

Prüfbericht-Nr.: <i>Test Report No.:</i>	50148967 001	Auftrags-Nr.: <i>Order No.:</i>	114077170	Seite 1 von 94 <i>Page 1 of 94</i>
Kunden-Referenz-Nr.: <i>Client Reference No.:</i>	N/A	Auftragsdatum: <i>Order date:</i>	31-Mar-2018	
Auftraggeber: <i>Client:</i>	Hon Hai Precision Industry Co., Ltd. No.151, Sec. 1, Nankan Rd., Lujhu Township, Taoyuan County, Taiwan			
Prüfgegenstand: <i>Test item:</i>	IEEE 802.11 a/b/g/n/ac 2x2 WiFi Module			
Bezeichnung / Typ-Nr.: <i>Identification / Type No.:</i>	WFU033-LGA			
Auftrags-Inhalt: <i>Order content:</i>	FCC / IC Test report			
Prüfgrundlage: <i>Test specification:</i>	FCC 47CFR Part 15: Subpart C Section 15.247 RSS-247 (02-2017)			
Wareneingangsdatum: <i>Date of receipt:</i>	8-May-2018			
Prüfmuster-Nr.: <i>Test sample No.:</i>	A000736956-001 A000736956-002			
Prüfzeitraum: <i>Testing period:</i>	8-May-2018 – 15-May-2018			
Ort der Prüfung: <i>Place of testing:</i>	EMC Laboratory Taipei			
Prüflaboratorium: <i>Testing laboratory:</i>	TUV Rheinland Taiwan Ltd.			
Prüfergebnis*: <i>Test result*:</i>	Pass			
Report Date / tested by:	kontrolliert von / reviewed by:			
2018-05-30 SamC.J. Kuo/Project Engineer	2018-05-30 Arvin Ho/Vice General Manager			
Datum <i>Date</i>	Name / Stellung <i>Name / Position</i>	Unterschrift <i>Signature</i>	Datum <i>Date</i>	Name / Stellung <i>Name / Position</i>
Sonstiges / Other:				
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 MAXIMUM CONDUCTED OUTPUT POWER

RESULT: Passed

5.1.3 ON TIME AND DUTY CYCLE

5.1.4 6dB BANDWIDTH AND 99% BANDWIDTH

RESULT: Passed

5.1.5 PEAK POWER DENSITY

RESULT: Passed

5.1.6 CONDUCTED SPURIOUS EMISSIONS AND FREQUENCY BAND EDGE MEASURED IN 100kHz BANDWIDTH

RESULT: Passed

5.1.7 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

The following attachments are integral parts of this test report:

Appendix P: Photo Documentation

(File Name: 50148967APPENDIXP)

Appendix D: Test Result of Radiated Emissions

(File Name: 50148967APPENDIXD)

Test Specifications

The following standards were applied (in bold: product standards, otherwise: basic standards).

Table 1: Applied Standard and Test Levels

Radio
FCC 47 CFR Part 15: Subpart C Section 15.247 FCC 47 CFR Part 2: Subpart J Section 2.1091 FCC 47 CFR Part 1: Subpart I Section 1.1307 RSS-247 Issue 2 (Feb 2017) RSS-102 Issue 5 RSS-Gen, Issue 4, November 2014 ANSI C63.10:2013 FCC KDB558074 D01 DTS Meas Guidance v03r05

2. Test Sites

2.1 Test Facilities

TUV Rheinland Taiwan Ltd.
Taipei Office

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

FCC RegistrationNo.: 340738
IC Canada Registration No.: 9465A-1
TAF Accredited NCC Test Lab. No.:0759
TAF ISO17025 Certification effective periods: 2016-Jul-1st to 2019-Jun-30th



Testing Laboratory
0759

2.2 List of Test and Measurement Instruments

Table 2: List of Test and Measurement Equipment

Kind of Equipment	Manu-facturer	Type	S/N	Last Calibration	Next Calibration
Test Software	Farad	EZ_EMC	Ver. TUV3A1	N/A	N/A
EMI Test Receiver	R&S	ESR 7	101549	2017/11/10	2018/11/10
Spectrum Analyzer	R&S	FSV 40	100921	2018/05/02	2019/05/02
Spectrum Analyzer	Agilent	N9010A	MY53470241	2017/05/23	2018/05/22
Preamplifier (30MHz -1GHz)	HP	8447F	2805A03335	2017/08/14	2018/08/14
Preamplifier (18 GHz -40 GHz)	COM-POWER	PAM-840	461257	2018/01/18	2019/01/18
Pre-Amplifier (1GHz~18GHz)	EM Electronics	EM01G18G	60558	2017/11/21	2018/11/21
Bilog Antenna	TESEQ	CBL6111D	29804	2017/08/18	2018/08/18
Horn Antenna	ETS-Lindgren	3117	201918	2017/08/18	2018/08/18
Horn Antenna (18GHz~40GHz)	COM-POWER	AH-840	101029	2017/11/28	2018/11/28
Temp. & Humid. Chamber	Giant Force	GCT-099-40-S	MAF0103-007	2017/03/09	2019/03/09
LISN (1 phase)	R&S	ENV216	101243	2017/06/18	2018/06/18
LISN	R&S	ENV216	101262	2017/06/22	2018/06/21
Test Software	Audix	e3	Ver. 9	N/A	N/A
Test Software	Agilent	300328 testsystem	V1.9.1	N/A	N/A
Power sensor	Agilent	U2021XA	MY54020001	2018/03/31	2019/03/31

2.3 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.

2.4 Calibration

Equipment requiring calibration is calibrated periodically by the manufacturer or according to manufacturer's specifications. Additionally all equipment is verified for proper performance on a regular basis using in house standards or comparisons.

2.5 Measurement Uncertainty

The estimated combined standard uncertainty for radiated emissions and conducted emissions measurements are $\pm 3\text{dB}$.

Table 3: Emission Measurement Uncertainty

Parameter	Uncertainty
RF power, conducted	$\pm 1.5 \text{ dB}$
Adjacent channel power	$\pm 3 \text{ dB}$
Radiated emission of transmitter, valid up to 26 GHz	$\pm 6 \text{ dB}$
Radiated emission of receiver, valid up to 26 GHz	$\pm 6 \text{ dB}$
Temperature	$\pm 2 \text{ }^{\circ}\text{C}$
Humidity	$\pm 10 \text{ \%}$

3. General Product Information

3.1 Product Function and Intended Use

The EUT is an 802.11 a/b/g/n/ac module. It contains a Wi-Fi 2.4GHz and 5GHz 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	IEEE 802.11 a/b/g/n/ac 2x2 WiFi Module
Type Designation	WFU033-LGA
Product Type	WLAN (2TX, 2RX)
FCC ID	RX3-WFU033LGA
IC ID	2878F-WFU033LGA
HVIN	WFU033-LGA

Table 5: Technical Specification of EUT

Technical Specification	Value
Operating Frequencies	2412 MHz ~ 2462 MHz
Channel Spacing	5 MHz
Channel number	802.11b/g/n20 : 11 (2412 MHz ~ 2462 MHz), 802.11n40: 7 (2422 MHz ~ 2452 MHz)
Operation Voltage	3.3V
Modulation	802.11b: DSSS ; 802.11g/n: OFDM
Antenna gain	Refer to Table 6
Antenna Type	PIFA Antenna

Table 6: Table for Filed Antenna**Combination 1**

Ant.	Model Name	Antenna Type	Gain (dB)	
			2.4GHz	5GHz
1	79011W000-600-G	PIFA Antenna	0.88	2.97
2	79011VR00-600-G	PIFA Antenna	2.41	3.1

Combination 2

Ant.	Model Name	Antenna Type	Gain (dB)	
			2.4GHz	5GHz
1	79011VS00-600-G	PIFA Antenna	1.77	4.77
2	79011W100-600-G	PIFA Antenna	1.71	4.55

For 2.4GHz Bandedge test:

Combination1

For 2.4GHz Radiated Emission test:

Combination2 (Because Harmonic at 2.4GHz is nearby 5GHz, peak gain of 5GHz of combination 2 is higher.)

3.3 Independent Operation Modes

Basic operation modes are:

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

3.4 Noise Generating and Noise Suppressing Parts

Refer to the Circuit Diagram.

3.5 Submitted Documents

- | | |
|-------------------------|----------------------|
| - Bill of Material | - Circuit Diagram |
| - PCB Layout | - Instruction Manual |
| - Photo Document | - Rating Label |
| - Technical Description | |

4. Test Set-up and Operation Modes

4.1 Principle of Configuration Selection

The equipment under test (EUT) was configured to measure its maximum power level. The test modes were adapted accordingly in reference to the instructions for use.

4.2 Test Operation and Test Software

Setup for testing: Test samples are provided with a USB interface which makes it possible to control them through test software installed on a notebook computer.

This software, MT7662UQA was running on the laptop computer connected to the EUT. It was used to enable the operation modes listed in section 3.3 as appropriate.

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

IEEE 802.11b mode:

Channel Low (2412MHz), Channel Mid (2437MHz) and Channel High (2462MHz) with 1Mbps data rate were chosen for full testing.

IEEE 802.11g mode:

Channel Low (2412MHz), Channel Mid (2437MHz) and Channel High (2462MHz) with 6Mbps data rate were chosen for full testing.

IEEE 802.11n HT 20 mode:

Channel Low (2412MHz), Channel Mid (2437MHz) and Channel High (2462MHz) with 13Mbps data rate were chosen for full testing.

IEEE 802.11n HT 40 mode:

Channel Low (2422MHz), Channel Mid (2437MHz) and Channel High (2452MHz) with 13Mbps data rate were chosen for full testing.

