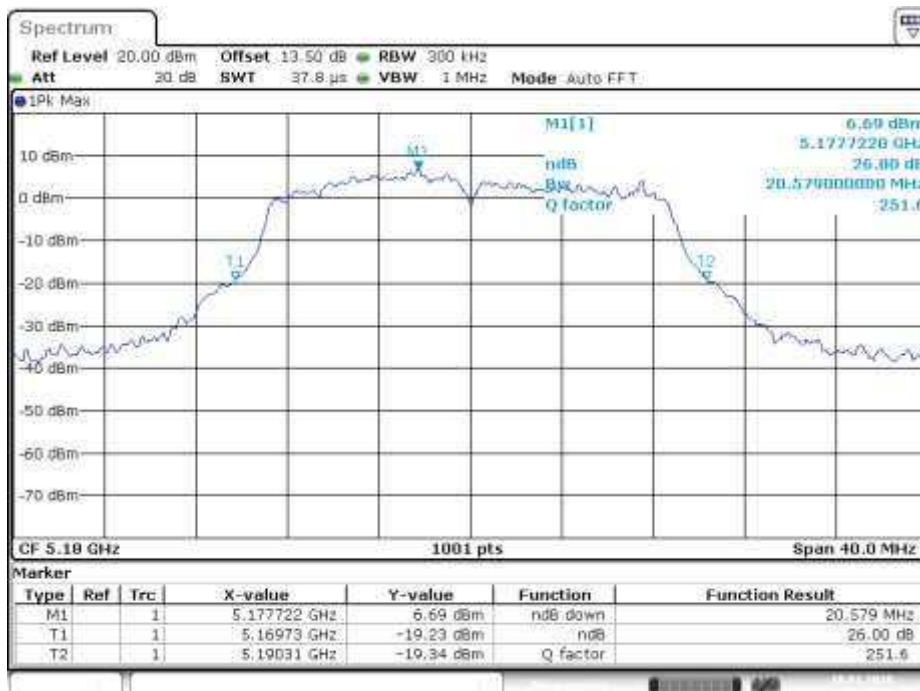
Date: 10.JAN.2020 18:36:32

**Ant 2**


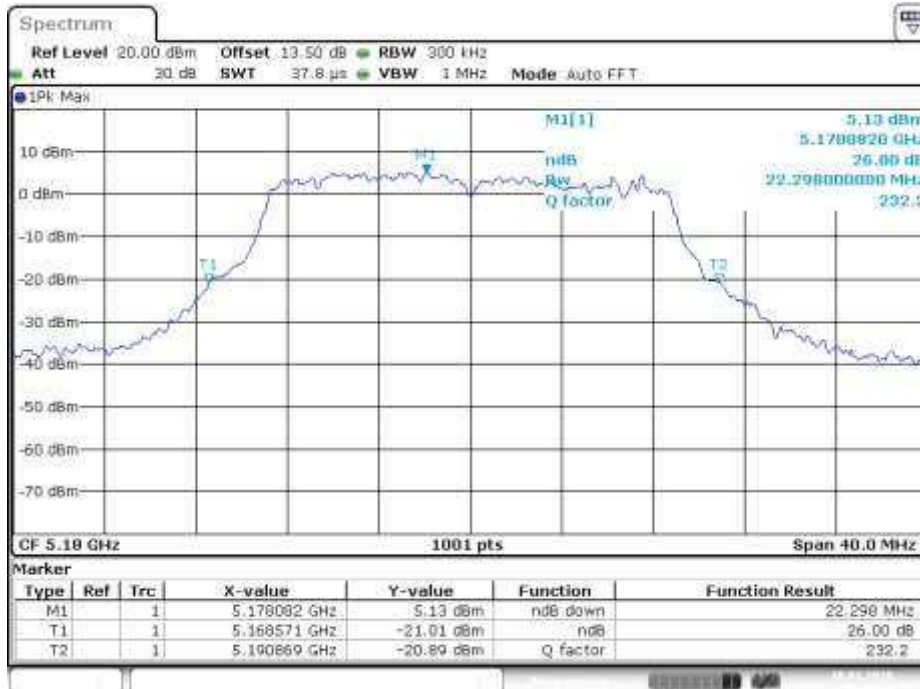
Date: 10.JAN.2020 18:37:25

**Ant 3**


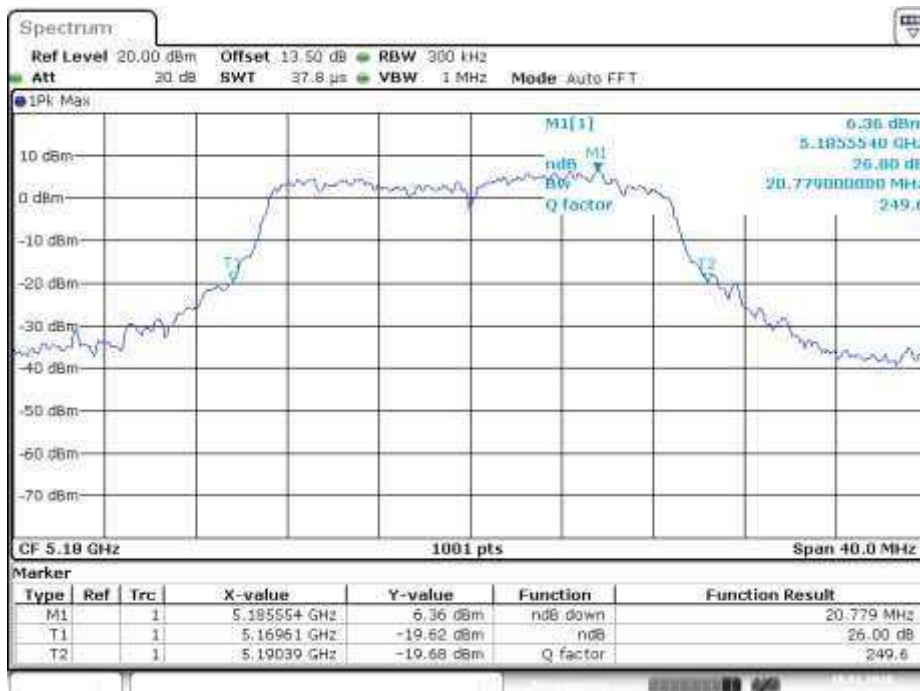
Date: 10.JAN.2020 18:38:17

**802.11n HT20 5180MHz**
**Ant 1**


Date: 10.JAN.2020 18:47:16

**Ant 2**


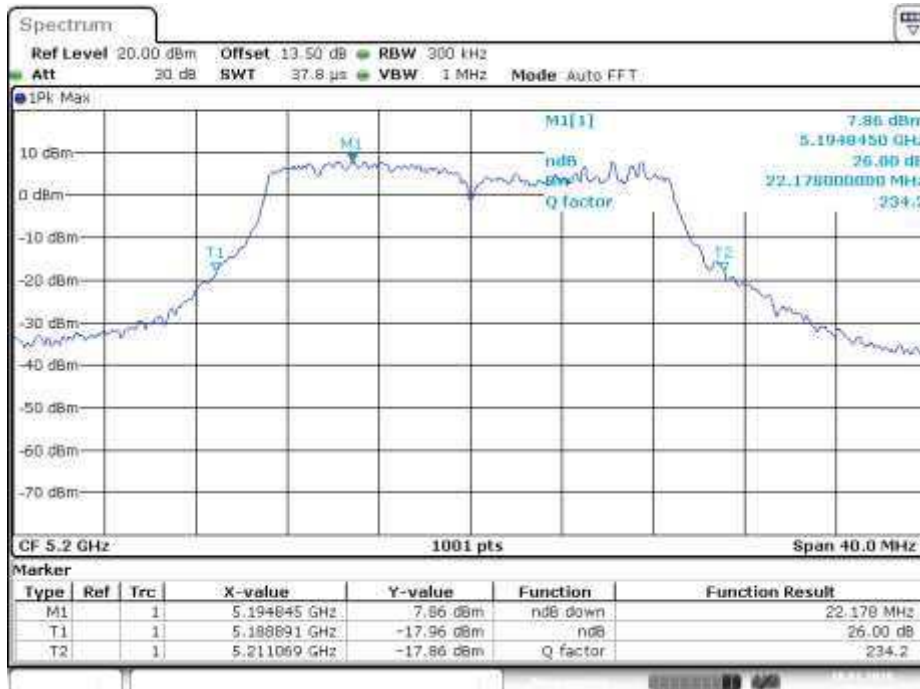
Date: 10.JAN.2020 18:49:02

**Ant 3**


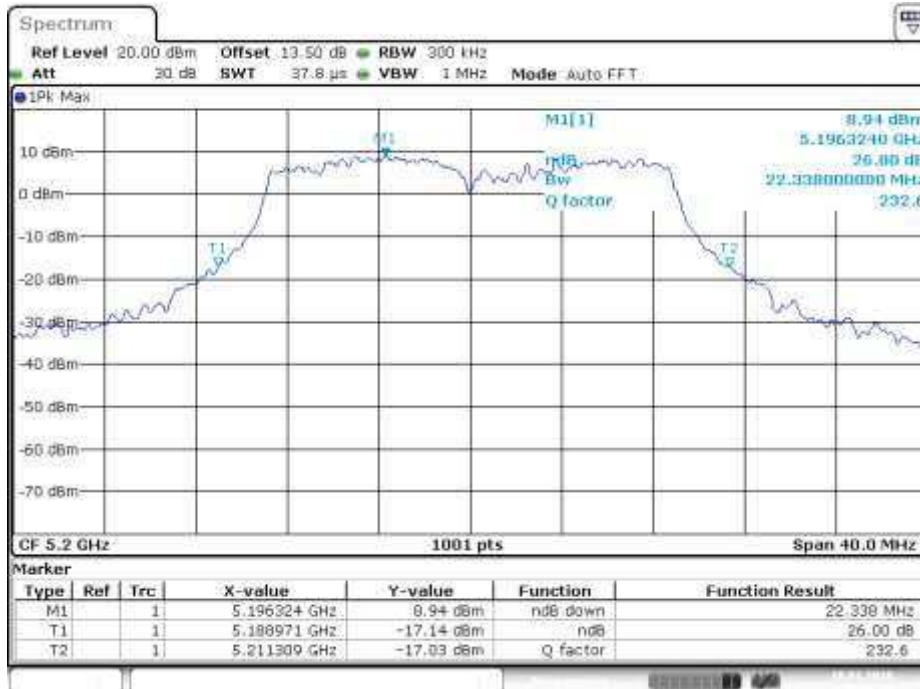
Date: 10.JAN.2020 18:49:54

**802.11n HT20 5200MHz**
**Ant 1**

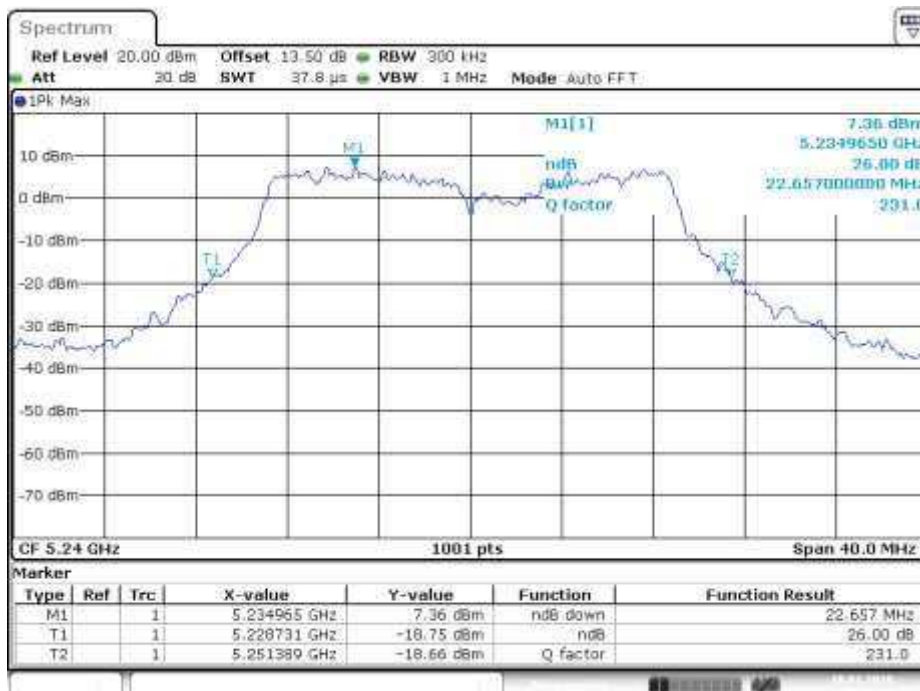

Date: 10.JAN.2020 18:53:09

**Ant 2**


Date: 10.JAN.2020 18:52:07

**Ant 3**


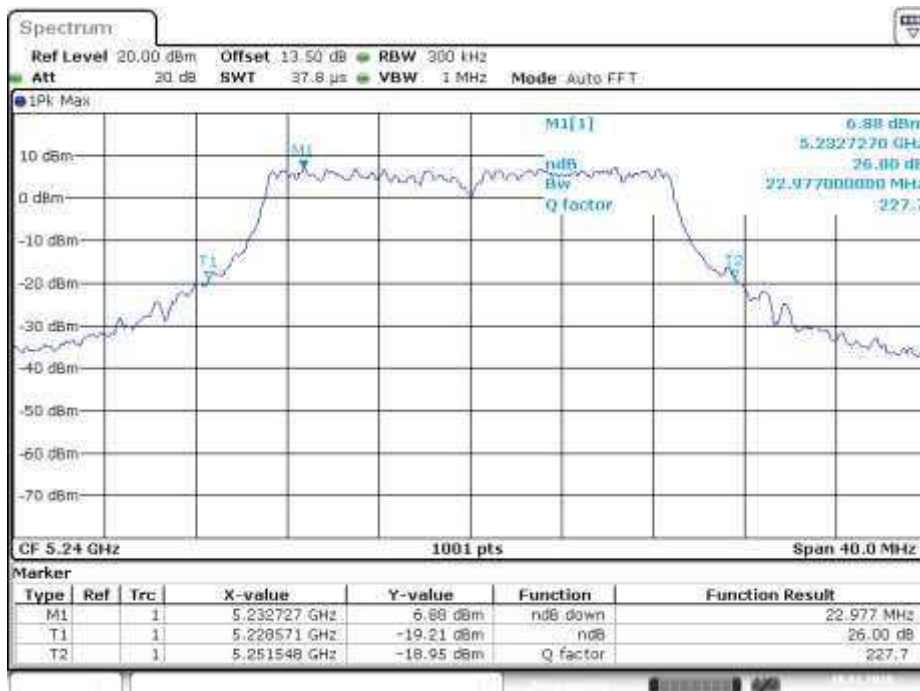
Date: 10.JAN.2020 18:51:17

**802.11a 5240MHz**
**Ant 1**


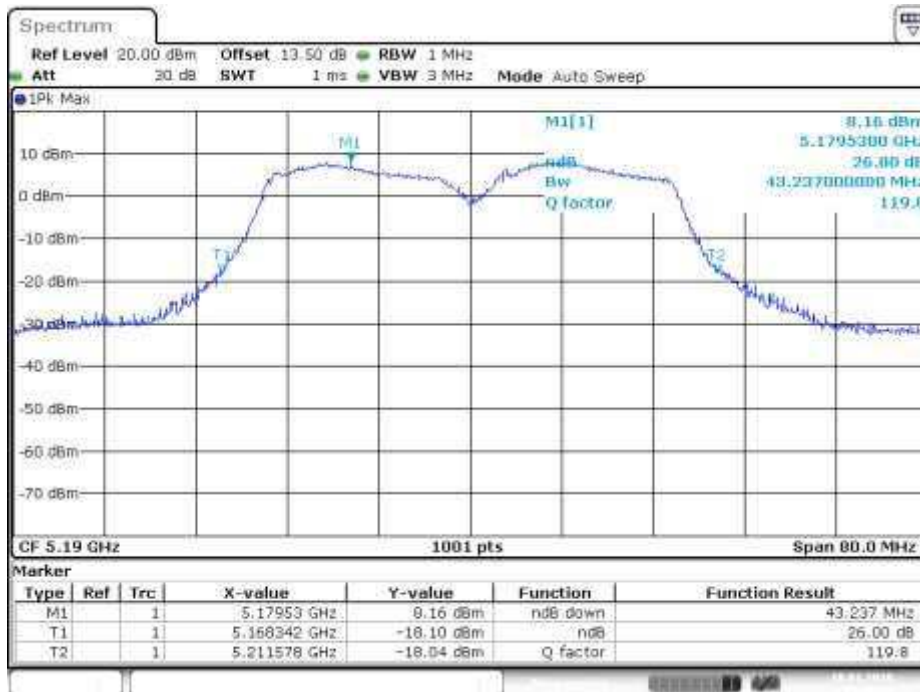
Date: 10.JAN.2020 18:54:40

**Ant 2**

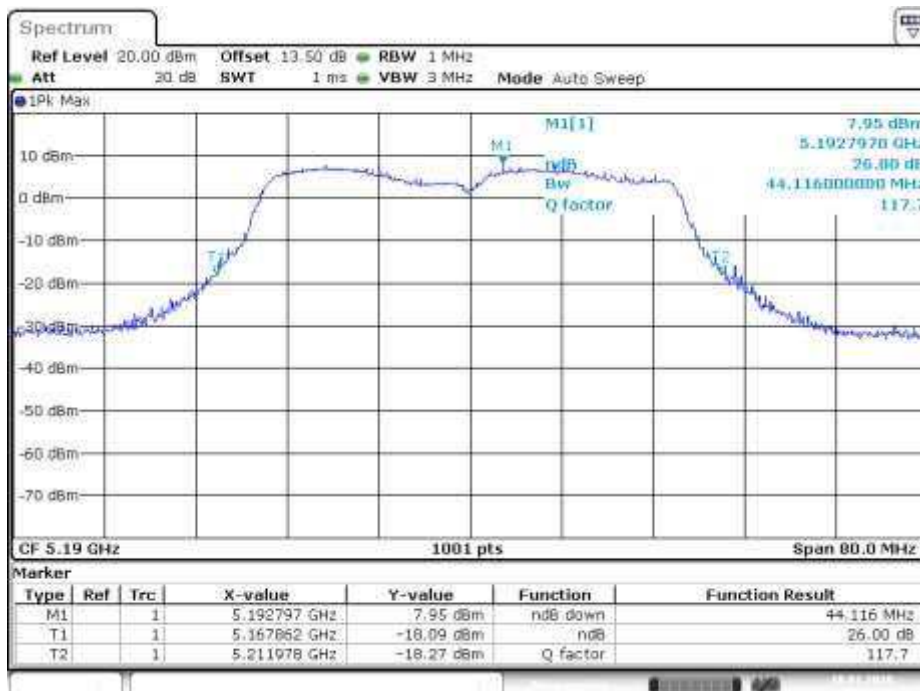

Date: 10.JAN.2020 18:55:54

**Ant 3**


Date: 10.JAN.2020 18:57:22

**802.11n HT40 5190MHz**
**Ant 1**


Date: 10.JAN.2020 19:00:21

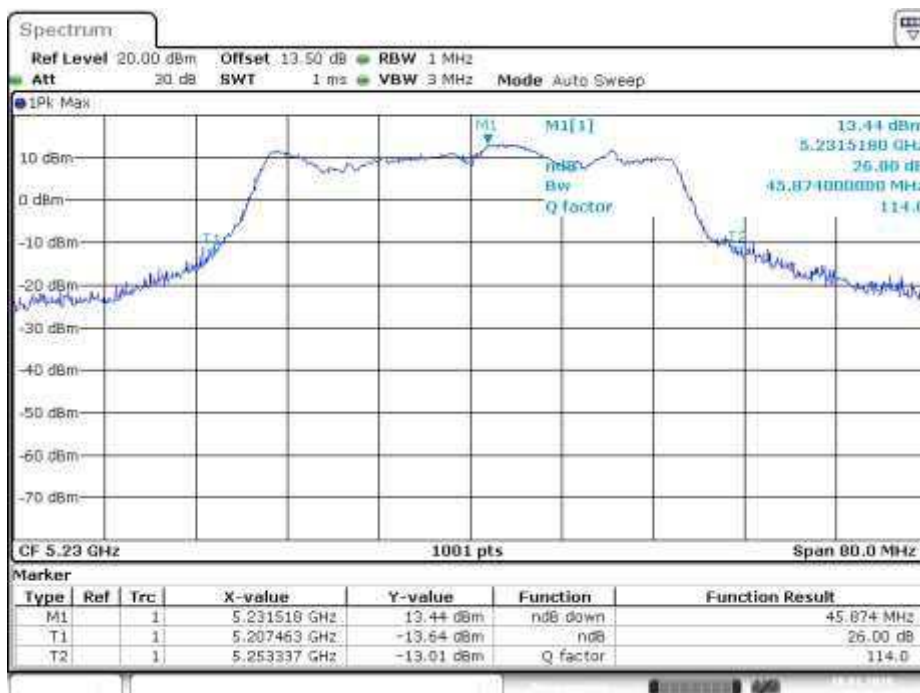
**Ant 2**


Date: 10.JAN.2020 19:01:14



**Ant 3**

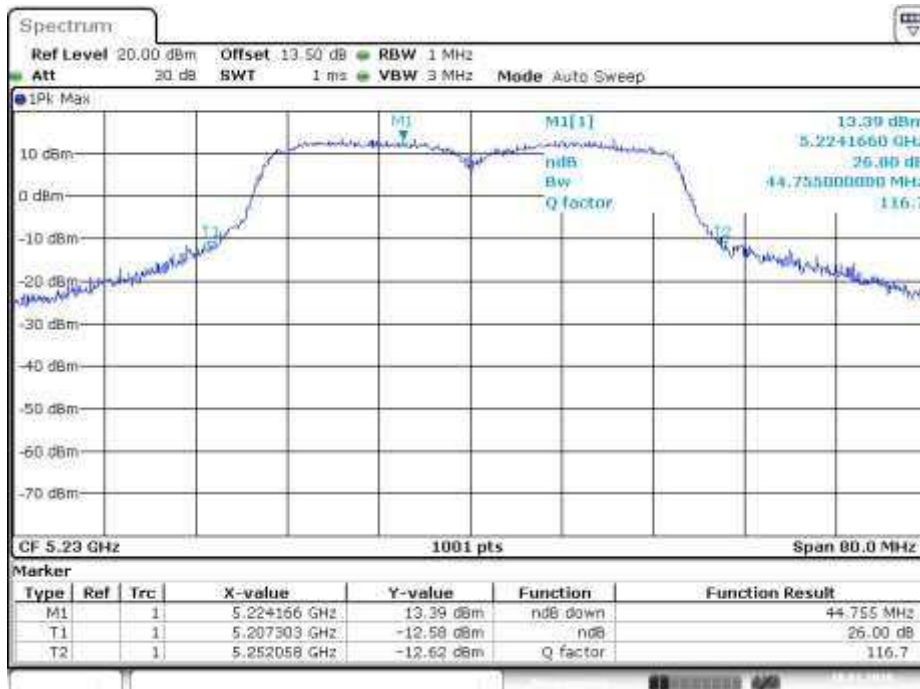

