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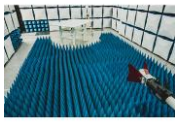

MEASUREMENT REPORT
LTE

Applicant Name:
Apple Inc.
1 Infinite Loop
Cupertino, CA
United States

Date of Testing:
10/31/2017-2/15/2018
Test Site/Location:
PCTEST Lab. Morgan Hill, CA, USA
Test Report Serial No.:
1C1710060006-03-R2.BCG

FCC ID:	**BCGA1954**
APPLICANT:	**Apple Inc.**

Application Type:	Certification
Model:	A1954
EUT Type:	Tablet Device
FCC Classification:	PCS Licensed Transmitter (PCB)
FCC Rule Part(s):	22, 24, & 27
ISED Specification:	RSS-130, RSS-132, RSS-133, RSS-139, RSS-195, RSS-199
Test Procedure(s):	ANSI C63.26-2015, ANSI/TIA-603-E-2016, KDB 971168 D01 v03

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in §2.947. Test results reported herein relate only to the item(s) tested.

This revised Test Report (S/N: 1C1710060006-03-R2.BCG) supersedes and replaces the previously issued test report (S/N: 1C1710060006-03-R1.BCG) on the same subject device for the same type of testing as indicated. Please discard or destroy the previously issued test report(s) and dispose of it accordingly.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Randy Ortanez
President

ACCREDITED
TESTING CERT#2041.02

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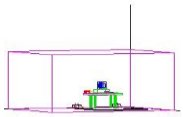
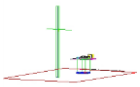


MEASUREMENT REPORT
FCC Part 22, 24, & 27



Mode	Tx Frequency (MHz)	ERP		EIRP		Emission Designator	Modulation
		Max. Power (W)	Max. Power (dBm)	Max. Power (W)	Max. Power (dBm)		
LTE Band 12	699.7 - 715.3	0.132	21.20	0.216	23.35	1M10G7D	QPSK
LTE Band 12	699.7 - 715.3	0.104	20.17	0.171	22.32	1M11W7D	16QAM
LTE Band 12	700.5 - 714.5	0.127	21.03	0.208	23.18	2M71G7D	QPSK
LTE Band 12	700.5 - 714.5	0.105	20.22	0.173	22.37	2M71W7D	16QAM
LTE Band 12	701.5 - 713.5	0.137	21.36	0.224	23.51	4M53G7D	QPSK
LTE Band 12	701.5 - 713.5	0.110	20.41	0.180	22.56	4M50W7D	16QAM
LTE Band 12	704 - 711	0.126	21.01	0.207	23.16	9M01G7D	QPSK
LTE Band 12	704 - 711	0.096	19.84	0.158	21.99	9M01W7D	16QAM
LTE Band 17	706.5 - 713.5	0.138	21.39	0.226	23.54	4M57G7D	QPSK
LTE Band 17	706.5 - 713.5	0.110	20.41	0.180	22.56	4M53W7D	16QAM
LTE Band 17	709 - 711	0.132	21.22	0.201	23.04	9M02G7D	QPSK
LTE Band 17	709 - 711	0.109	20.39	0.179	22.54	9M00W7D	16QAM
LTE Band 13	779.5 - 784.5	0.126	21.01	0.207	23.16	4M57G7D	QPSK
LTE Band 13	779.5 - 784.5	0.100	20.02	0.165	22.17	4M53W7D	16QAM
LTE Band 13	782	0.112	20.51	0.185	22.66	8M98G7D	QPSK
LTE Band 13	782	0.102	20.10	0.168	22.25	9M00W7D	16QAM
LTE Band 5	824.7 - 848.3	0.185	22.67	0.303	24.82	1M10G7D	QPSK
LTE Band 5	824.7 - 848.3	0.151	21.78	0.247	23.93	1M11W7D	16QAM
LTE Band 5	825.5 - 847.5	0.171	22.34	0.281	24.49	2M71G7D	QPSK
LTE Band 5	825.5 - 847.5	0.146	21.64	0.239	23.79	2M71W7D	16QAM
LTE Band 5	826.5 - 846.5	0.185	22.68	0.304	24.83	4M55G7D	QPSK
LTE Band 5	826.5 - 846.5	0.146	21.65	0.240	23.80	4M53W7D	16QAM
LTE Band 5	829 - 844	0.171	22.33	0.271	24.33	9M04G7D	QPSK
LTE Band 5	829 - 844	0.139	21.43	0.227	23.56	9M02W7D	16QAM
LTE Band 26	824.7 - 848.3	0.189	22.76	0.310	24.91	1M10G7D	QPSK
LTE Band 26	824.7 - 848.3	0.149	21.72	0.244	23.87	1M11W7D	16QAM
LTE Band 26	825.5 - 847.5	0.189	22.77	0.310	24.92	2M72G7D	QPSK
LTE Band 26	825.5 - 847.5	0.149	21.72	0.244	23.87	2M71W7D	16QAM
LTE Band 26	826.5 - 846.5	0.189	22.77	0.310	24.92	4M57G7D	QPSK
LTE Band 26	826.5 - 846.5	0.151	21.78	0.247	23.93	4M52W7D	16QAM
LTE Band 26	829 - 844	0.189	22.77	0.310	24.92	9M03G7D	QPSK
LTE Band 26	829 - 844	0.151	21.78	0.247	23.93	9M04W7D	16QAM