4.3 Auxiliary Equipment

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

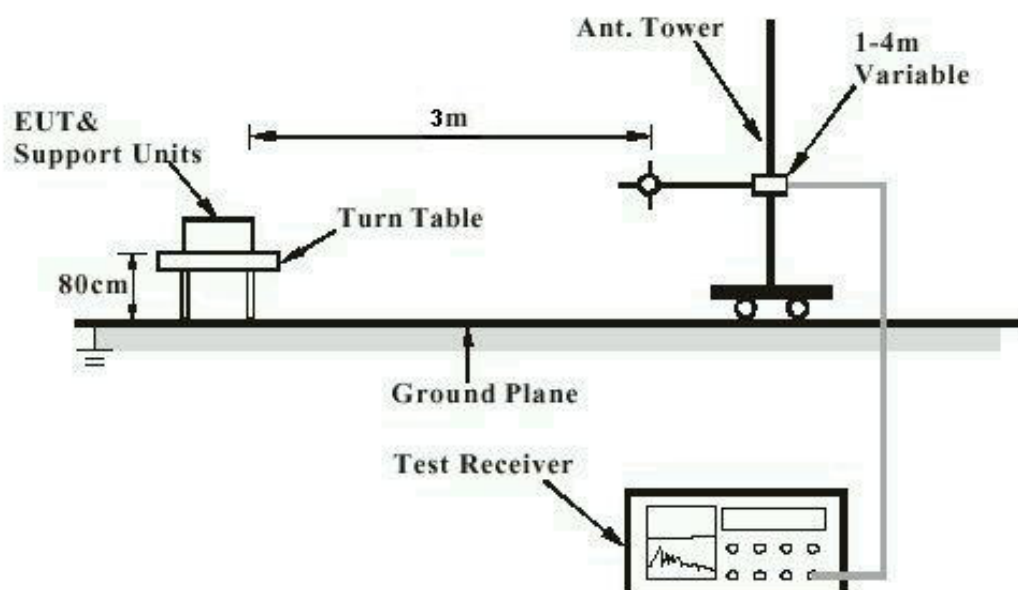
Description	Manufacturer	Model No.	Serial No.
Notebook(EMC-06)	Lenovo	TP00048A	PB-0F8B2

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)

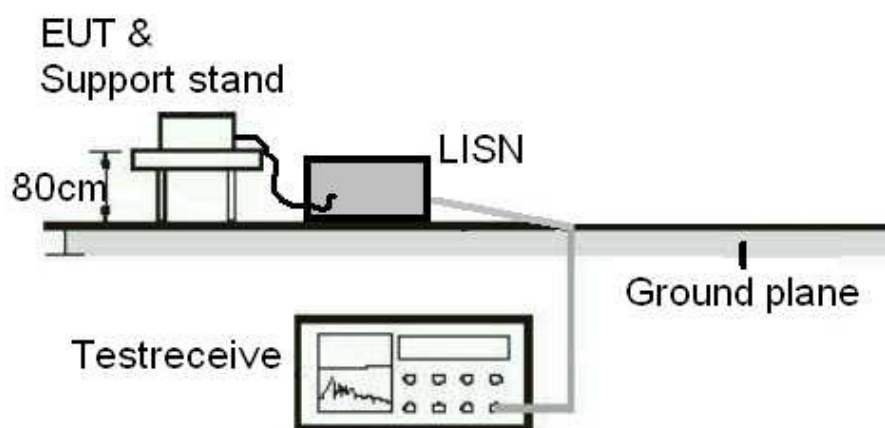
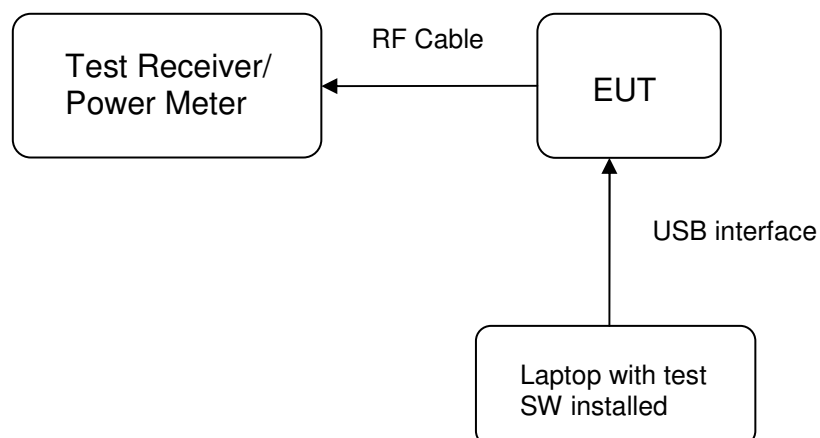


Diagram of Measurement Equipment Configuration for Conducted Transmitter Measurement



4.6 Environmental Condition

Temperature	18 - 25°C
Humidity	35 – 75%

5. Test Results

5.1 Transmitter Requirement & Test Suites

5.1.1 Antenna Requirement

RESULT:**Passed**

Test standard : FCC Part 15.247(b)(4), Part 15.203 and RSS-Gen 8.3

Limit : the use of antennas with directional gains that do not exceed 6 dBi

According to the manufacturer declaration, the module has two combinations of antennas as below table. 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.

Combination 1

Ant.	Model Name	Antenna Type	Gain (dB)	
			2.4GHz	5GHz
1	79011W000-600-G	PIFA Antenna	0.88	2.97
2	79011VR00-600-G	PIFA Antenna	2.41	3.1

Combination 2

Ant.	Model Name	Antenna Type	Gain (dB)	
			2.4GHz	5GHz
1	79011VS00-600-G	PIFA Antenna	1.77	4.77
2	79011W100-600-G	PIFA Antenna	1.71	4.55

5.1.2 Maximum Conducted Output Power

RESULT:

Passed

Test standard : FCC Part 15.247(b)(3), RSS-247 5.4(d)
 Basic standard : ANSI C63.10:2013, KDB558074
 Limit : FCC Part 15.247(b), RSS-247 5.4(d)
 1 Watt / 30dBm
 Kind of test site : Shielded room/Conducted room

Test setup

Test Channel : Low/ Middle/ High
 Operation Mode : A

Table 7: Test result of Maximum Output Power (802.11b)

ANT1				
Duty Cycle:	0.98	Juty Fac	0.09	dB
802.11b (MHz)	Avg (dBm)	Setting	Average Power (dBm) (Add Fac.)	RESULT
2412	16.71	1D	16.80	PASS
2437	16.63	1D	16.63	PASS
2462	16.84	1D	16.84	PASS

ANT2				
Duty Cycle:	0.98	Juty Fac	0.09	dB
802.11b (MHz)	Avg (dBm)	Setting	Average Power (dBm) (Add Fac.)	RESULT
2412	16.88	1D	16.97	PASS
2437	16.8	1D	16.80	PASS
2462	16.86	1D	16.86	PASS

Note: Average conducted power is equal to measured power plus duty factor, where duty factor is $10\log(1/0.98)$.

Table 8: Test result of Maximum Output Power (802.11g)

ANT1				
Duty Cycle:	0.88	Juty Fac	0.56	dB
802.11g (MHz)	Avg (dBm)	Setting	Average Power (dBm) (Add Fac.)	RESULT
2412	14.98	1C	15.54	PASS
2437	16.24	1F	16.24	PASS
2462	12.62	17	12.62	PASS

ANT2				
Duty Cycle:	0.88	Juty Fac	0.56	dB
802.11g (MHz)	Avg (dBm)	Setting	Average Power (dBm) (Add Fac.)	RESULT
2412	14.6	1C	15.16	PASS
2437	16.26	20	16.26	PASS
2462	12.21	17	12.21	PASS

Note: Average conducted power is equal to measured power plus duty factor, where duty factor is $10\log(1/0.88)$.

Table 9: Test result of Maximum Output Power (802.11n HT20)

ANT1+ANT2								
Duty Cycle:	0.87	Duty fac:	0.60	dB		ANT1 Average Power (dBm) (Add Fac.)	ANT2 Average Power (dBm) (Add Fac.)	Total Average Power (dBm) (Add Fac.)
802.11n HT20 (MHz)	ANT1		ANT2					RESULT
	Avg (dBm)	Set	Avg (dBm)	Set				
2412	12.06	16	12.1	16	12.66	12.70	15.70	PASS
2437	12.58	17	12.03	17	13.18	12.63	15.93	PASS
2462	12.39	16	12.11	17	12.99	12.71	15.87	PASS

Note: Average conducted power is equal to measured power plus duty factor, where duty factor is $10\log(1/0.87)$.

Table 10: Test result of Maximum Output Power (802.11n HT40)

ANT1+ANT2								
Duty Cycle:	0.78	Duty fac:	1.08	dB		ANT1 Average Power (dBm) (Add Fac.)	ANT2 Average Power (dBm) (Add Fac.)	Total Average Power (dBm) (Add Fac.)
802.11n HT40 (MHz)	ANT1		ANT2					RESULT
	Avg (dBm)	Set	Avg (dBm)	Set				
2422	9.53	16	10.15	16	10.61	11.23	13.94	PASS
2437	12.37	17	11.36	17	13.45	12.44	15.98	PASS
2452	9.96	16	10.02	17	11.04	11.10	14.08	PASS

Note: Average conducted power is equal to measured power plus duty factor, where duty factor is $10\log(1/0.78)$.