Date: 10.JAN.2020 19:02:08

**802.11n HT40 5230MHz**
**Ant 1**


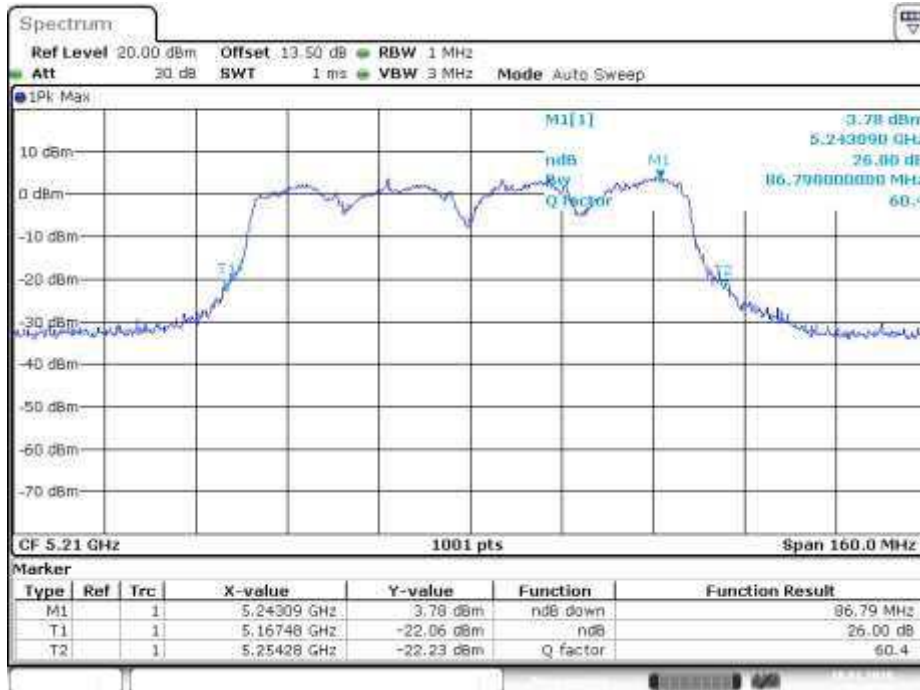
Date: 10.JAN.2020 19:06:00

**Ant 2**

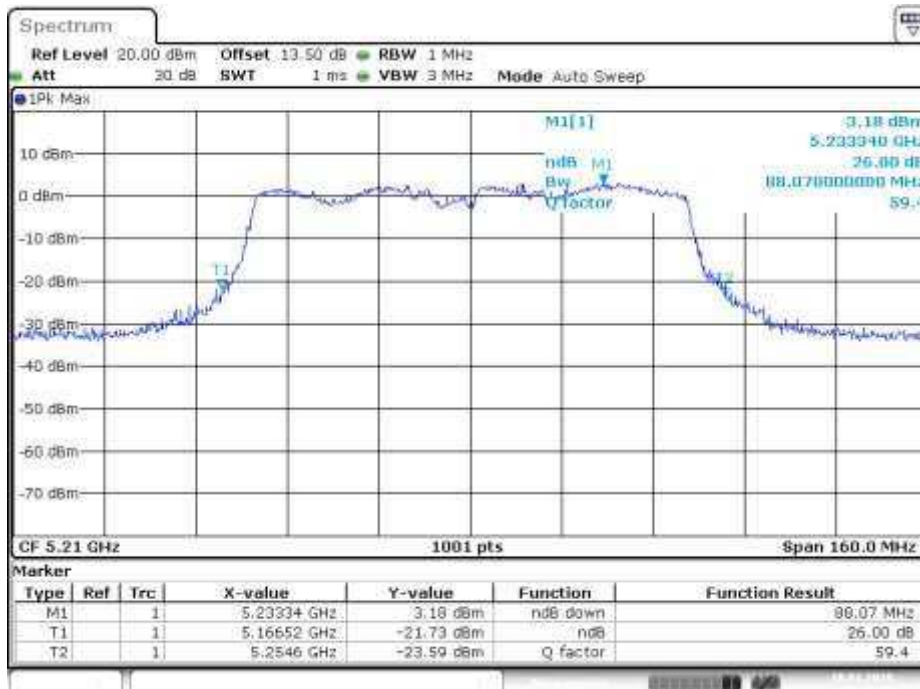

Date: 10.JAN.2020 19:04:47

**Ant 3**


Date: 10.JAN.2020 19:03:16

**802.11ac VHT80 5210MHz**
**Ant 1**


Date: 10.JAN.2020 18:17:56

**Ant 2**


Date: 10.JAN.2020 18:21:56

**Ant 3**


Date: 10.JAN.2020 18:22:59

### 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

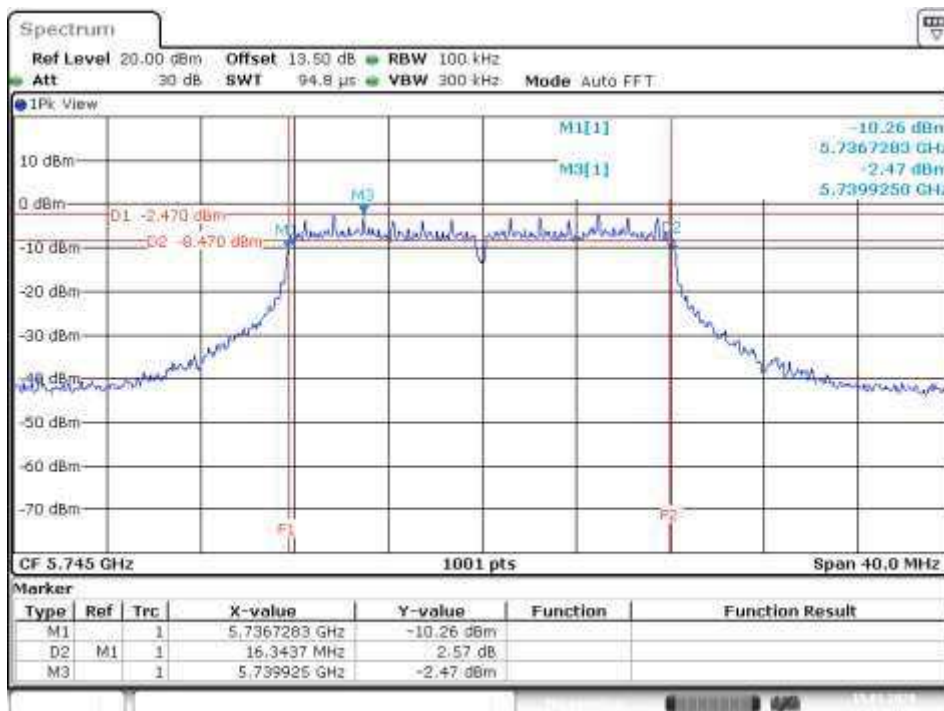
**Test setup**

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

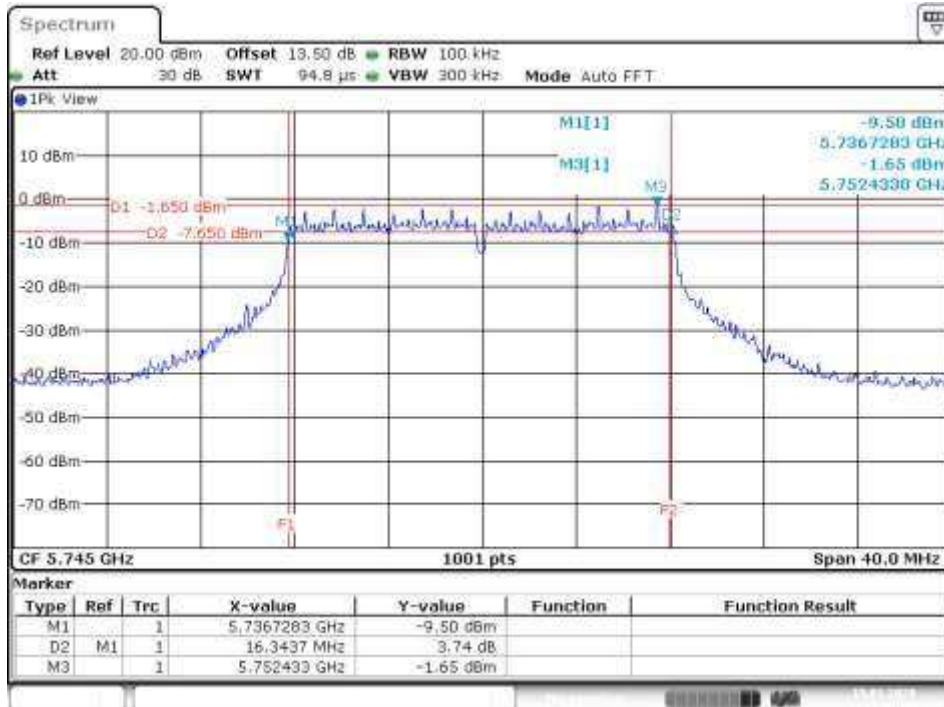
**Table 11: Test result of 6dB Bandwidth**

Mode	Channel Frequency (MHz)	6dB Bandwidth (MHz)			6dB Bandwidth Limit (kHz)	Result
		Ant 1	Ant 2	Ant 3		
802.11a	5745	16.34	16.34	16.34	>500	Pass
	5785	16.46	16.50	16.46	>500	Pass
	5825	16.42	16.46	16.46	>500	Pass
802.11n HT20	5745	17.70	17.70	17.70	>500	Pass
	5785	17.82	17.94	17.82	>500	Pass
	5825	17.78	17.74	17.66	>500	Pass
802.11n HT40	5755	36.36	36.36	36.44	>500	Pass
	5795	36.28	36.36	36.34	>500	Pass
802.11ac VHT80	5775	75.92	74.97	75.60	>500	Pass