5.1.3 On Time and Duty Cycle

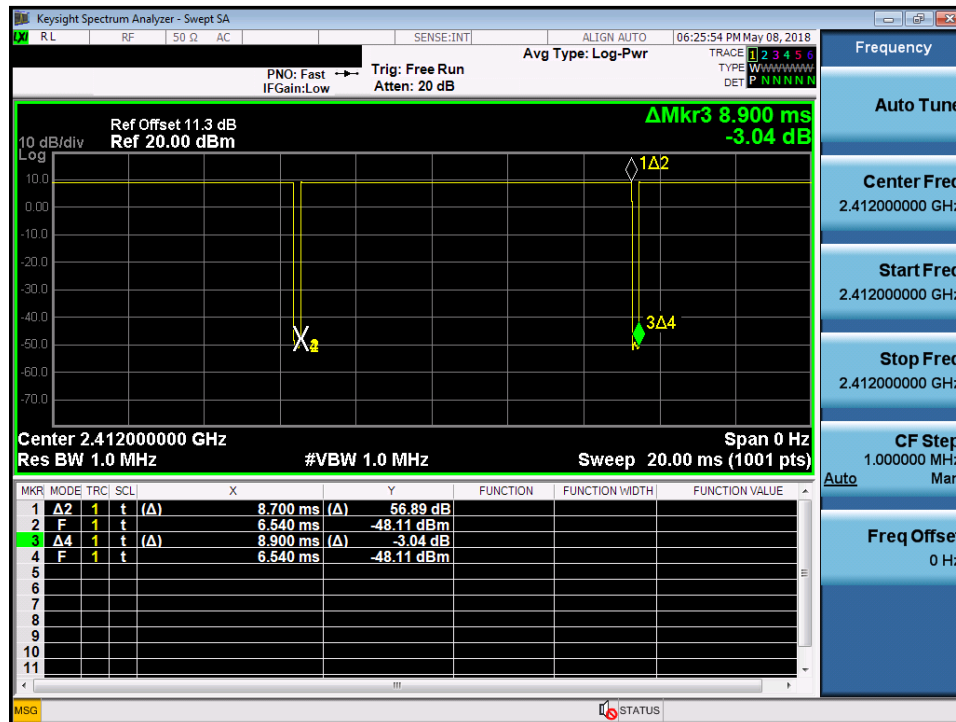
Test standard : KDB 558074 Zero-Span Spectrum Analyzer Method
Limit : None; for reporting purposes only
Kind of test site : Shielded room/Conducted room

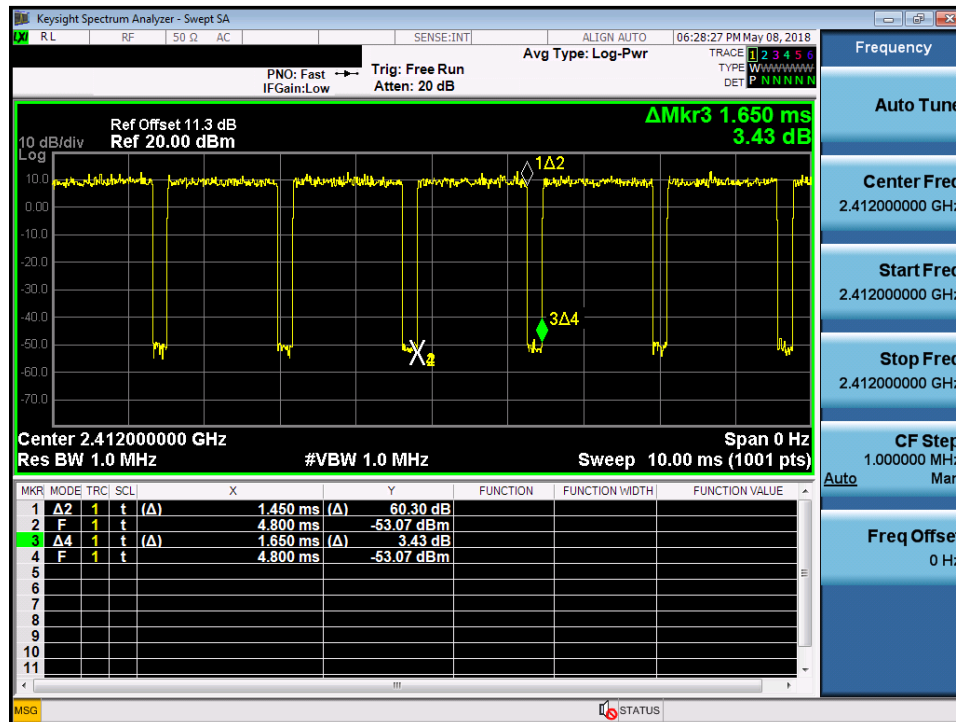
Test setup

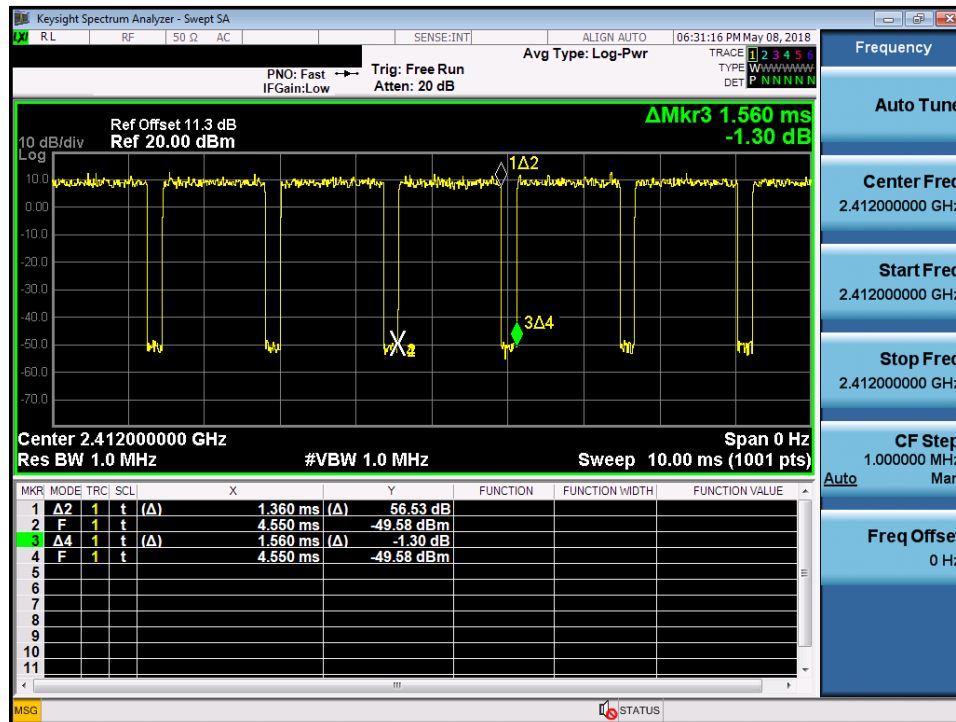
Operation Mode : A

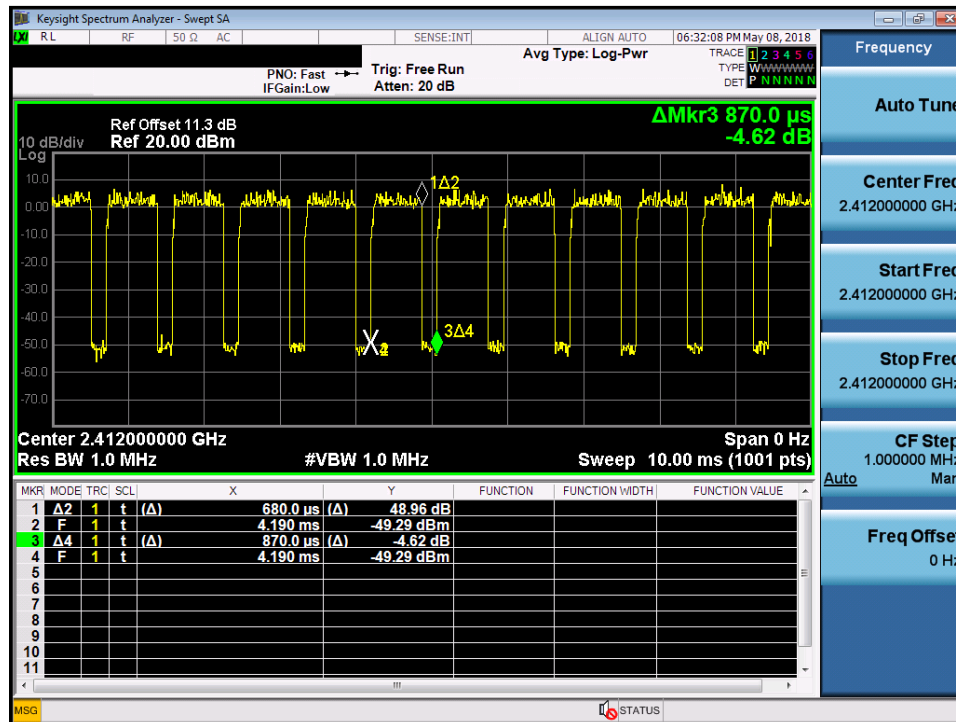
Table 11: Result of Duty Cycle

Mode	ON Time (msec)	Period (msec)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
802.11b	8.7	8.9	98	0.09
802.11g	1.45	1.65	88	0.56
802.11n HT20	1.36	1.56	87	0.56
802.11n HT40	0.68	0.87	78	1.08

DUTY CYCLE PLOT, 802.11b


DUTY CYCLE PLOT, 802.11g


DUTY CYCLE PLOT, 802.11n HT20


DUTY CYCLE PLOT, 802.11n HT40


5.1.4 6dB Bandwidth and 99% Bandwidth**RESULT:****Passed**

Test standard	:	FCC Part 15.247(a)(2), RSS-247 5.2(a)
Basic standard	:	ANSI C63.10:2013, KDB558074
Limit	:	FCC Part 15.247(a)(2), RSS-247 5.2(a)
Kind of test site	:	Shielded room/Conducted room

Test setup

Test Channel	:	Low/ Middle/ High
Operation Mode	:	A

Table 12: Test result of 6dB Bandwidth (802.11b)

Channel	Channel Frequency (MHz)	6dB Bandwidth (MHz)	Limit (MHz)	Result
Low Channel	2412	10.07	0.5	Pass
Mid Channel	2437	10.07	0.5	Pass
High Channel	2462	10.08	0.5	Pass

Table 13: Test result of 6dB Bandwidth (802.11g)

Channel	Channel Frequency (MHz)	6dB Bandwidth (MHz)	Limit (MHz)	Result
Low Channel	2412	16.07	0.5	Pass
Mid Channel	2437	16.05	0.5	Pass
High Channel	2462	16.03	0.5	Pass

Table 14: Test result of 6dB Bandwidth (802.11n HT20)

Channel	Channel Frequency (MHz)	6dB Bandwidth (MHz)	Limit (MHz)	Result
Low Channel	2412	17.07	0.5	Pass
Mid Channel	2437	15.96	0.5	Pass
High Channel	2462	16.9	0.5	Pass

Table 15: Test result of 6dB Bandwidth (802.11n HT40)

Channel	Channel Frequency (MHz)	6dB Bandwidth (MHz)	Limit (MHz)	Result
Low Channel	2412	35.39	0.5	Pass
Mid Channel	2437	35.4	0.5	Pass
High Channel	2462	35.21	0.5	Pass

Table 16: Test result of 99% Bandwidth (802.11b)

Channel	Channel Frequency (MHz)	99% Bandwidth (MHz)
Low Channel	2412	12.26
Mid Channel	2437	12.271
High Channel	2462	12.346

Table 17: Test result of 99% Bandwidth (802.11g)

Channel	Channel Frequency (MHz)	99% Bandwidth (MHz)
Low Channel	2412	16.875
Mid Channel	2437	16.964
High Channel	2462	17.141

Table 18: Test result of 99% Bandwidth (802.11n HT20)

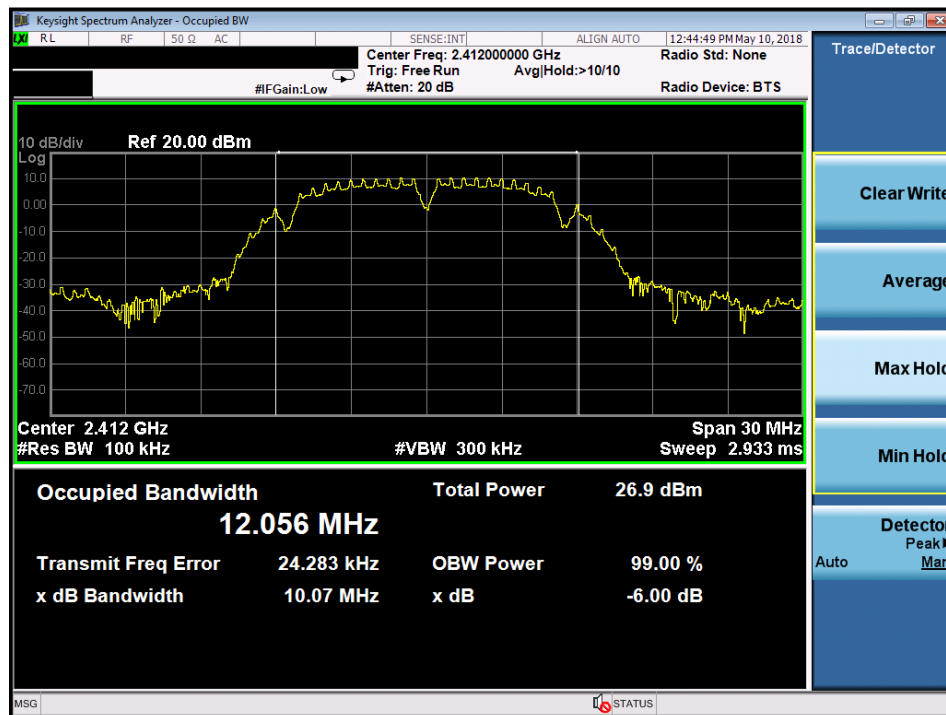
Channel	Channel Frequency (MHz)	99% Bandwidth (MHz)
Low Channel	2412	17.708
Mid Channel	2437	17.7
High Channel	2462	17.722

Table 19: Test result of 99% Bandwidth (802.11n HT40)

Channel	Channel Frequency (MHz)	99% Bandwidth (MHz)
Low Channel	2412	36.154
Mid Channel	2437	36.117
High Channel	2462	36.11

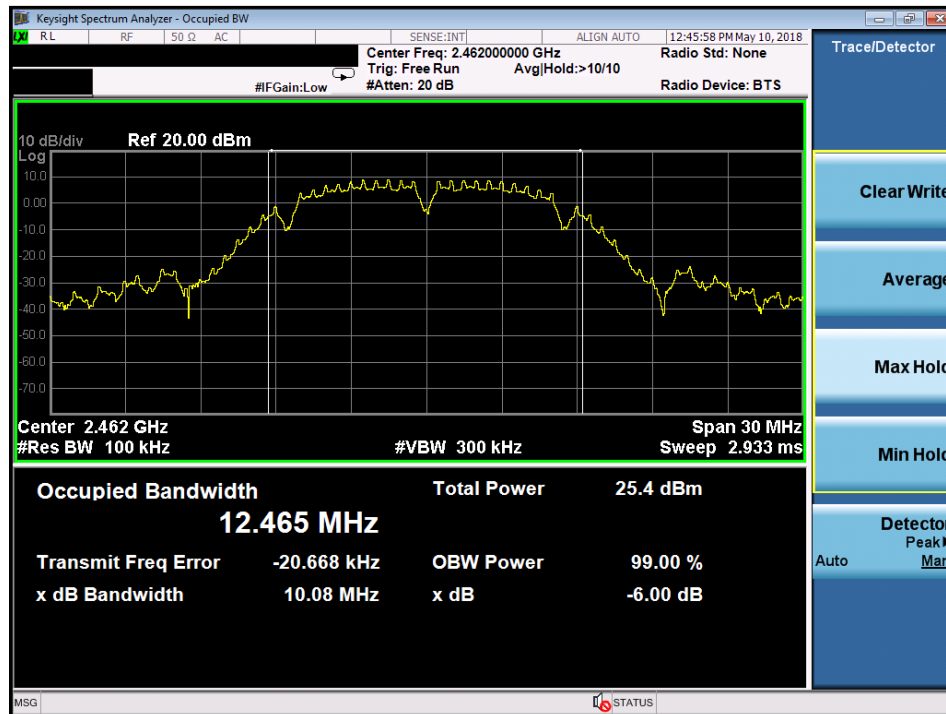
Test Plot of 6dB Bandwidth (802.11b)

Low Channel



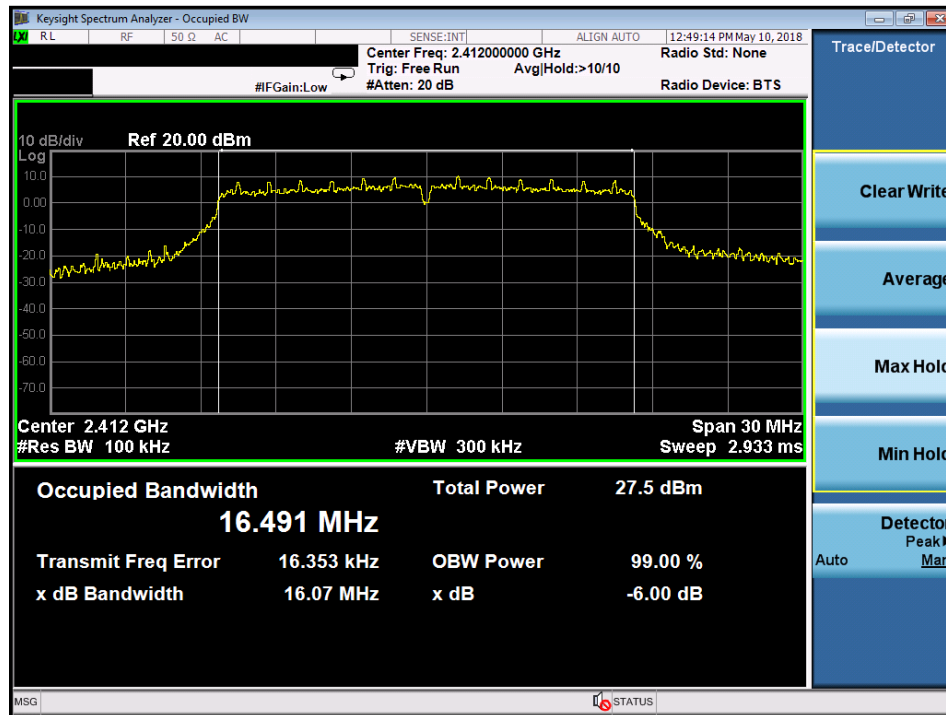
Middle Channel



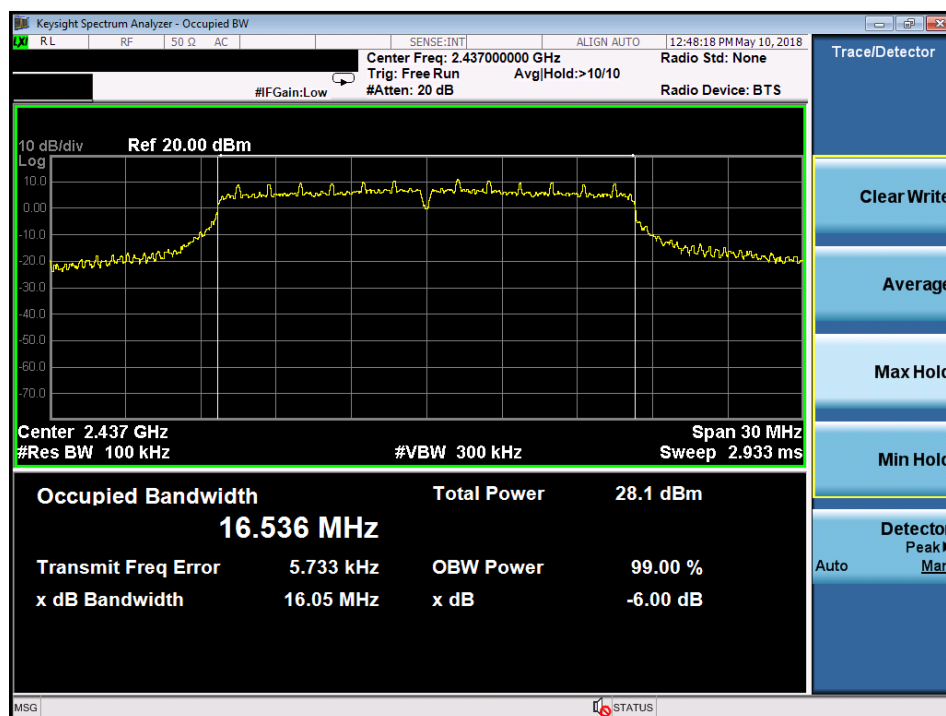
High Channel


Test Plot of 6dB Bandwidth (802.11g)