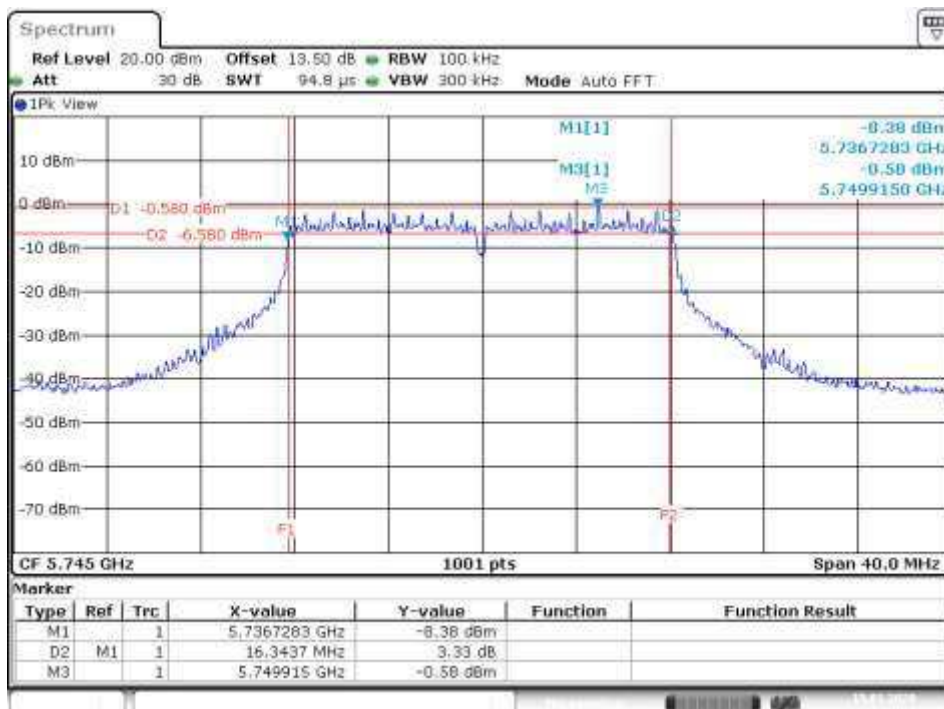
## Test Plot of 6dB Bandwidth

**802.11a**
**5745MHz**
**Ant 1**


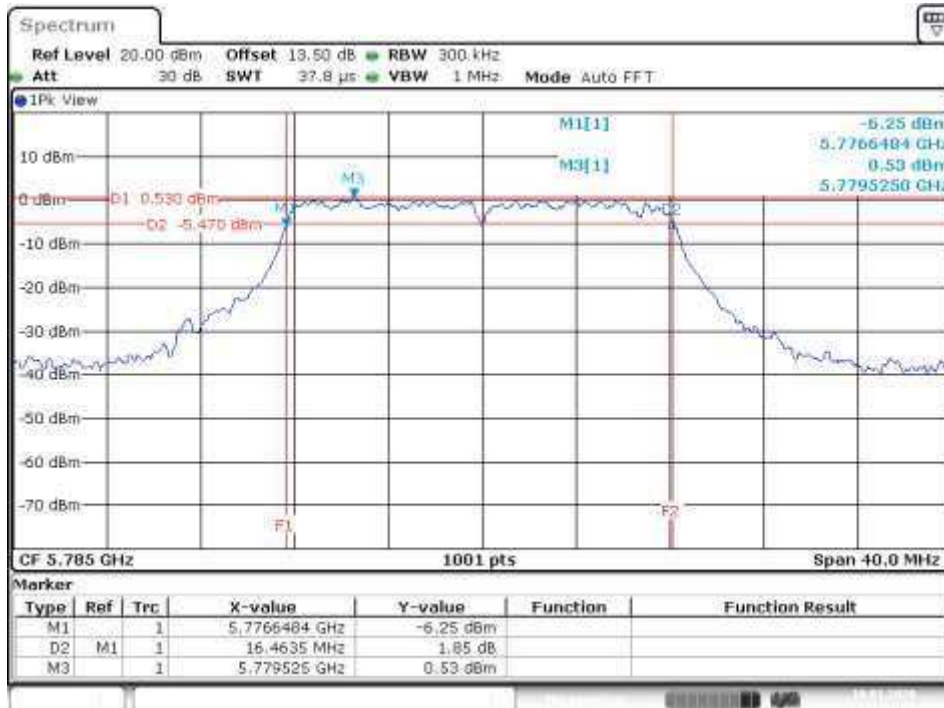
Date: 15.JAN.2020 18:43:50

**Ant 2**


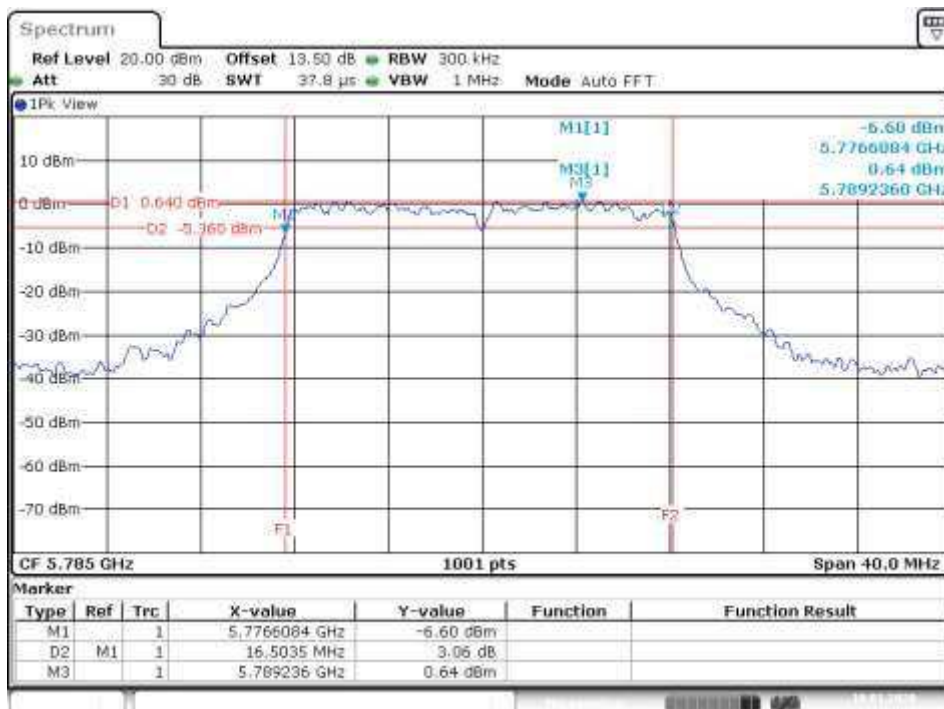
Date: 15.JAN.2020 18:45:02

**Ant 3**


Date: 15.JAN.2020 18:47:01

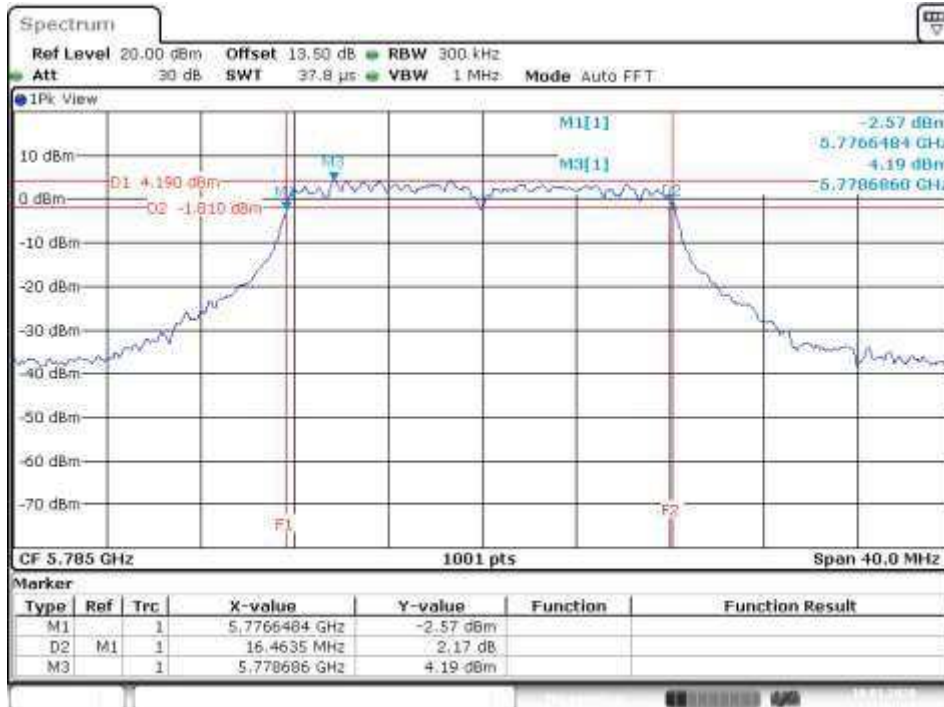
**5785MHz**
**Ant 1**


Date: 10.JAN.2020 22:51:53

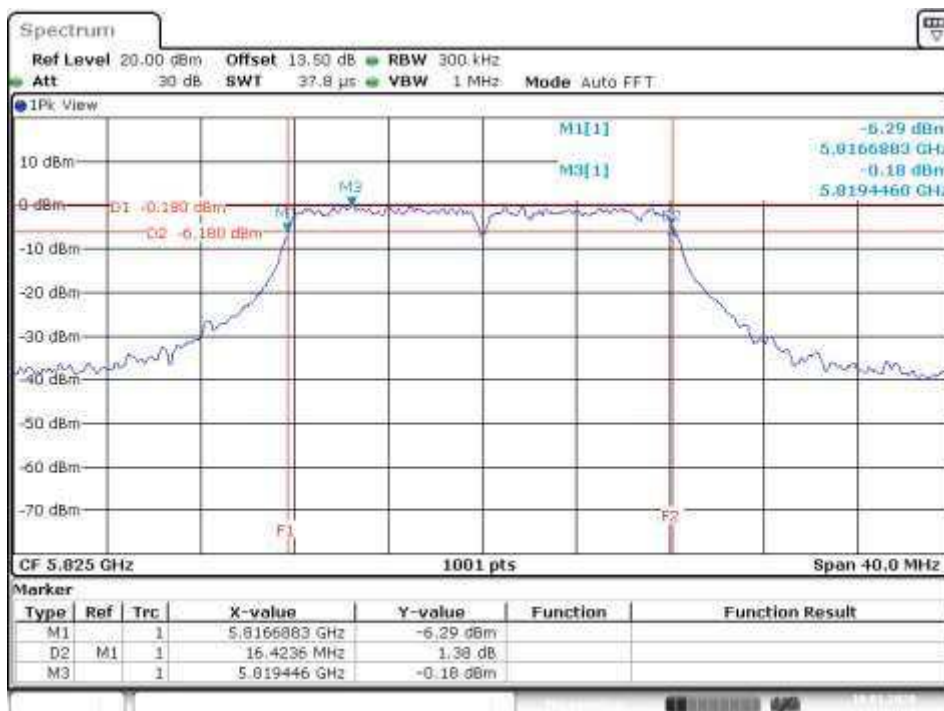
**Ant 2**


Date: 10.JAN.2020 22:53:10

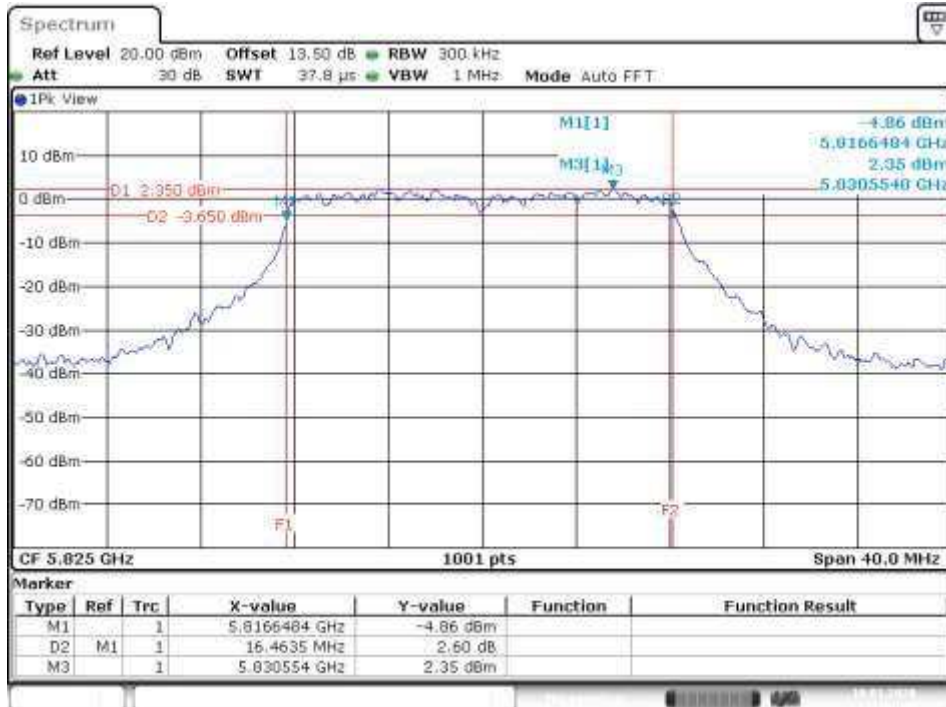


**Ant 3**


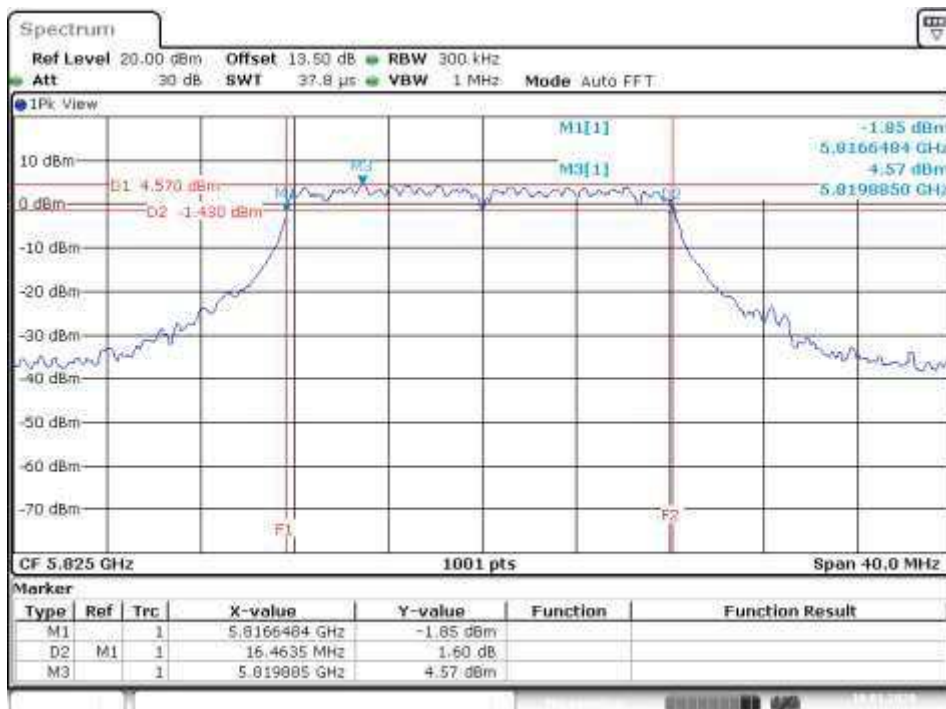
Date: 10.JAN.2020 22:54:32

**5825MHz**
**Ant 1**


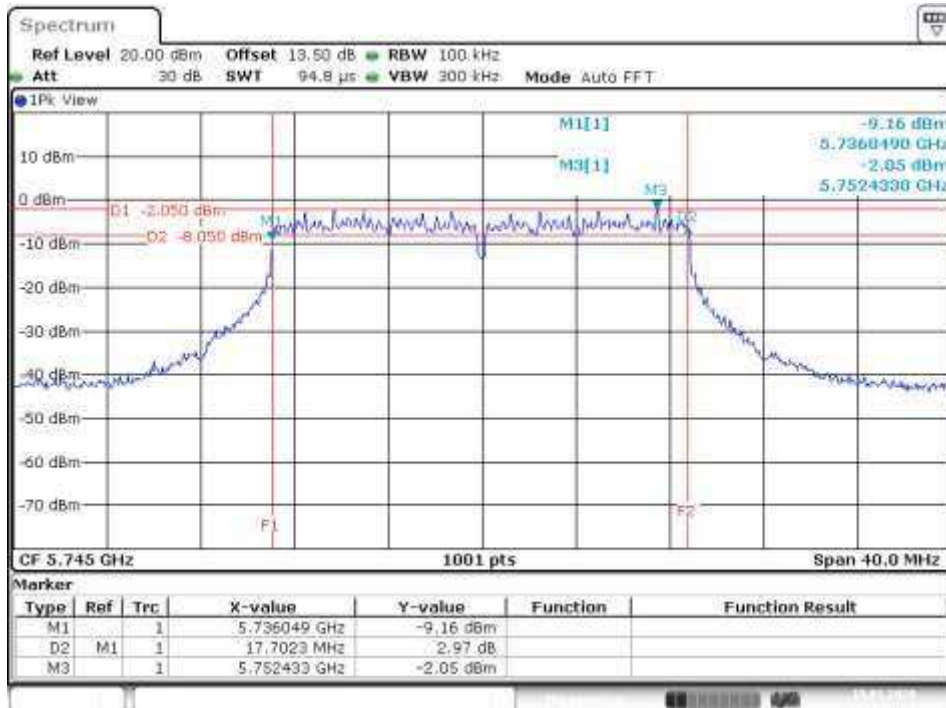
Date: 10.JAN.2020 22:56:23

**Ant 2**


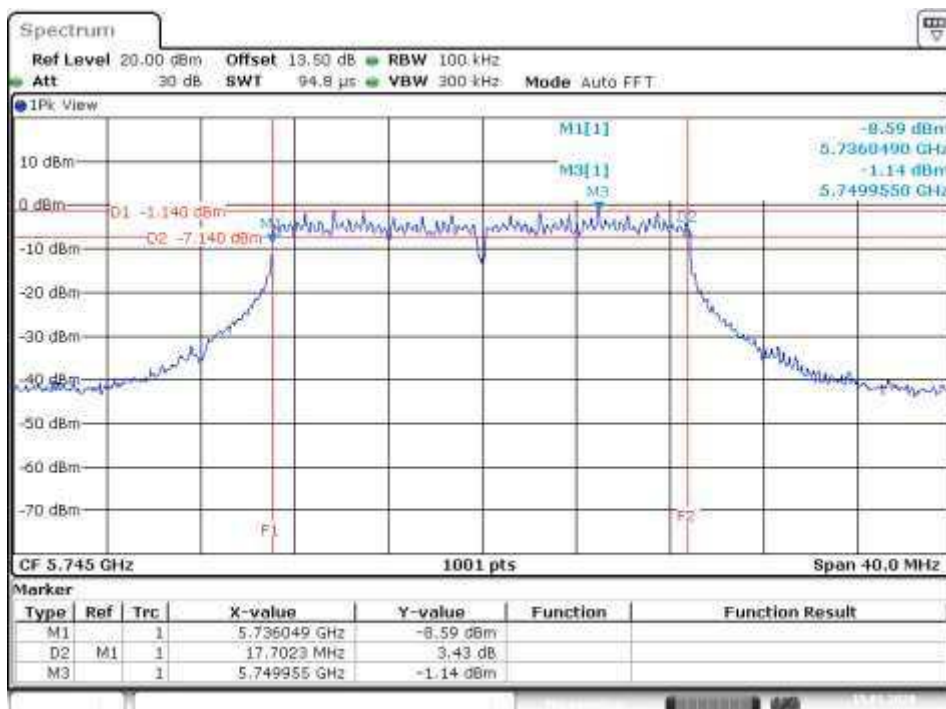
Date: 10.JAN.2020 22:57:46

**Ant 3**


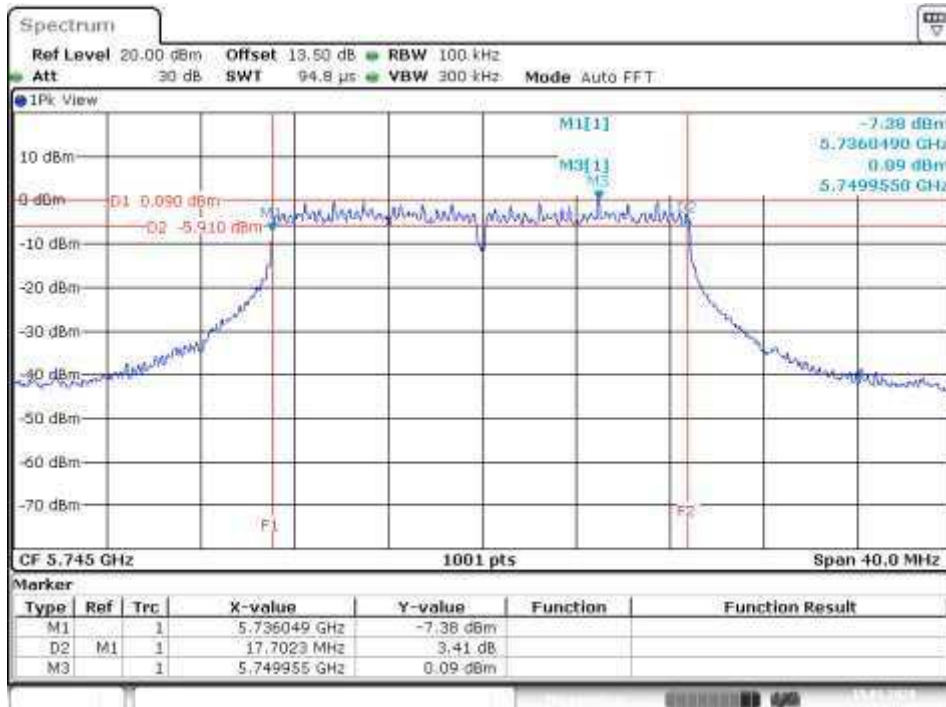
Date: 10.JAN.2020 22:59:12