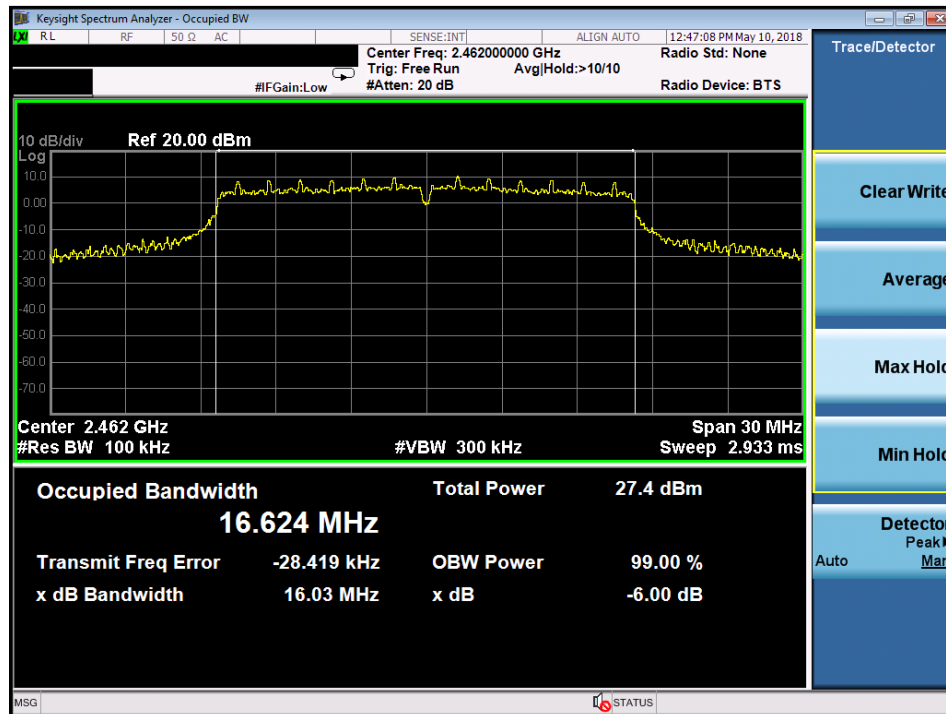
Low Channel



Middle Channel

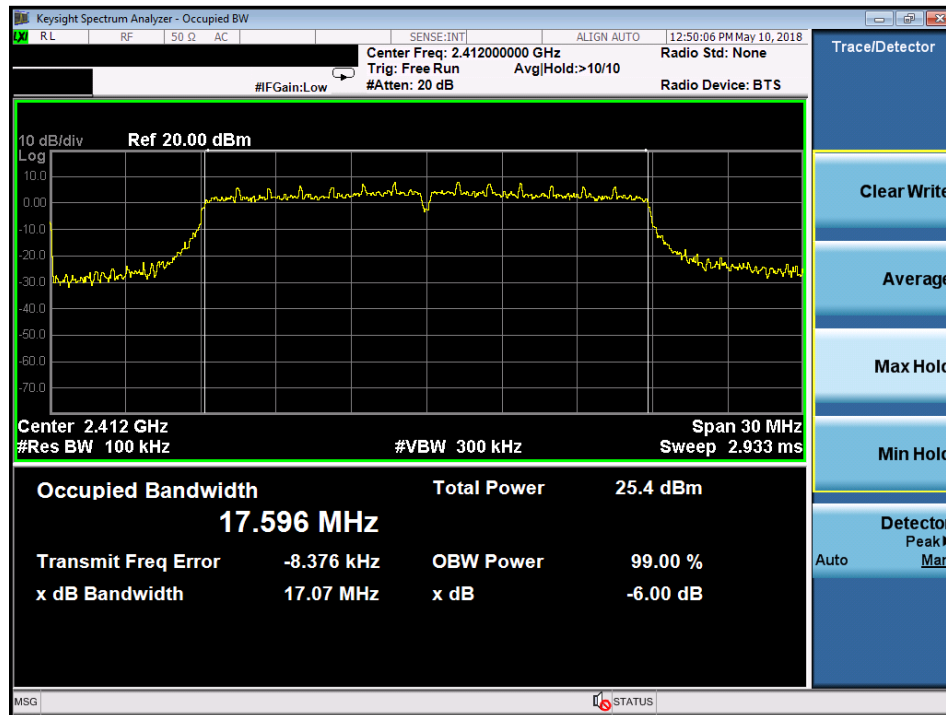


High Channel

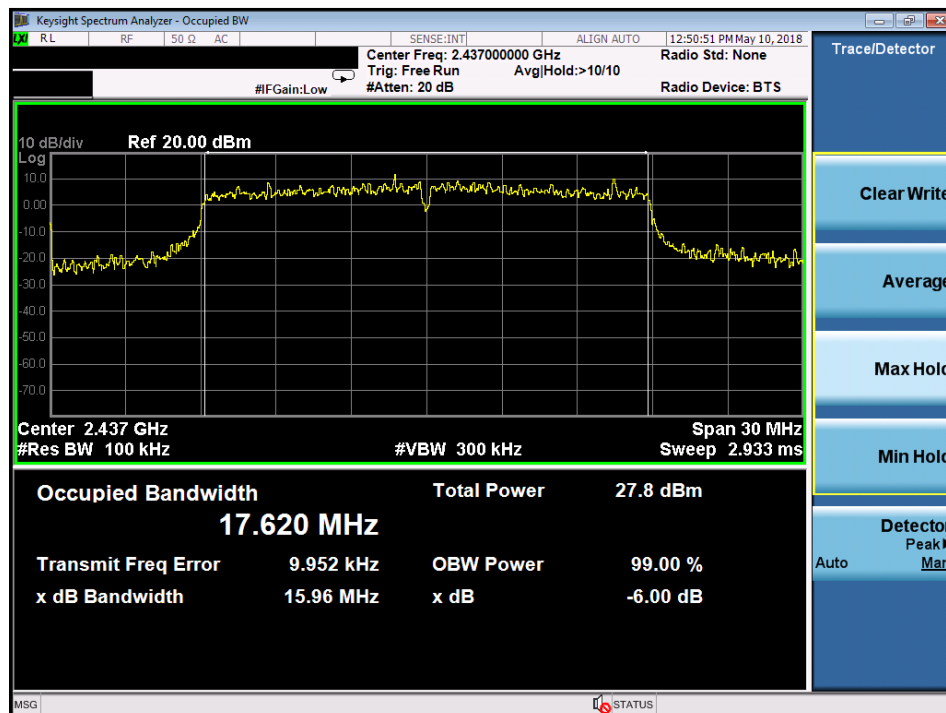


Test Plot of 6dB Bandwidth (802.11n HT20)

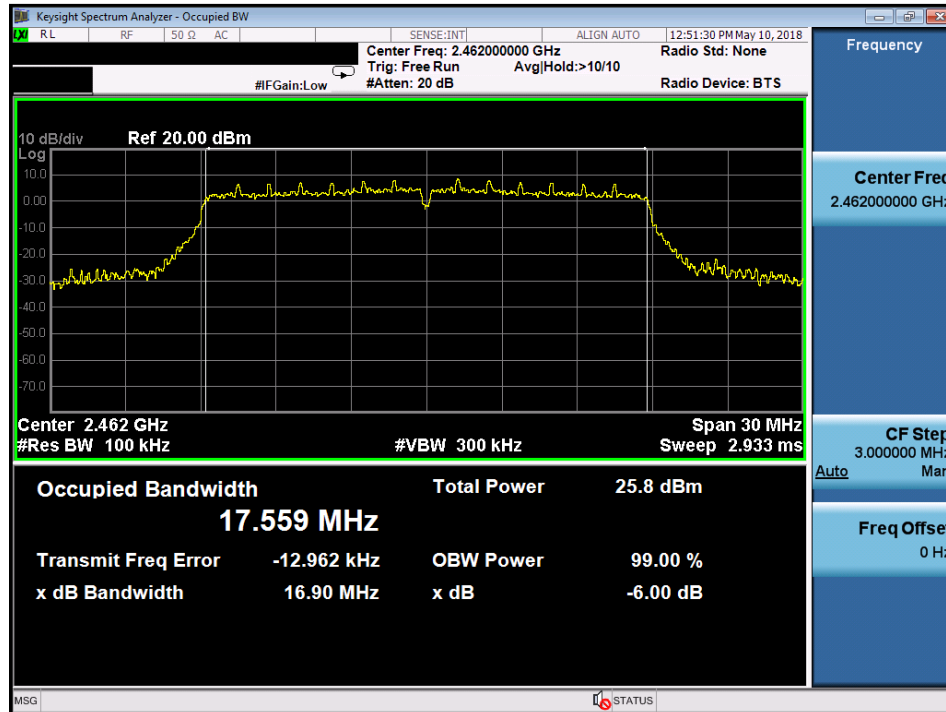
Low Channel



Middle Channel

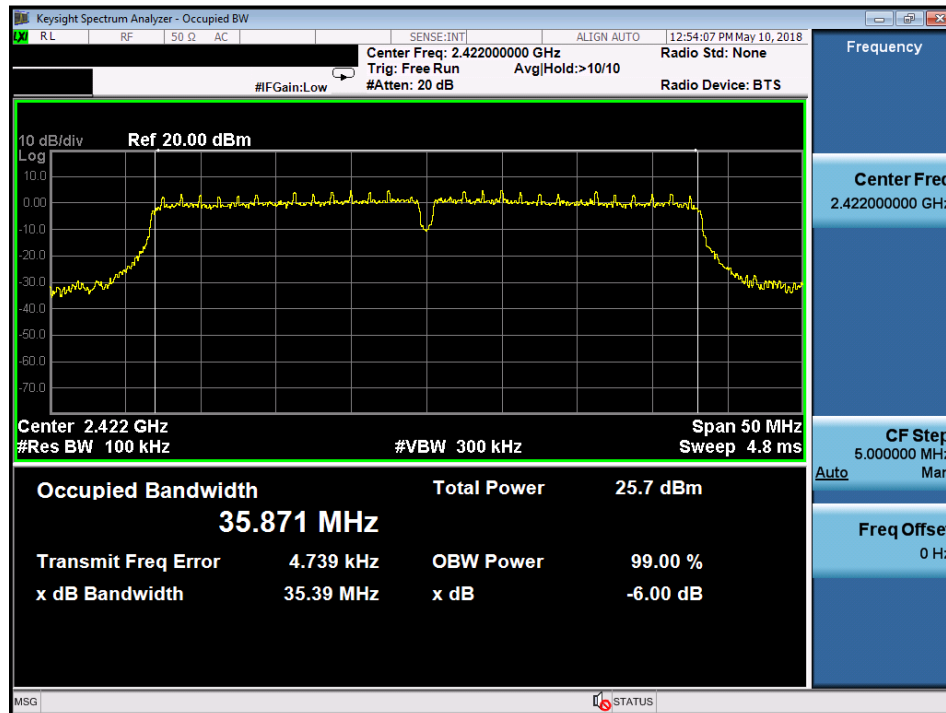


High Channel

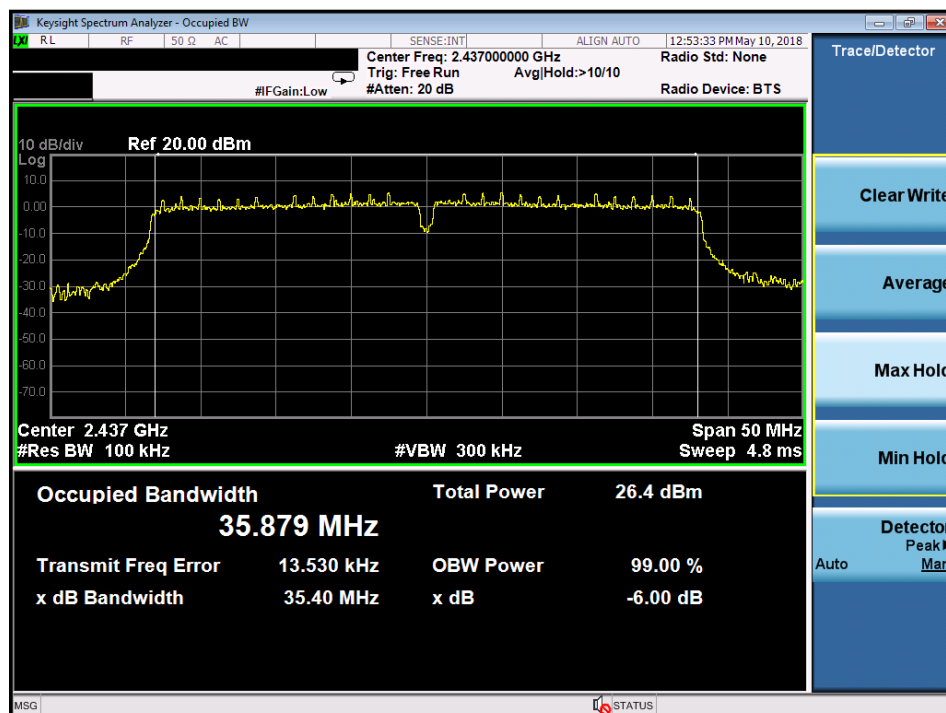


Test Plot of 6dB Bandwidth (802.11n HT40)