**802.11n HT20**  
**5745MHz**  
**Ant 1**


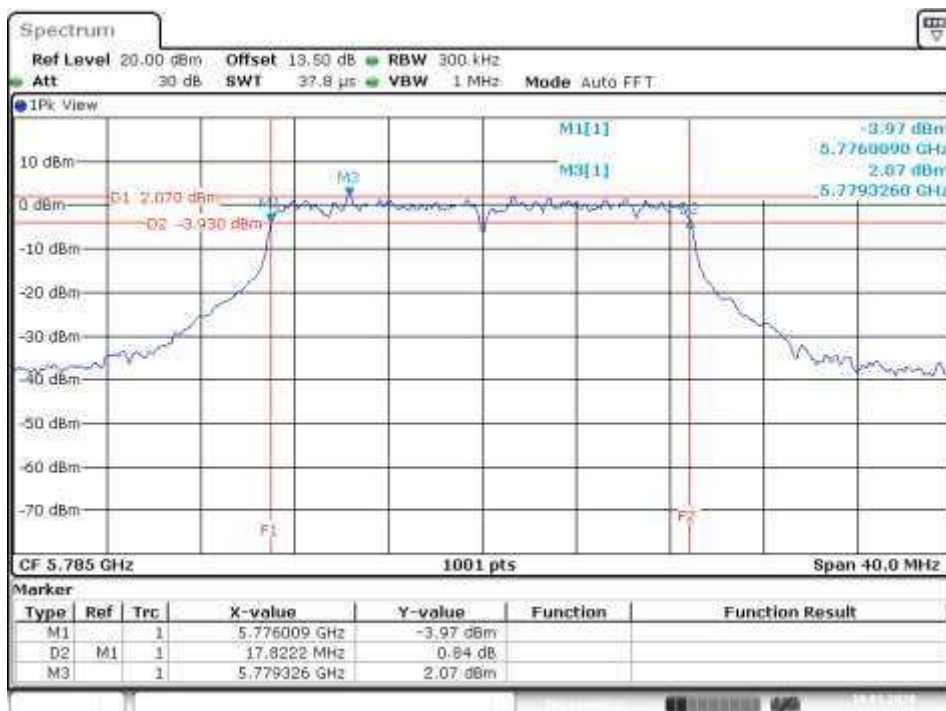
Date: 15.JAN.2020 18:52:37

**Ant 2**


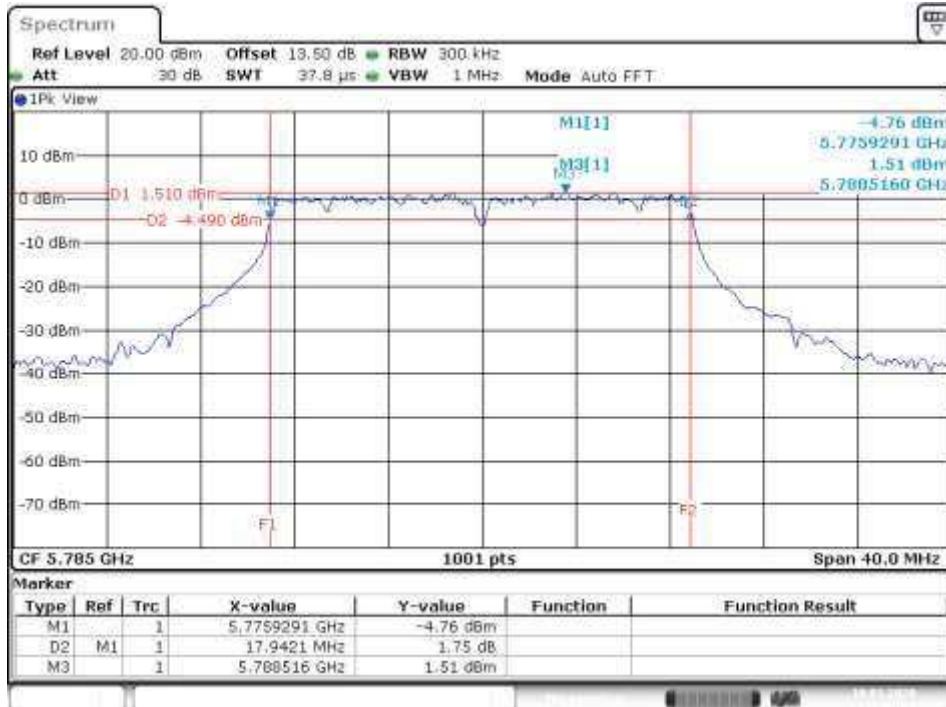
Date: 15.JAN.2020 18:54:00

**Ant 3**


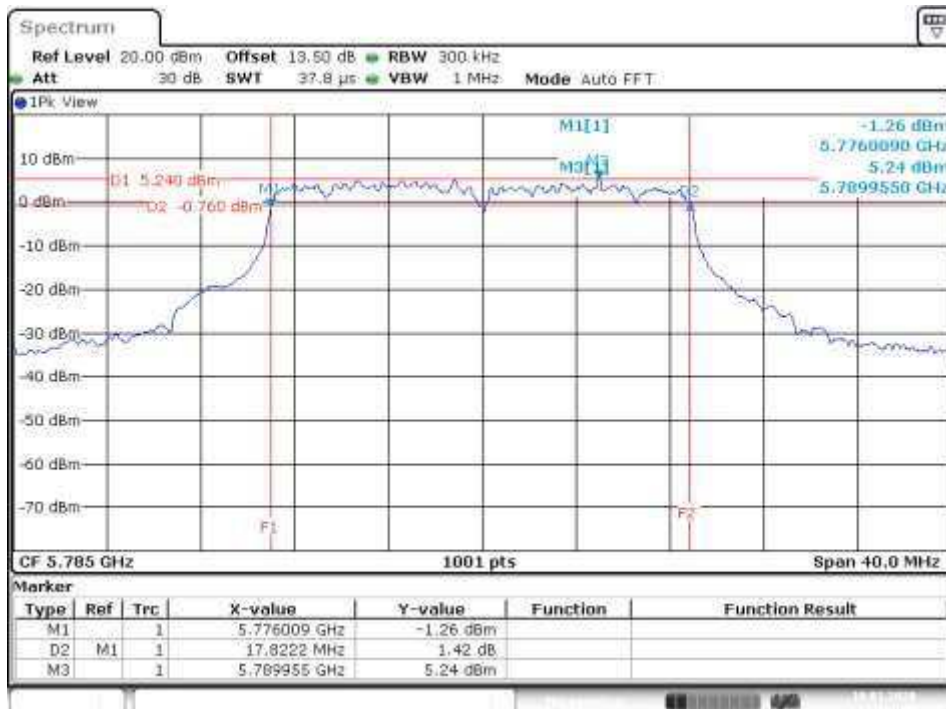
Date: 15.JAN.2020 18:55:42

**5785MHz**
**Ant 1**


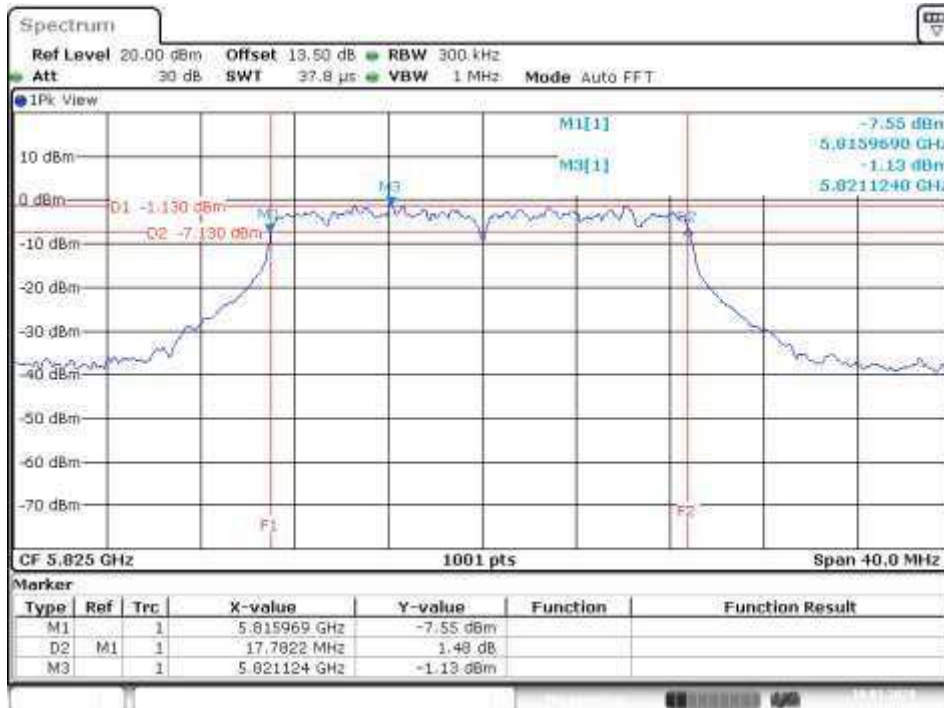
Date: 10.JAN.2020 23:08:15

**Ant 2**


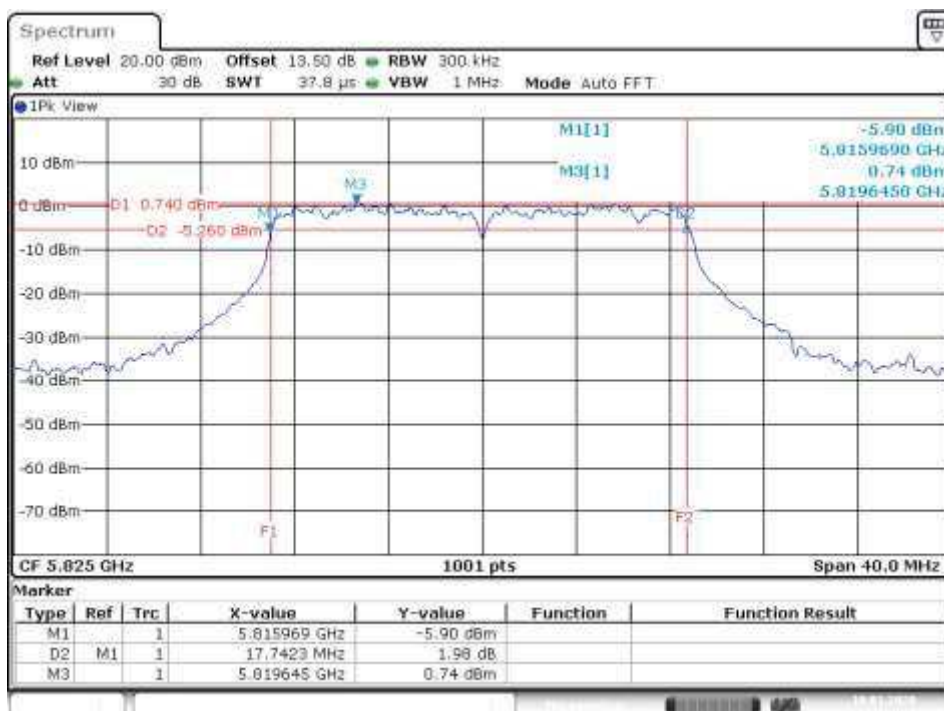
Date: 10.JAN.2020 23:09:41

**Ant 3**


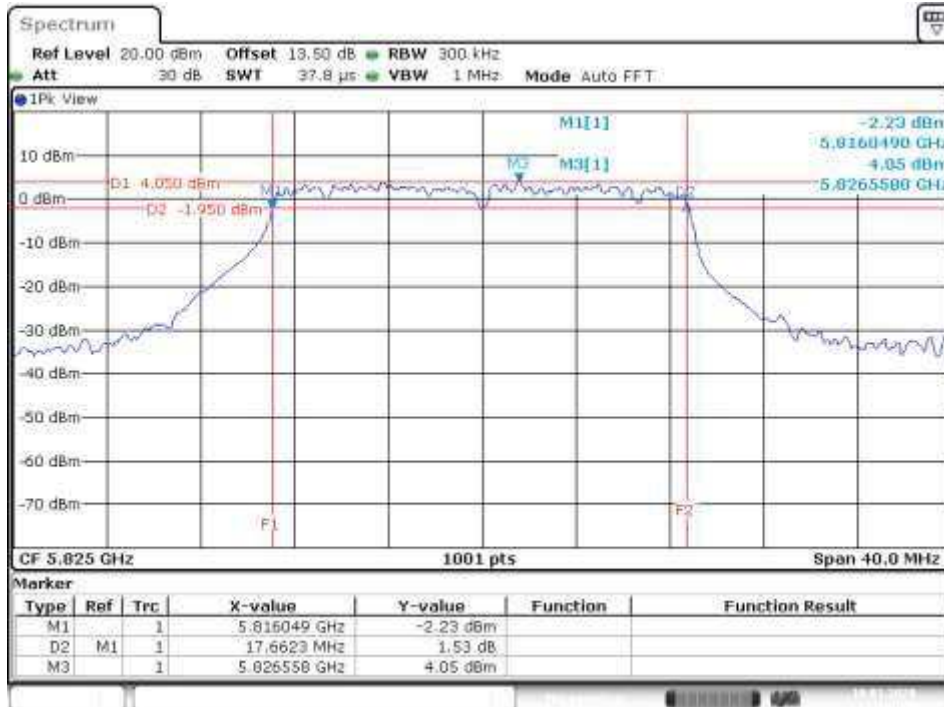
Date: 10.JAN.2020 23:11:30

**5825MHz**
**Ant 1**


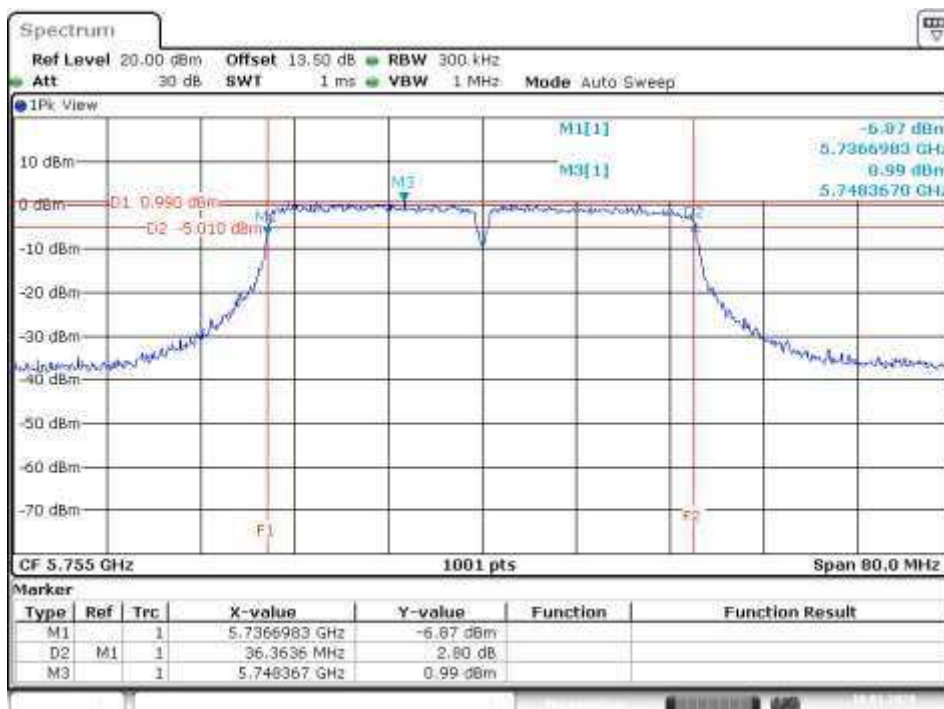
Date: 10.JAN.2020 23:15:06

**Ant 2**


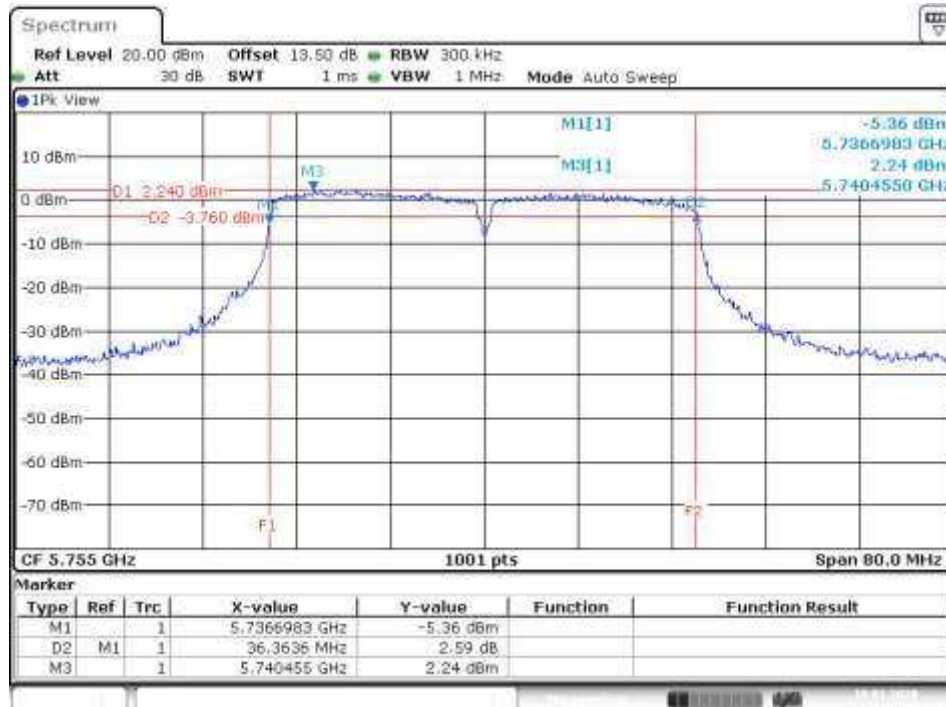
Date: 10.JAN.2020 23:16:37

**Ant 3**


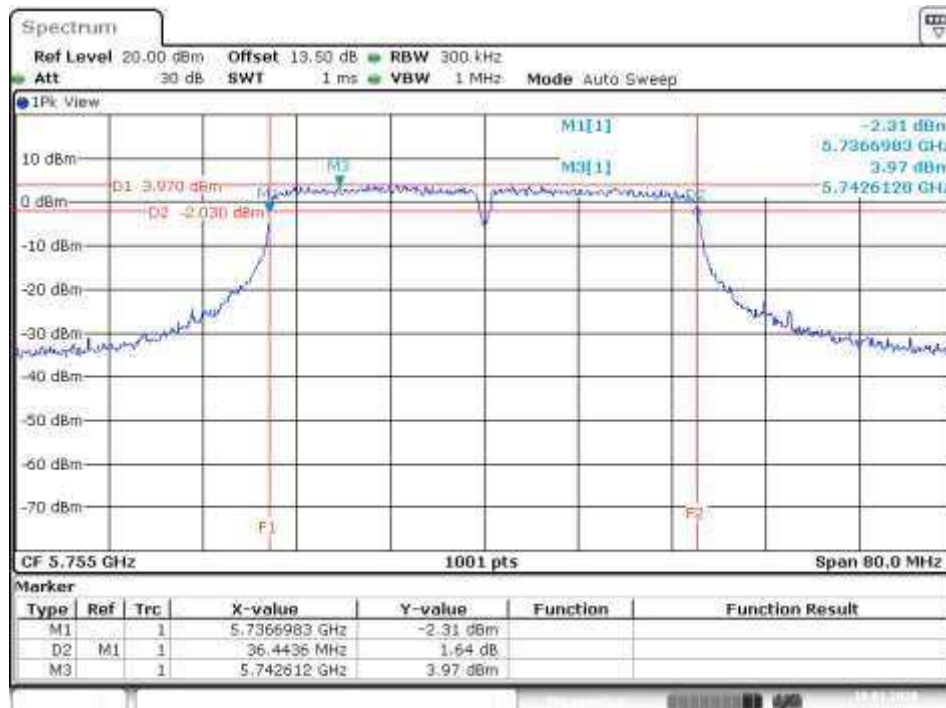
Date: 10.JAN.2020 23:18:59

**802.11n HT40**
**5755MHz**
**Ant 1**


Date: 10.JAN.2020 21:12:27

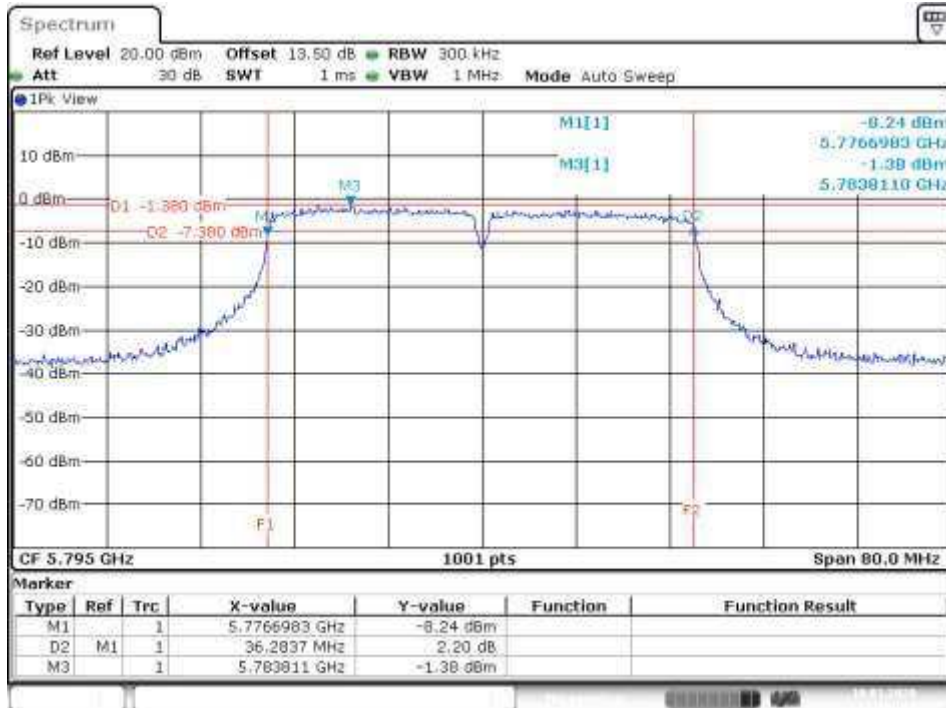
**Ant 2**


Date: 10.JAN.2020 21:14:09