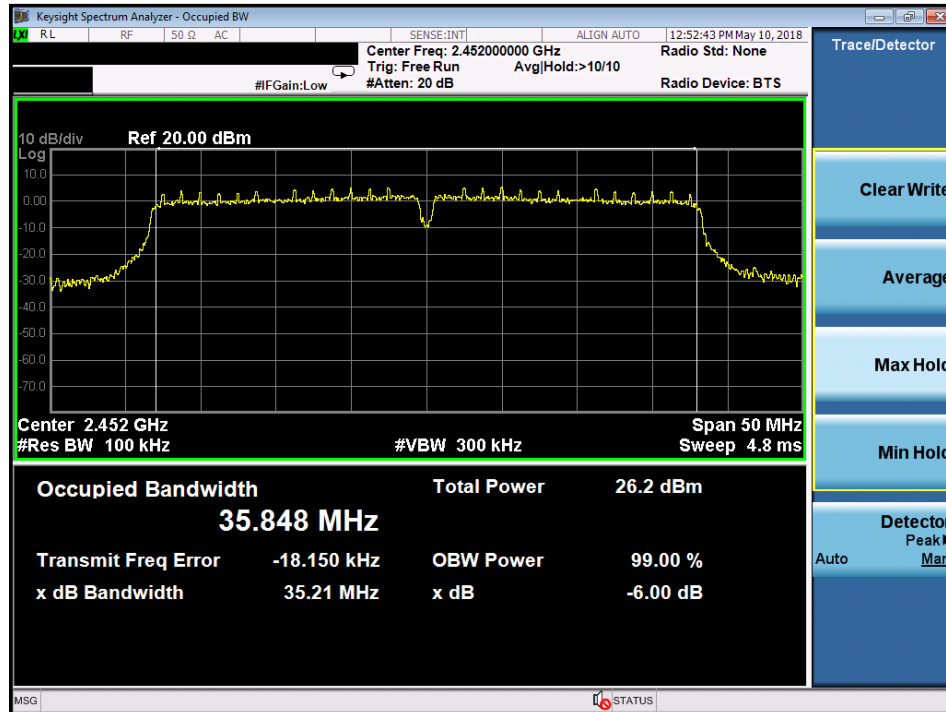
Low Channel



Middle Channel

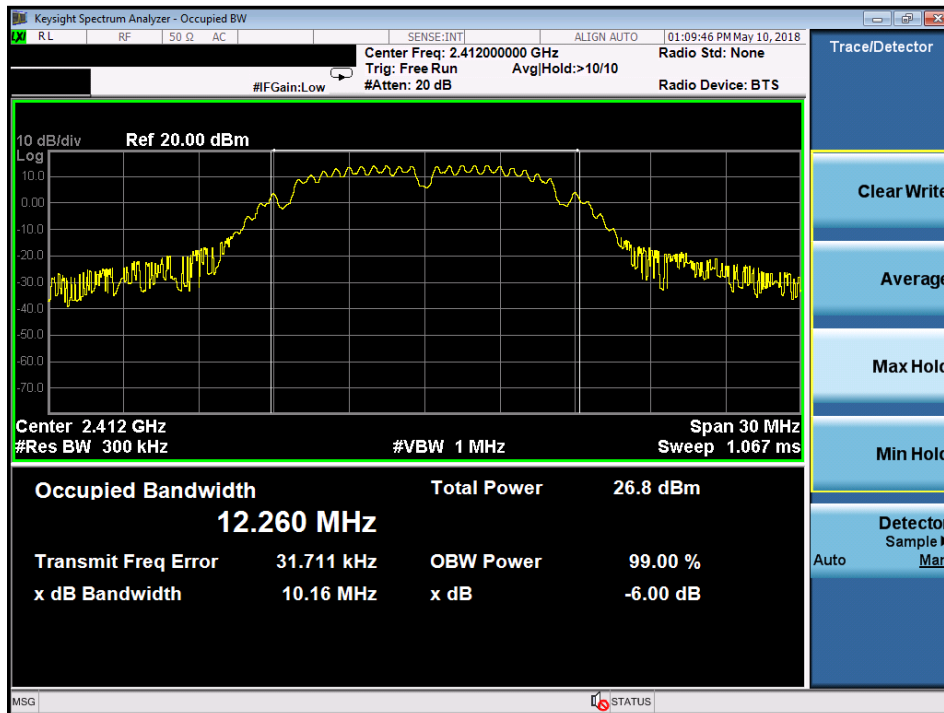


High Channel

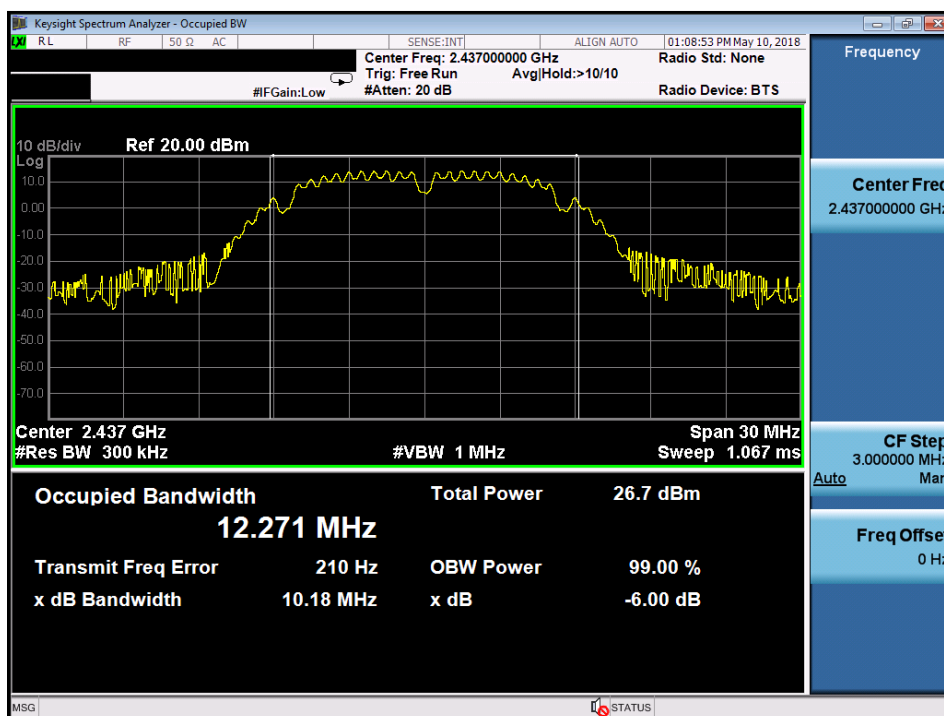


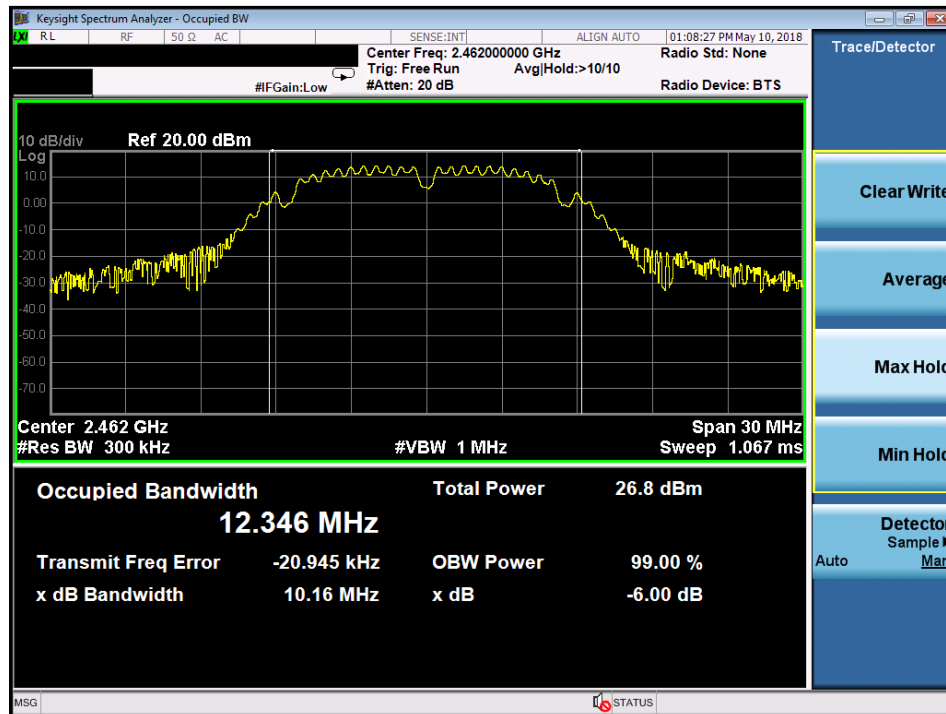
Test Plot of 99% Bandwidth (802.11b)

Low Channel



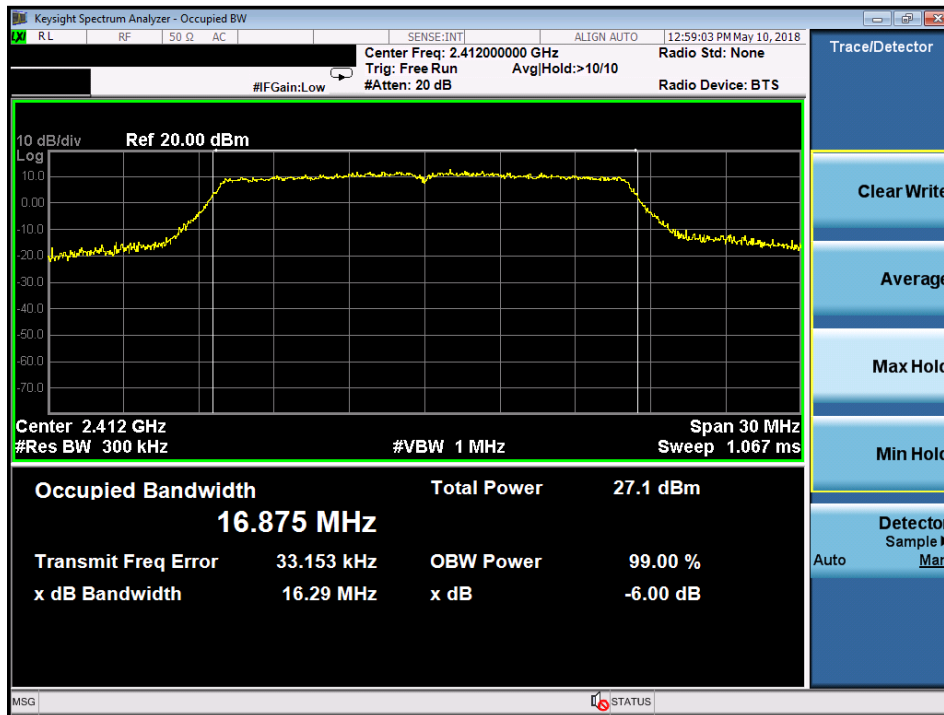
Middle Channel



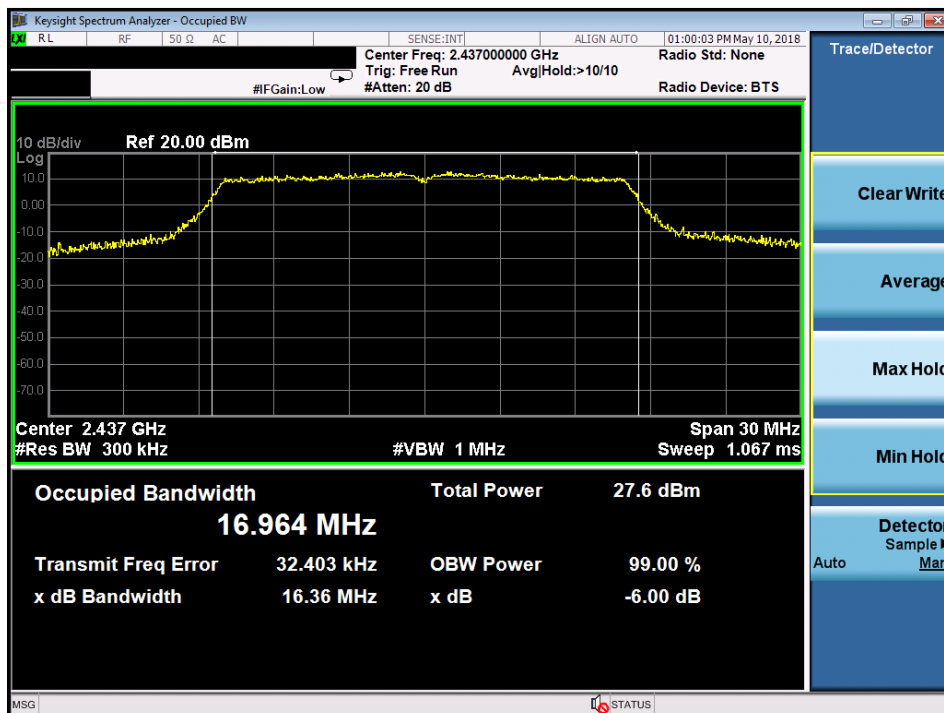
High Channel


Test Plot of 99% Bandwidth (802.11g)