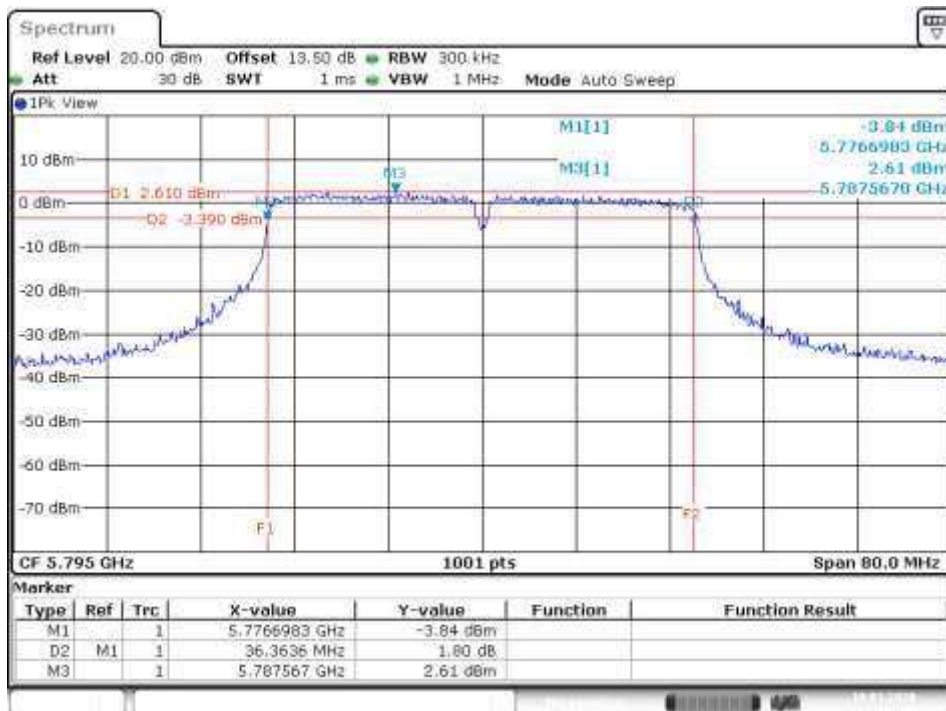
**Ant 3**


Date: 10.JAN.2020 21:16:30

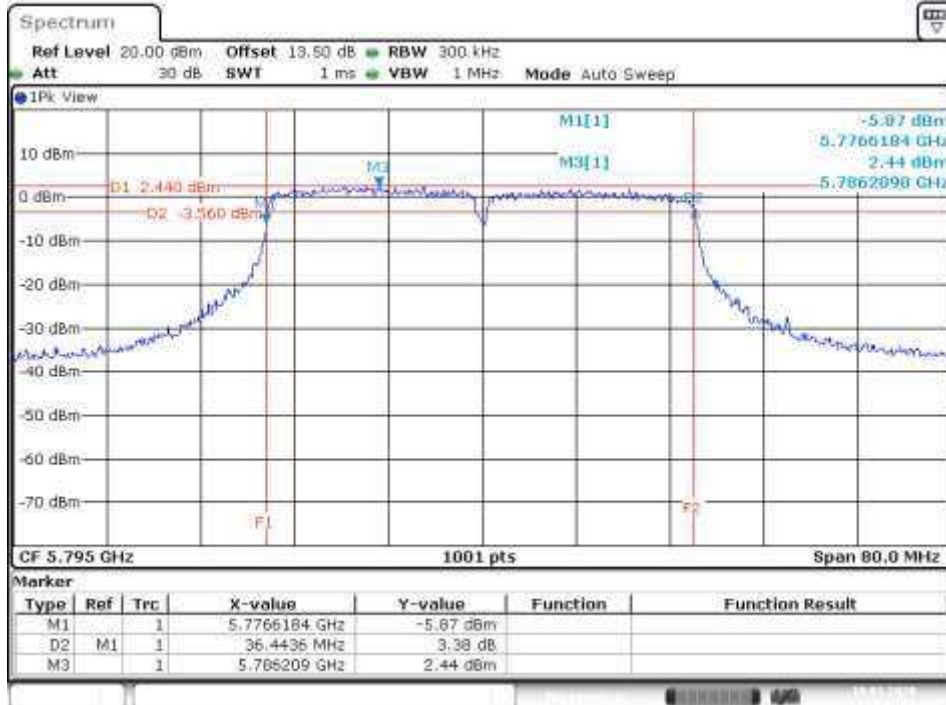


**5795MHz**
**Ant 1**


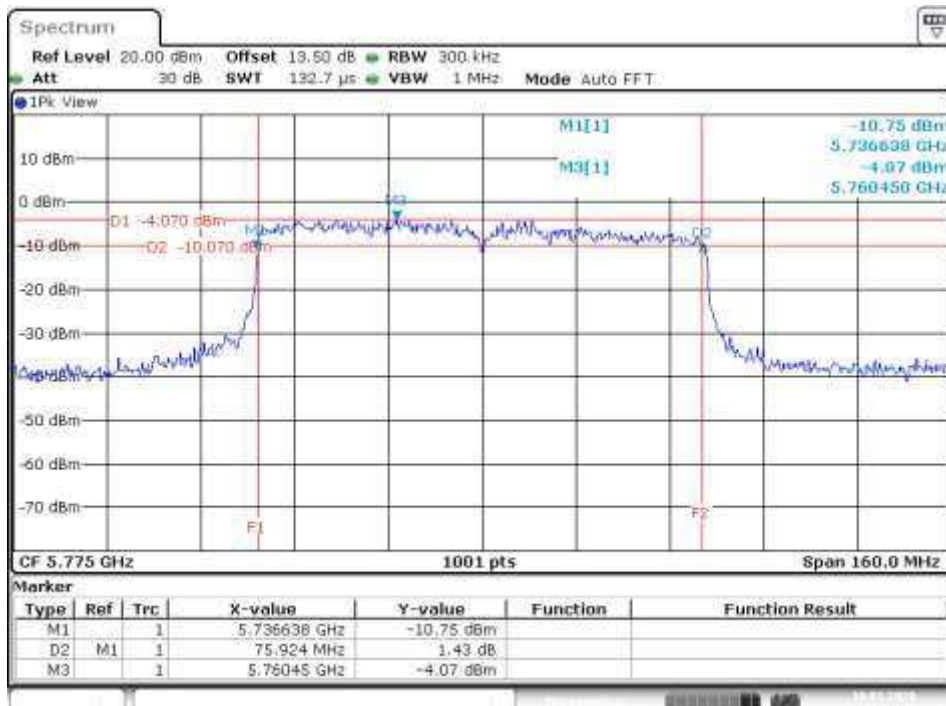
Date: 10.JAN.2020 22:33:34

**Ant 2**


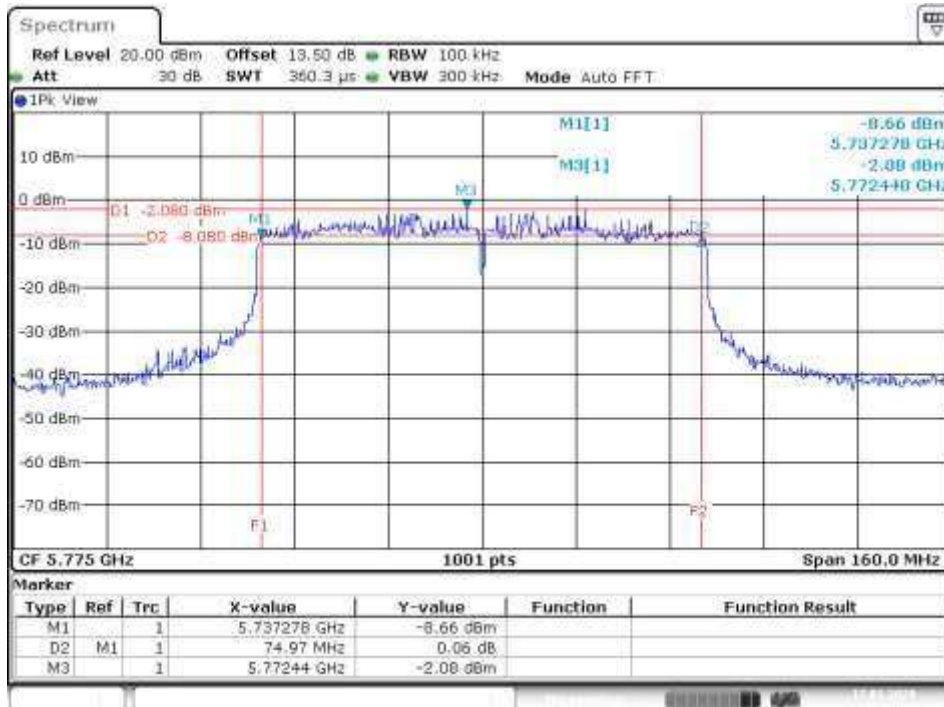
Date: 10.JAN.2020 22:39:43

**Ant 3**


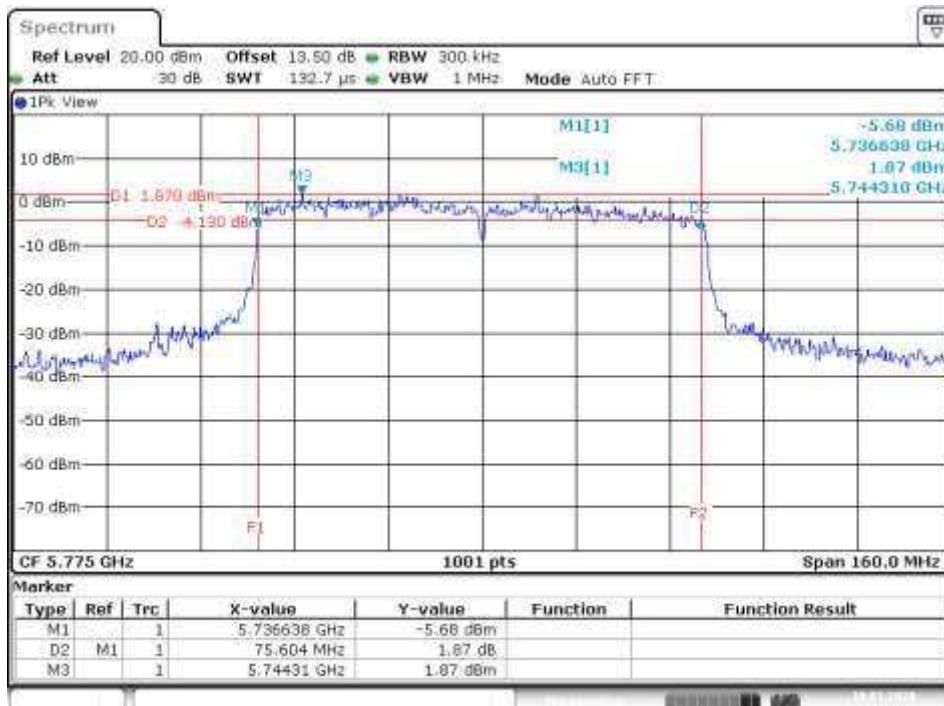
Date: 10.JAN.2020 22:43:53

**802.11ac VHT80**
**5755MHz**
**Ant 1**


Date: 10.JAN.2020 22:02:45

**Ant 2**


Date: 17.JAN.2020 00:37:07

**Ant 3**


Date: 10.JAN.2020 21:26:29

## 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**

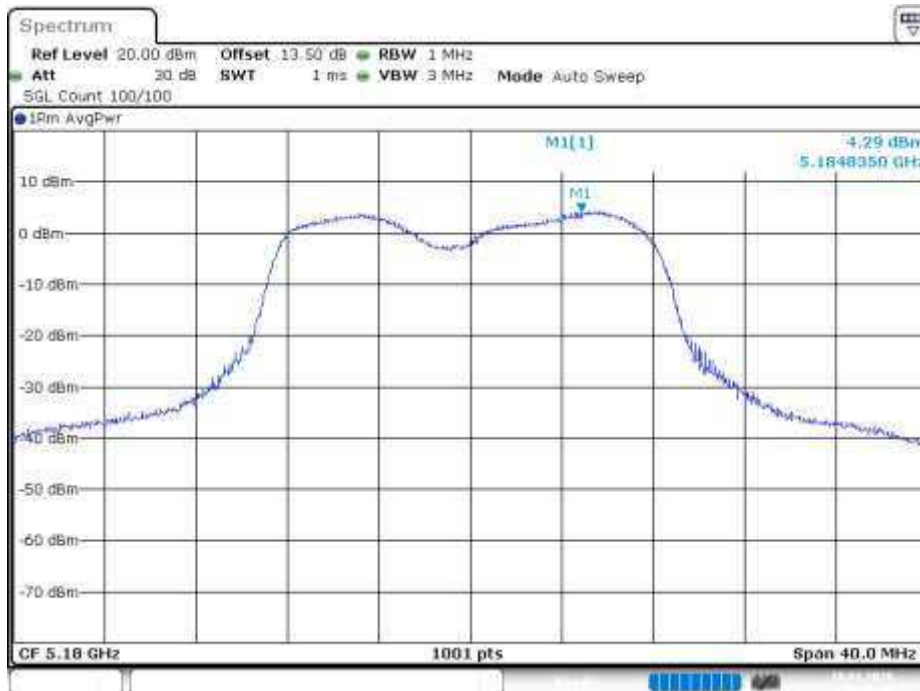
Mode	Channel Frequency (MHz)	Conducted Power Density (dBm/MHz)				Power Density Limit (dBm/MHz)
		Ant 1	Ant 2	Ant 3	Total	
802.11a	5180	4.29	3.87	3.98	8.92	14.10
	5200	5.93	5.87	5.27	10.57	14.10
	5240	6.38	4.66	6.06	10.63	14.10
802.11n HT20	5180	3.85	3.28	4.01	8.56	14.10
	5200	6.51	6.22	6.96	11.41	14.10
	5240	5.15	4.62	5.27	9.85	14.10
802.11n HT40	5190	-0.55	-1.28	-0.13	4.22	14.10
	5230	4.79	3.57	4.29	9.10	14.10
802.11ac VHT80	5210	-5.05	-6.21	-5.1	-0.57	14.10

Directional gain = 4.13 dBi + 10log(3) = 8.9 dBi > 6 dBi , so the power density limit shall be reduced to 17-(8.9-6) = 14.10 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	-5.64	-4.55	-3.72	0.30	26.29
	5785	-4.3	-4.02	-0.87	2.10	26.29
	5825	-4.77	-3	-0.45	2.50	26.29
802.11n HT20	5745	-5.84	-4.78	-3.27	0.33	26.29
	5785	-4.52	-4.30	-0.54	2.12	26.29
	5825	-7.35	-5.33	-1.69	0.69	26.29
802.11n HT40	5755	-4.91	-3.3	-1.72	1.73	26.29
	5795	-7.31	-3.24	-3	0.73	26.29
802.11ac VHT80	5775	-8.97	-6.15	-4.34	-1.24	26.29

Directional gain = 4.94 dBi + 10log(3) = 9.71 dBi > 6 dBi , so the power density limit shall be reduced to 30-(9.71-6) = 26.29 dBm.