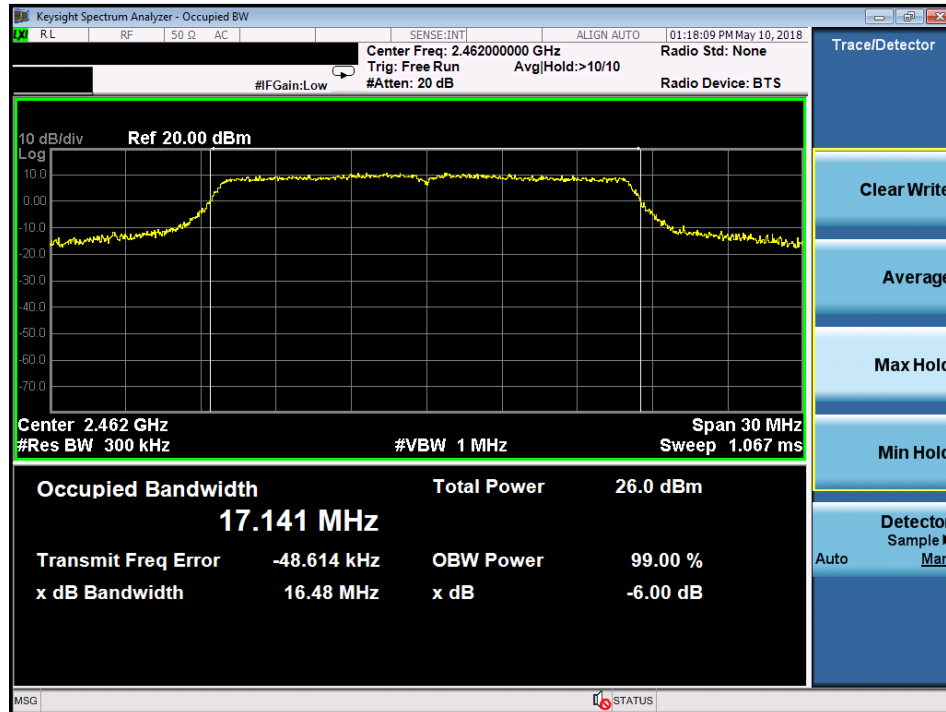
Low Channel



Middle Channel

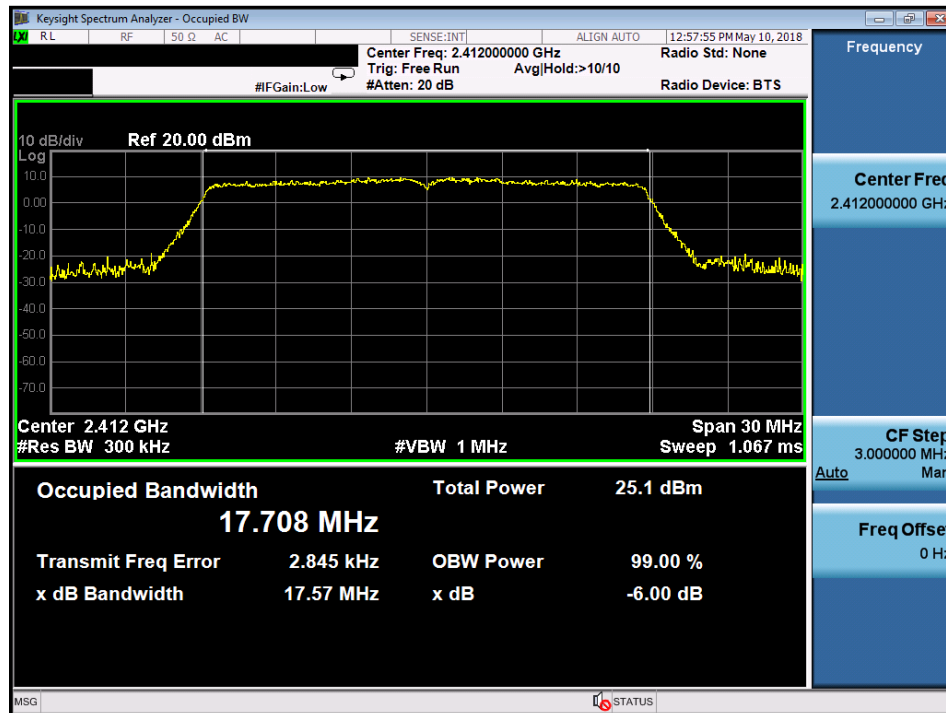


High Channel

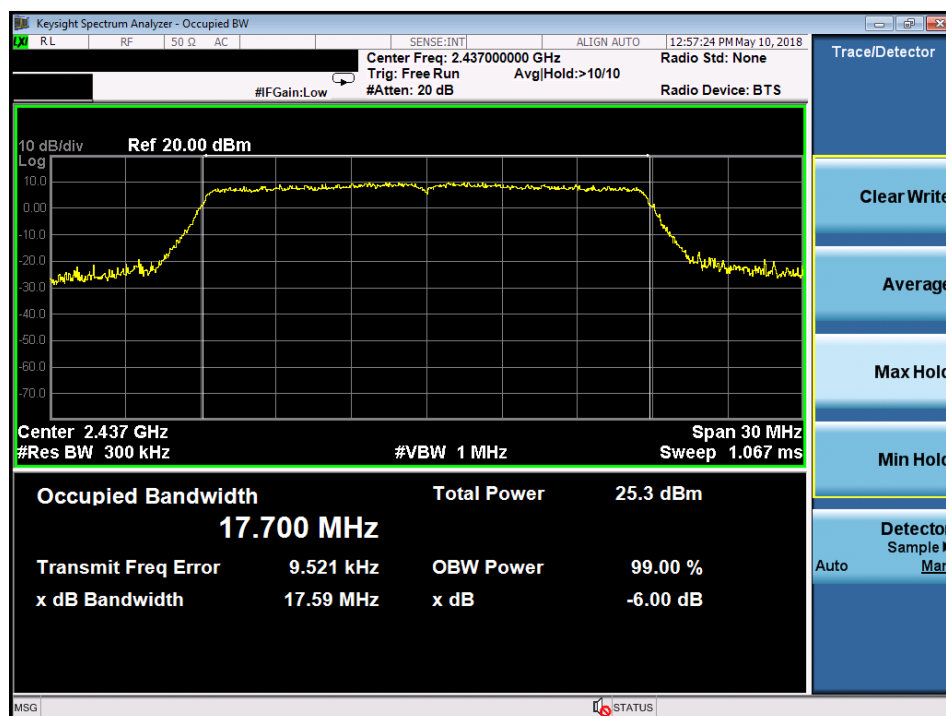


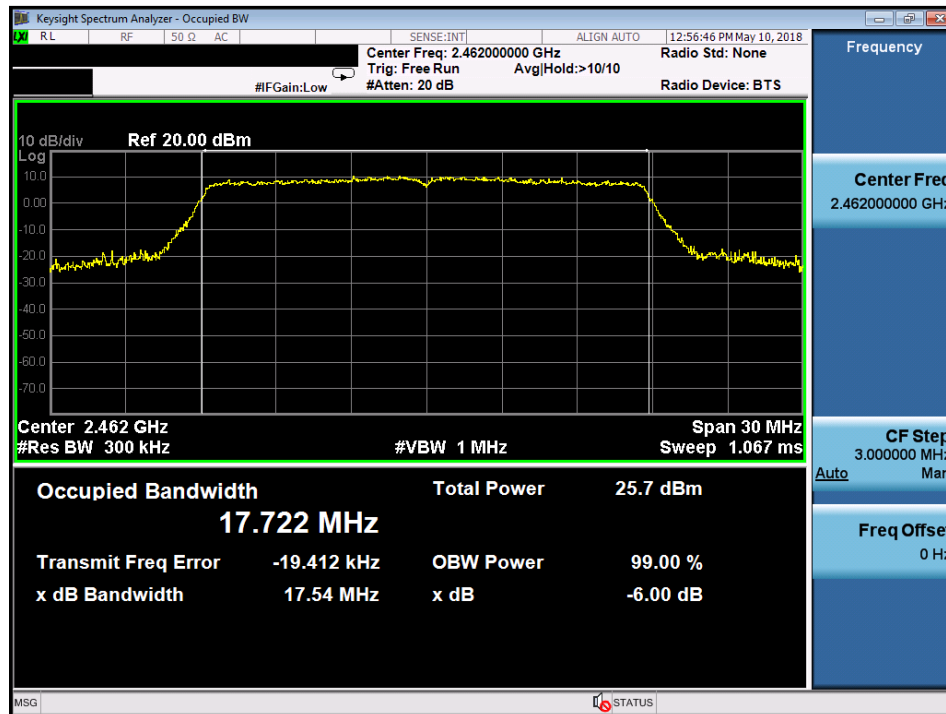
Test Plot of 99% Bandwidth (802.11n HT20)

Low Channel



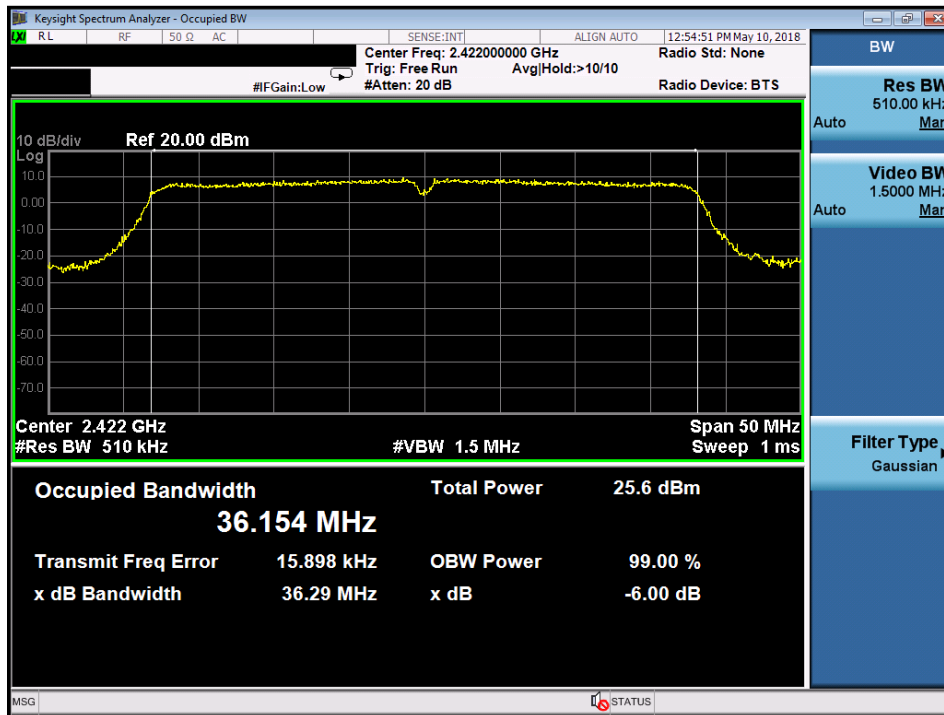
Middle Channel



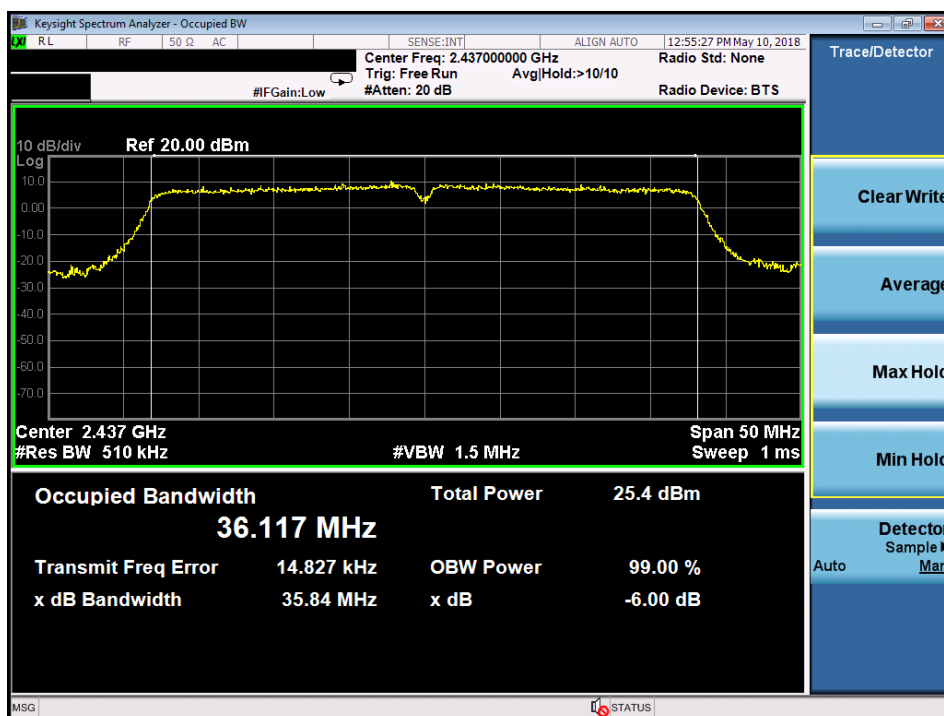
High Channel


Test Plot of 99% Bandwidth (802.11n HT40)

Low Channel



Middle Channel



High Channel