## Test Plot of Power Density

**802.11a 5180MHz**
**Ant 1**


Date: 10. JAN. 2020 18:26:40

**Ant 2**


Date: 10. JAN. 2020 18:27:59

**Ant 3**


Date: 10.JAN.2020 18:29:01

**802.11a 5200MHz**
**Ant 1**


Date: 15.JAN.2020 18:34:20

**Ant 2**


Date: 15.JAN.2020 18:30:45

**Ant 3**


Date: 15.JAN.2020 18:22:33



**802.11a 5240MHz**
**Ant 1**

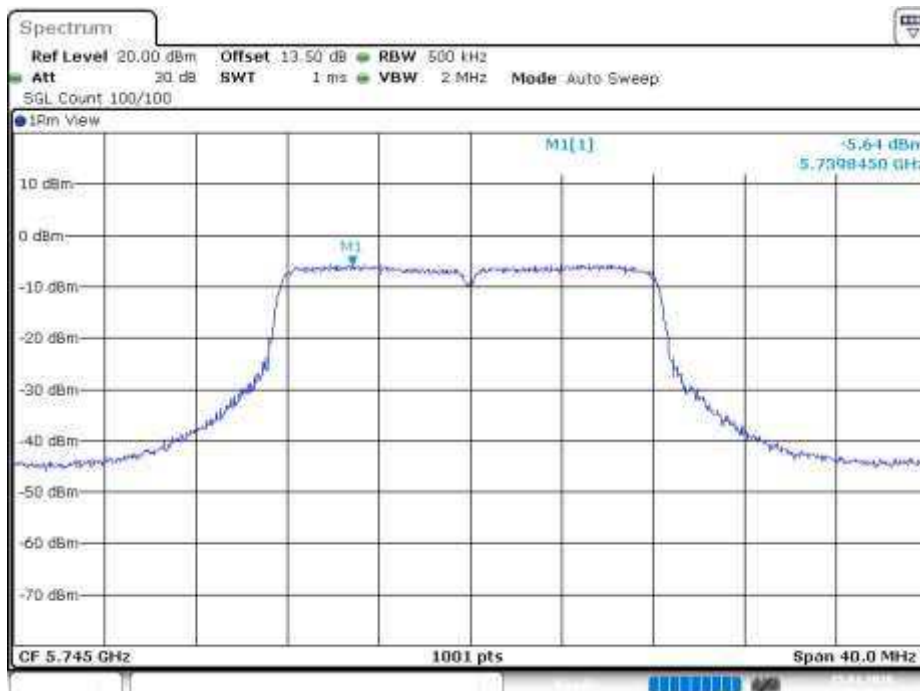

Date: 10.JAN.2020 18:37:07

**Ant 2**

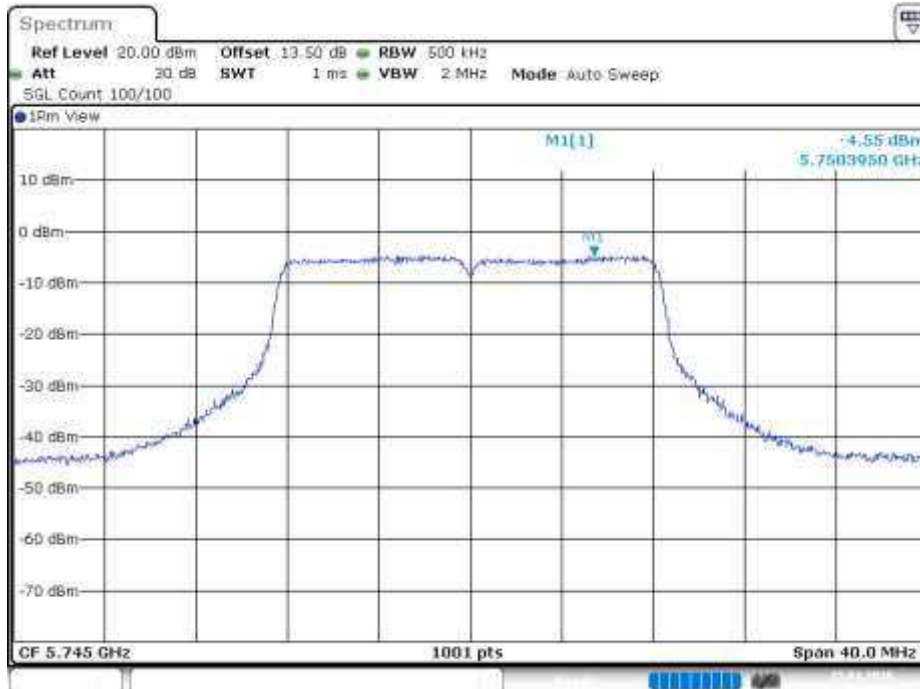

Date: 10.JAN.2020 18:37:59

**Ant 3**


Date: 10.JAN.2020 18:38:50

**802.11a 5745MHz**
**Ant 1**


Date: 15.JAN.2020 18:44:29

**Ant 2**


Date: 15.JAN.2020 18:45:53

**Ant 3**

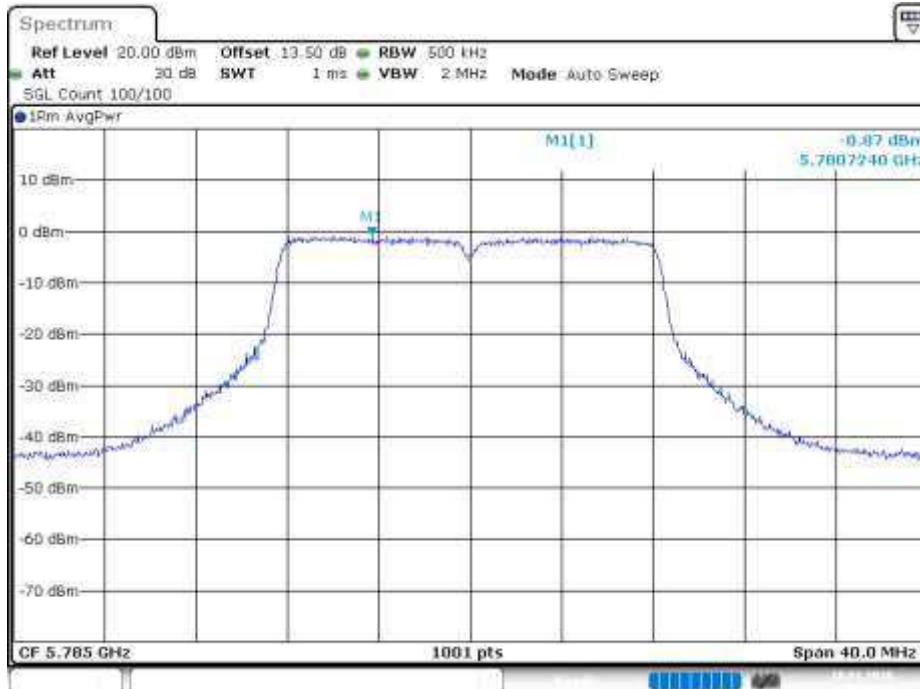

Date: 15.JAN.2020 18:47:55

**802.11a 5785MHz**
**Ant 1**

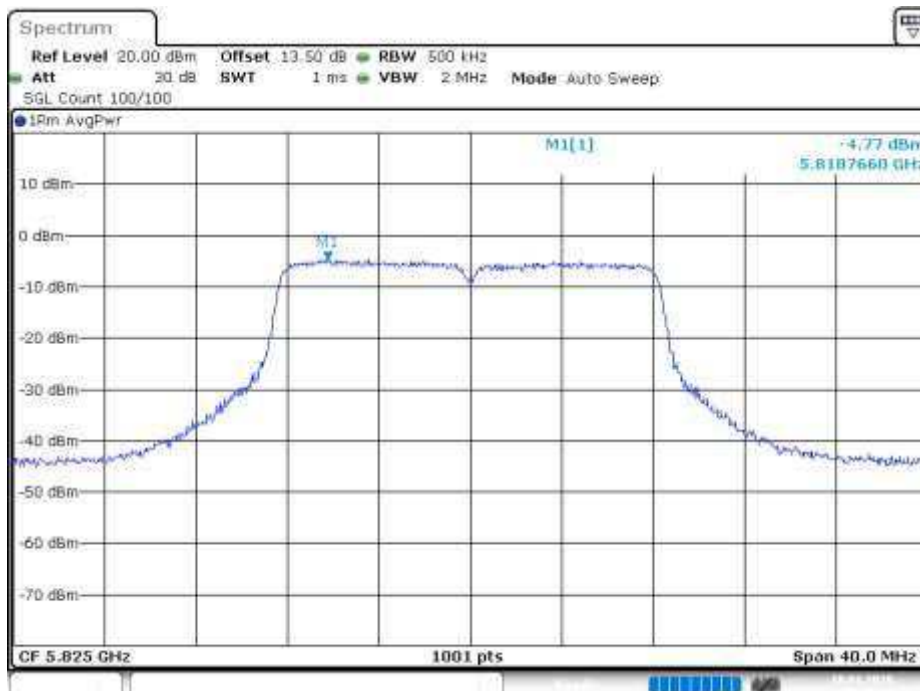

Date: 10.JAN.2020 22:52:38

**Ant 2**

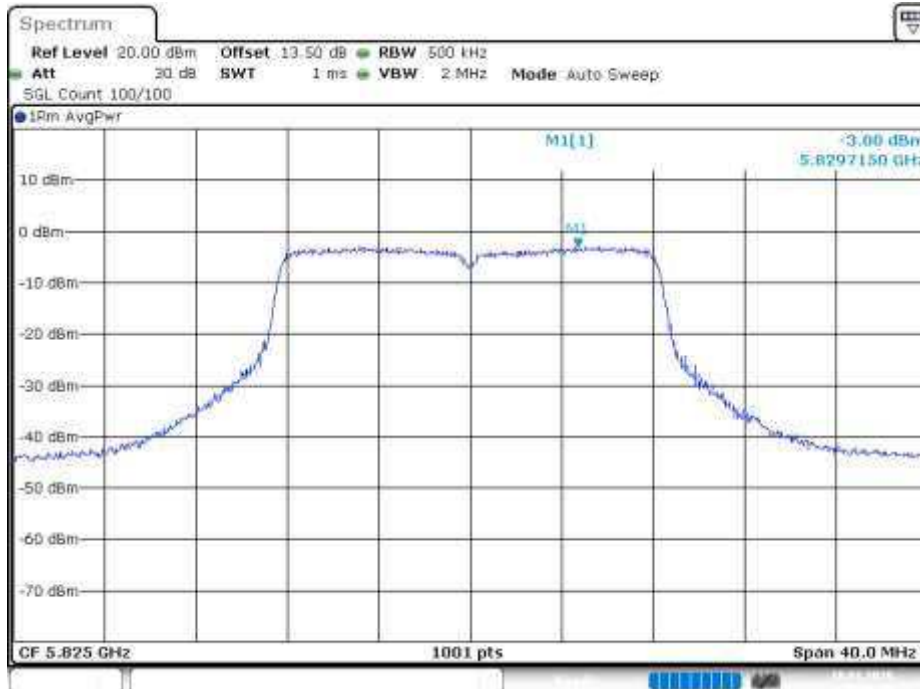

Date: 10.JAN.2020 22:53:55

**Ant 3**


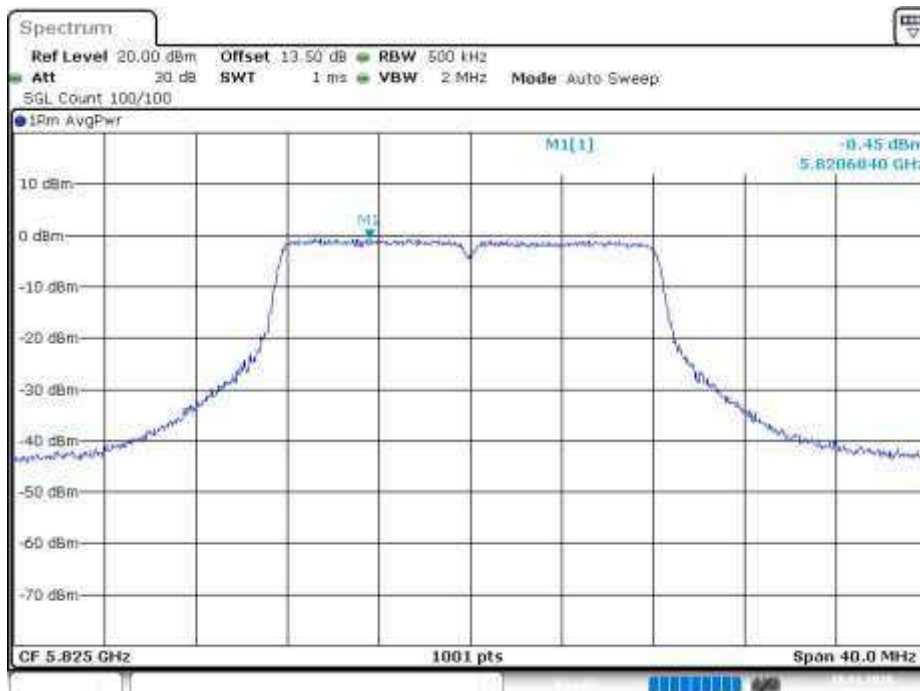
Date: 10.JAN.2020 22:55:27

**802.11a 5825MHz**
**Ant 1**


Date: 10.JAN.2020 22:57:14

**Ant 2**


Date: 10.JAN.2020 22:58:29

**Ant 3**


Date: 10.JAN.2020 22:59:52

**802.11n HT20 5180MHz**
**Ant 1**


Date: 10.JAN.2020 18:48:39

**Ant 2**


Date: 10.JAN.2020 18:49:36

**Ant 3**


Date: 10.JAN.2020 18:50:32

**802.11n HT20 5200MHz**
**Ant 1**


Date: 10.JAN.2020 18:53:59



**Ant 2**


Date: 10.JAN.2020 18:52:48

**Ant 3**


Date: 10.JAN.2020 18:51:49

**802.11n HT20 5240MHz**
**Ant 1**

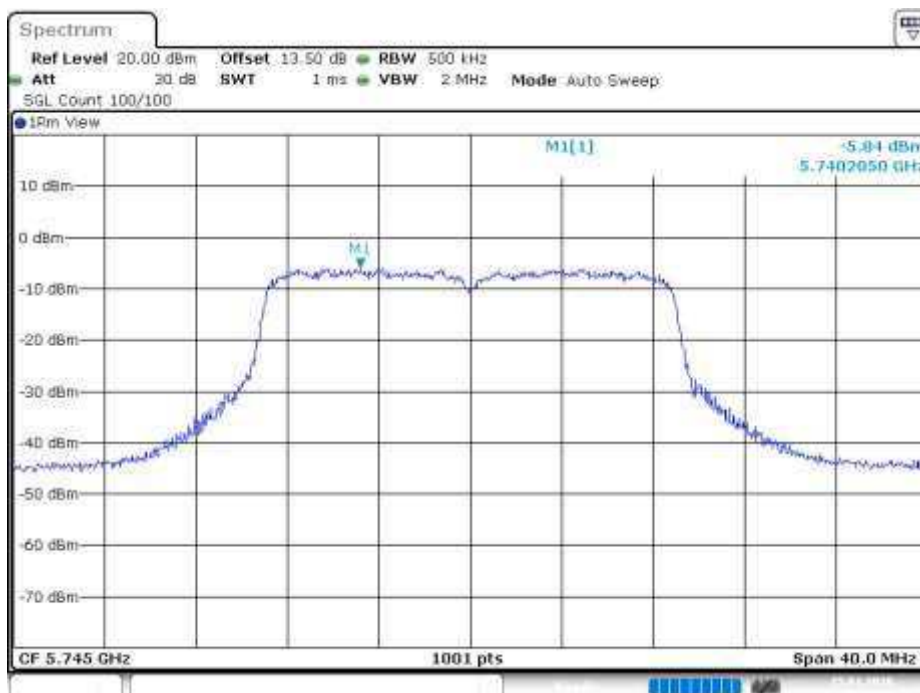

Date: 10.JAN.2020 18:55:33

**Ant 2**


Date: 10.JAN.2020 18:56:56

**Ant 3**

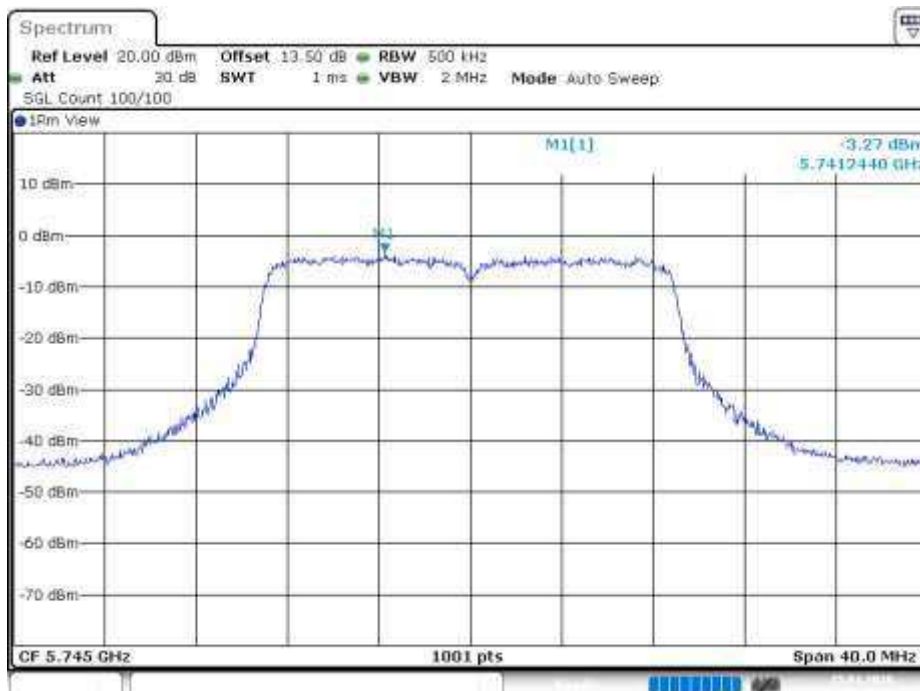

Date: 10.JAN.2020 18:57:56

**802.11n HT20 5745MHz**
**Ant 1**


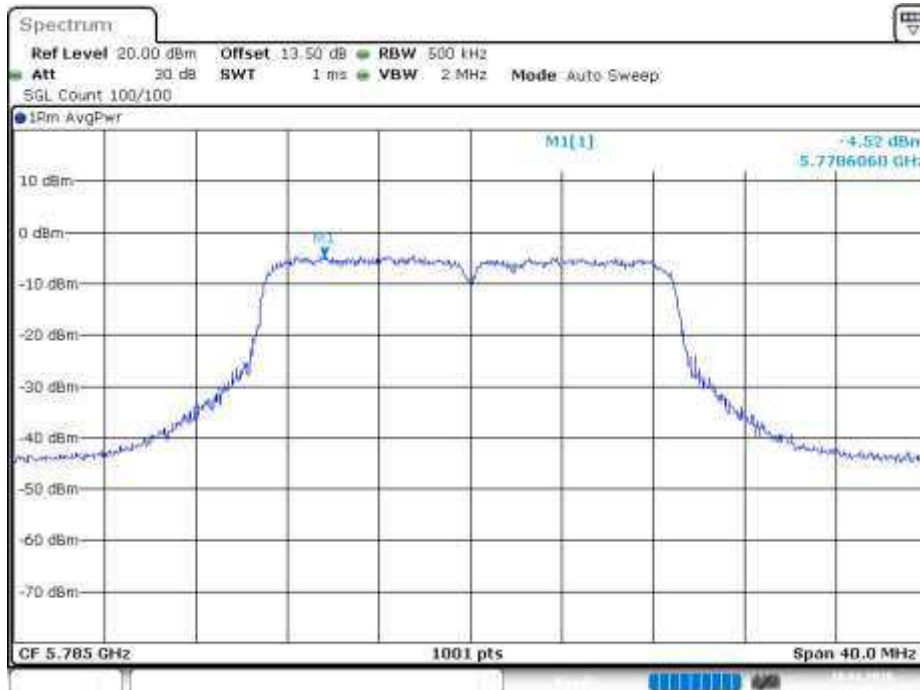
Date: 15.JAN.2020 18:53:27

**Ant 2**

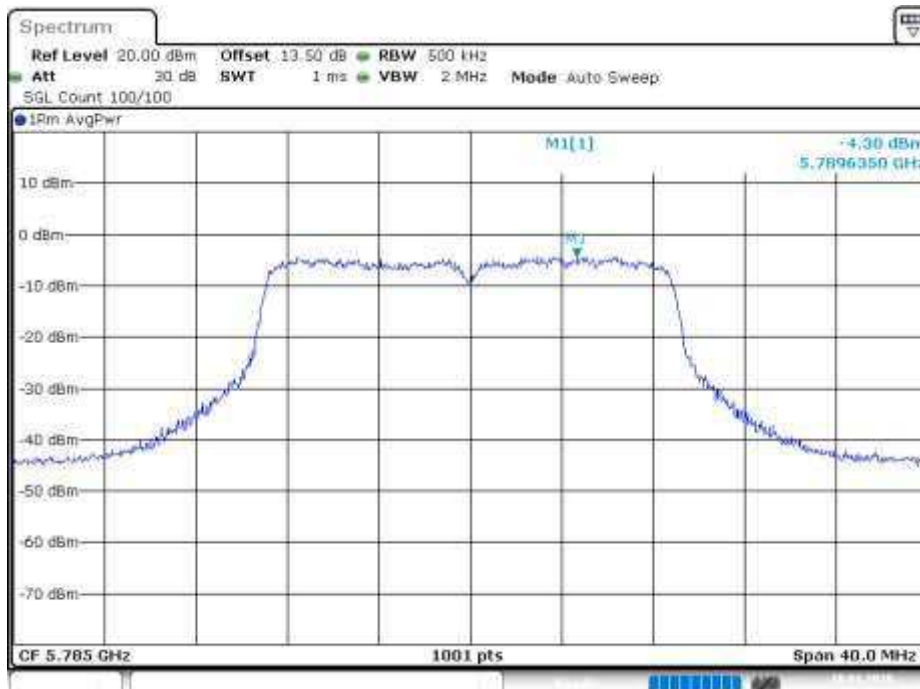

Date: 15.JAN.2020 18:54:46

**Ant 3**


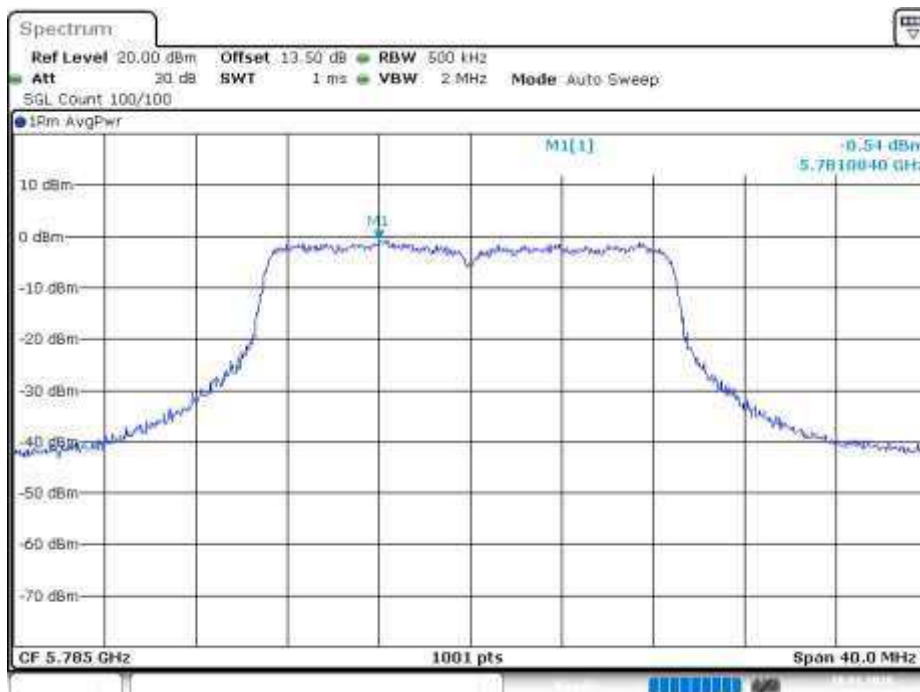
Date: 15.JAN.2020 18:57:39

**802.11n HT20 5785MHz**
**Ant 1**


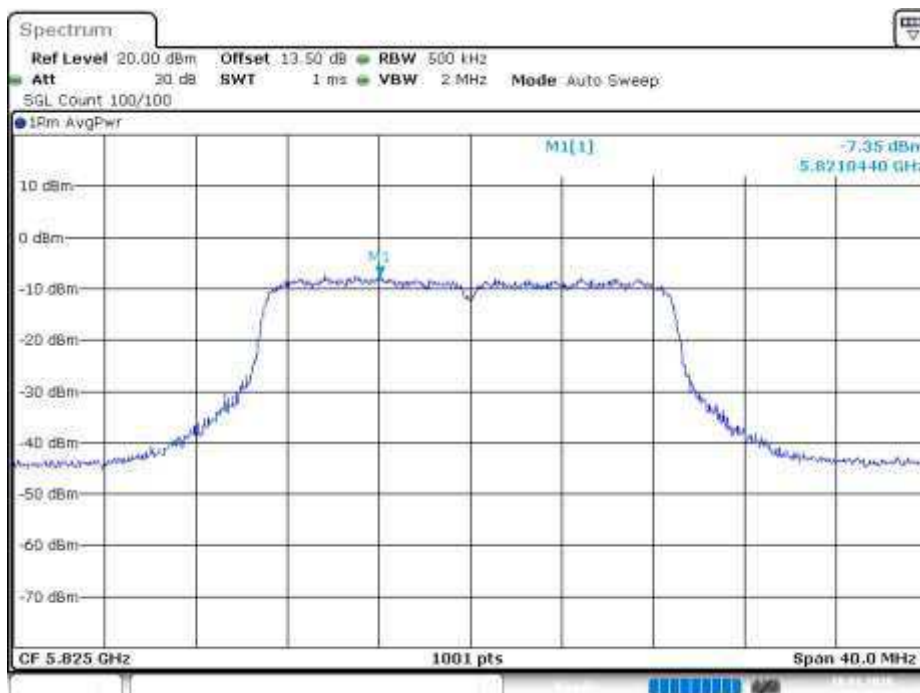
Date: 10.JAN.2020 23:09:13

**Ant 2**


Date: 10.JAN.2020 23:10:53

**Ant 3**


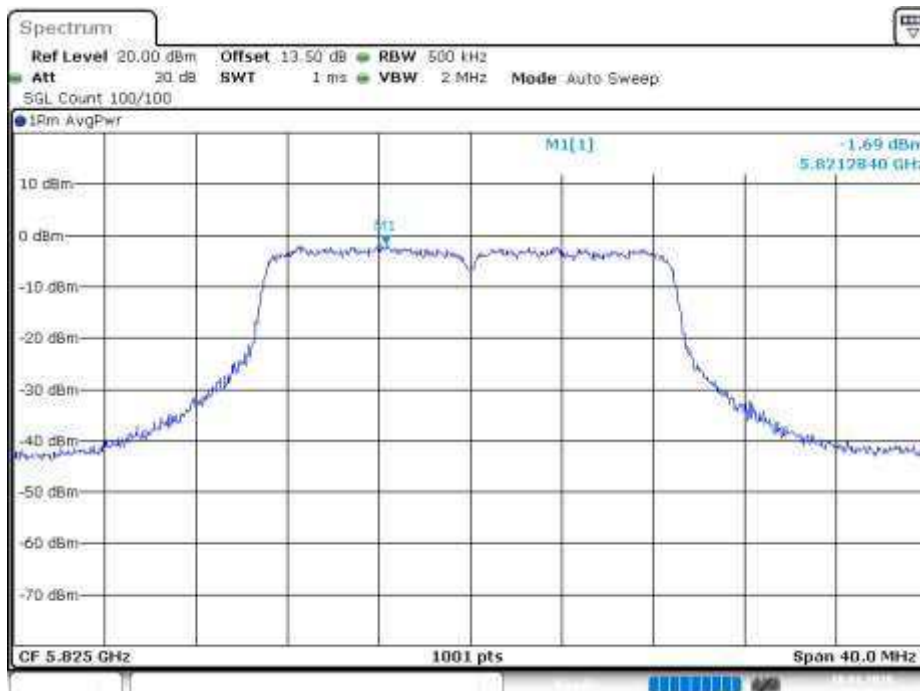
Date: 10.JAN.2020 23:12:20

**802.11n HT20 5825MHz**
**Ant 1**


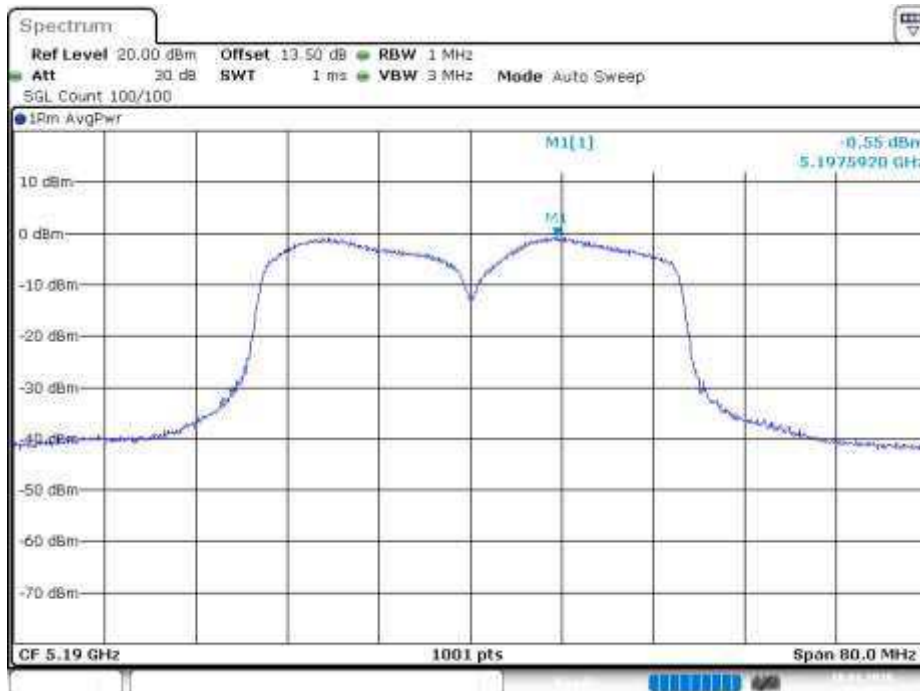
Date: 10.JAN.2020 23:15:57

**Ant 2**


Date: 10.JAN.2020 23:17:33

**Ant 3**


Date: 10.JAN.2020 23:19:50

**802.11n HT40 5190MHz**
**Ant 1**


Date: 10.JAN.2020 19:00:56

**Ant 2**


Date: 10.JAN.2020 19:01:46



**Ant 3**


Date: 10.JAN.2020 19:02:39

**802.11ac VHT40 5230MHz**
**Ant 1**


Date: 10.JAN.2020 19:06:33

**Ant 2**


Date: 10.JAN.2020 19:05:37

**Ant 3**

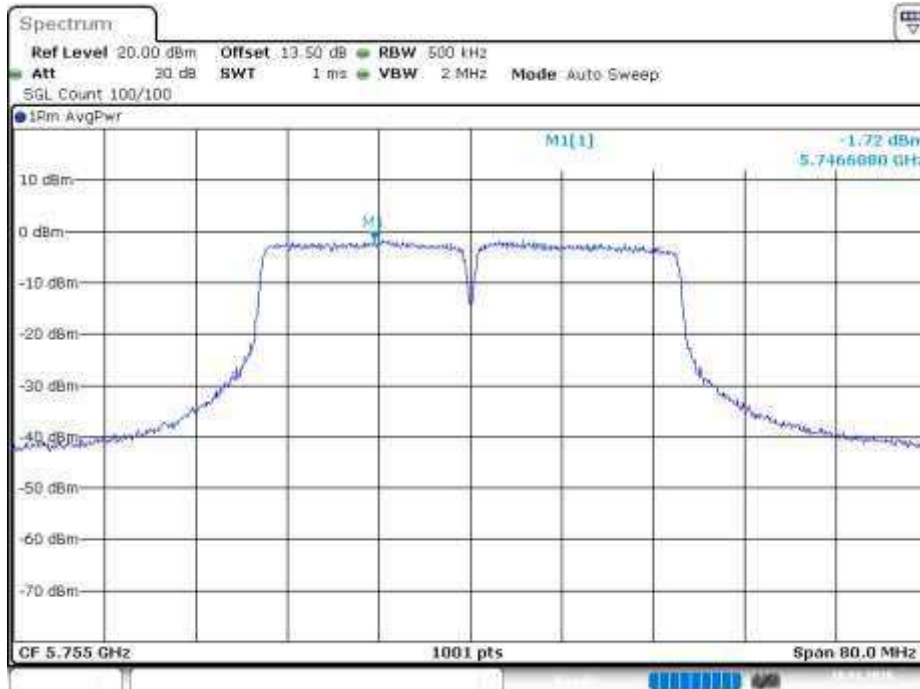

Date: 10.JAN.2020 19:04:00

**802.11n HT40 5755MHz**
**Ant 1**


Date: 10.JAN.2020 21:13:41

**Ant 2**


Date: 10.JAN.2020 21:15:03

**Ant 3**


Date: 10.JAN.2020 21:17:10

**802.11n HT40 5795MHz**
**Ant 1**


Date: 10.JAN.2020 22:37:07

**Ant 2**


Date: 10.JAN.2020 22:41:03

**Ant 3**


Date: 10.JAN.2020 22:44:58

**802.11ac VHT80 5210MHz**
**Ant 1**


Date: 10.JAN.2020 18:19:39

**Ant 2**


Date: 10.JAN.2020 18:22:40

**Ant 3**


Date: 10.JAN.2020 18:23:48

**802.11ac VHT80 5775MHz**
**Ant 1**


Date: 10.JAN.2020 22:05:54

**Ant 2**


Date: 10.JAN.2020 22:09:50

**Ant 3**


Date: 10.JAN.2020 21:27:32



### 5.1.7 Frequency Stability Measurement

**RESULT:**
**Passed**

Test standard : FCC 15.407(g)  
 Basic standard : ANSI C63.10: 2013  
 Limits : ±20ppm  
 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	5199.97164			5.454
120	5199.97164			5.454
108	5199.97135			5.510
Temp°C	Measurement Frequency (MHz)			
	0 Minute	2 Minute	5 Minute	10 Minute
50	5199.93488	5199.93459	5199.93459	5199.93459
40	5199.94182	5199.94153	5199.94153	5199.94153
30	5199.95803	5199.99797	5199.95774	5199.99768
20	5199.97106	5199.97077	5199.97077	5199.97077
10	5199.99016	5199.99016	5199.98987	5199.98987
0	5200.00232	5200.00203	5200.00203	5200.00203
-10	5200.0081	5200.00839	5200.00839	5200.00839
-20	5200.01013	5200.01071	5200.01129	5200.01129
-30	5199.95861	5199.99826	5199.95832	5199.99768
Limit (ppm)	±20			
Max. Deviation (ppm)	12.523	12.579	12.579	12.579

Frequency (MHz)	5785			
Voltage (V)	Measurement Frequency (MHz)			Max. Deviation (ppm)
132	5784.94443			9.606
120	5784.94067			10.256
108	5784.94848			8.906
Temp°C	Measurement Frequency (MHz)			
	0 Minute	2 Minute	5 Minute	10 Minute
50	5784.92735	5784.92735	5784.92735	5784.92735
40	5784.93575	5784.93546	5784.93546	5784.93517
30	5784.95282	5784.95282	5784.95282	5784.95282
20	5784.96758	5784.96816	5784.96787	5784.96787
10	5784.98842	5784.98871	5784.98842	5784.98871
0	5785.00232	5785.00232	5785.00232	5785.00203
-10	5785.00955	5785.00926	5785.00926	5785.00897
-20	5785.01245	5785.01245	5785.01245	5785.01245
-30	5784.99855	5784.99826	5784.99826	5784.99826
Limit (ppm)	±20			
Max. Deviation (ppm)	12.558	12.558	12.558	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) must comply with the radiated emission limits specified in FCC 15.209(a)  
 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

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.

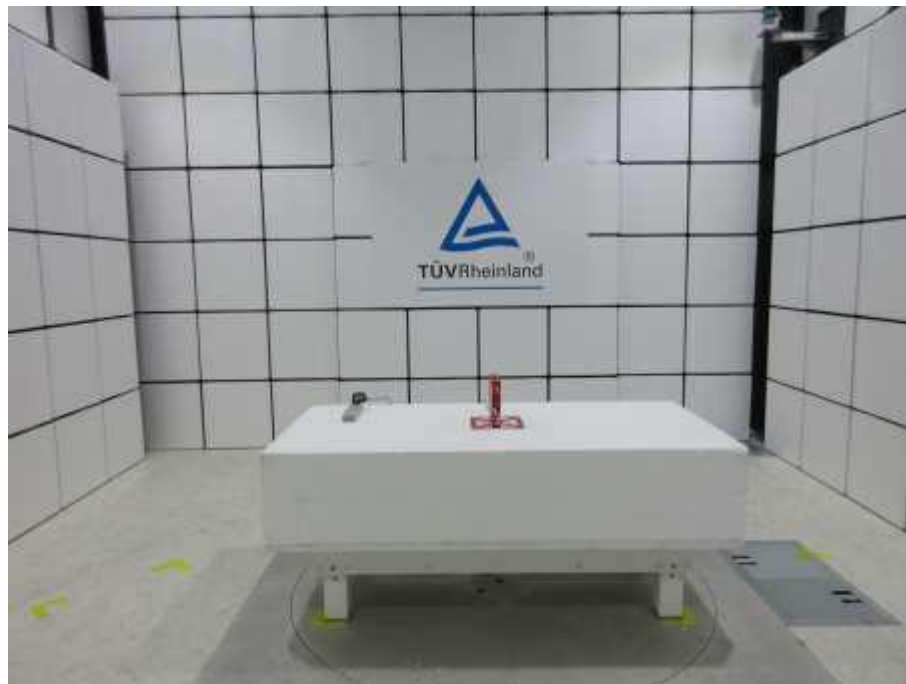
**FCC Maximum Exposure:****Maximum Exposure:**

Power to Antenna (mW)	152.41 mW
Power to Antenna (dBm)	21.8 dBm
Antenna Gain	4.94 dBi
Power+Ant Gain	475.3 mW
Distance	20 cm
S=	0.095 mW/cm <sup>2</sup>

**Limit FCC: 1500-100,000 MHz 1.0 mW/cm<sup>2</sup>**

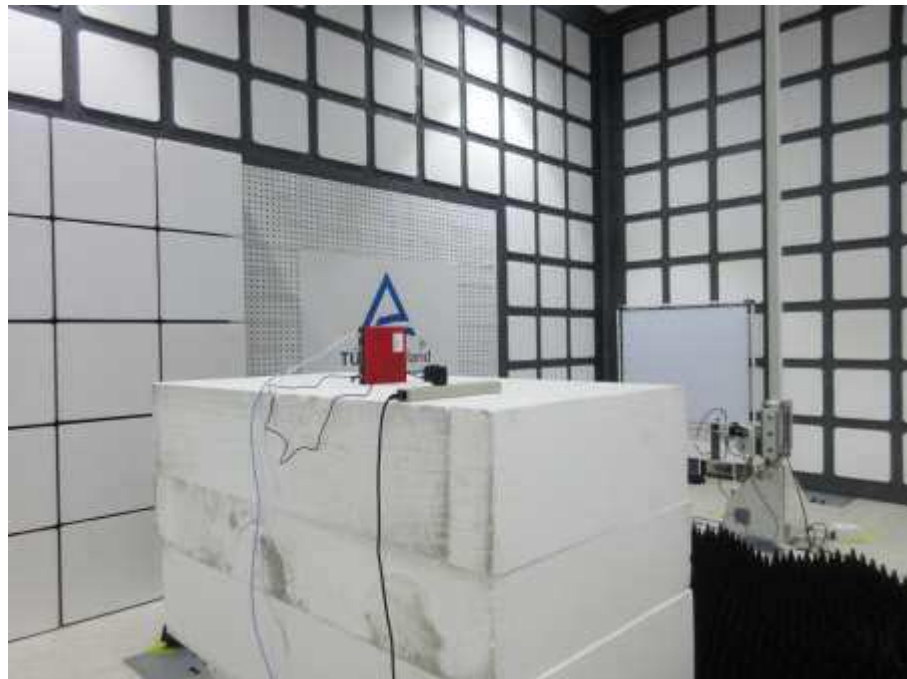
## 7. Photographs of the Test Set-Up

**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)**



## 8. List of Tables

Table 1: Applied Standard and Test Levels .....	5
Table 2: List of Test and Measurement Equipment .....	7
Table 3: Emission Measurement Uncertainty.....	8
Table 4: Basic Information of EUT .....	9
Table 5: Technical Specification of EUT .....	9
Table 6: Channel Frequency Table .....	10
Table 7: Table for Parameters of Test Software Setting .....	12
Table 8: Test result of Duty Cycle .....	17
Table 9: FCC Test result of Average Output Power.....	21
Table 10: Test result of 26dB & 99% Bandwidth.....	22
Table 11: Test result of 6dB Bandwidth .....	37
Table 12: Test result of FCC Power Density .....	53
Table 13: Test result of Frequency Stability .....	81

## 9. List of Photographs

Photograph 1: Set-up for Spurious Emissions (Front View 1).....	86
Photograph 2: Set-up for Spurious Emissions (Front View 2).....	86
Photograph 3: Set-up for Spurious Emissions (Back View 1) .....	87
Photograph 4: Set-up for Spurious Emissions (Back View 2).....	87
Photograph 5: Set-up for Spurious Emissions (Back View 3).....	88
Photograph 6: Set-up for Mains Conducted testing (Front View).....	88
Photograph 7: Set-up for Mains Conducted testing (Back View).....	89