EUT Overview (<1GHz)

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Mode	Tx Frequency (MHz)	EIRP		Emission Designator	Modulation
		Max. Power (W)	Max. Power (dBm)		
LTE Band 4	1710.7 - 1754.3	0.316	25.00	1M10G7D	QPSK
LTE Band 4	1710.7 - 1754.3	0.251	24.00	1M11W7D	16QAM
LTE Band 4	1711.5 - 1753.5	0.305	24.84	2M71G7D	QPSK
LTE Band 4	1711.5 - 1753.5	0.244	23.88	2M71W7D	16QAM
LTE Band 4	1712.5 - 1752.5	0.315	24.98	4M57G7D	QPSK
LTE Band 4	1712.5 - 1752.5	0.251	24.00	4M53W7D	16QAM
LTE Band 4	1715 - 1750	0.313	24.96	9M03G7D	QPSK
LTE Band 4	1715 - 1750	0.251	24.00	9M00W7D	16QAM
LTE Band 4	1717.5 - 1747.5	0.310	24.92	13M5G7D	QPSK
LTE Band 4	1717.5 - 1747.5	0.251	24.00	13M5W7D	16QAM
LTE Band 4	1720 - 1745	0.316	25.00	18M0G7D	QPSK
LTE Band 4	1720 - 1745	0.251	24.00	18M1W7D	16QAM
LTE Band 2	1850.7 - 1909.3	0.398	26.00	1M10G7D	QPSK
LTE Band 2	1850.7 - 1909.3	0.348	25.42	1M10W7D	16QAM
LTE Band 2	1851.5 - 1908.5	0.397	25.99	2M72G7D	QPSK
LTE Band 2	1851.5 - 1908.5	0.335	25.25	2M71W7D	16QAM
LTE Band 2	1852.5 - 1907.5	0.405	26.07	4M56G7D	QPSK
LTE Band 2	1852.5 - 1907.5	0.339	25.30	4M53W7D	16QAM
LTE Band 2	1855 - 1905	0.406	26.08	9M02G7D	QPSK
LTE Band 2	1855 - 1905	0.337	25.28	9M01W7D	16QAM
LTE Band 2	1857.5 - 1902.5	0.457	26.60	13M5G7D	QPSK
LTE Band 2	1857.5 - 1902.5	0.359	25.55	13M5W7D	16QAM
LTE Band 2	1860 - 1900	0.481	26.82	18M0G7D	QPSK
LTE Band 2	1860 - 1900	0.406	26.09	17M9W7D	16QAM
LTE Band 25	1850.7 - 1914.3	0.485	26.86	1M10G7D	QPSK
LTE Band 25	1850.7 - 1914.3	0.383	25.83	1M11W7D	16QAM
LTE Band 25	1851.5 - 1913.5	0.479	26.80	2M71G7D	QPSK
LTE Band 25	1851.5 - 1913.5	0.368	25.66	2M71W7D	16QAM
LTE Band 25	1852.5 - 1912.5	0.484	26.85	4M56G7D	QPSK
LTE Band 25	1852.5 - 1912.5	0.372	25.71	4M53W7D	16QAM
LTE Band 25	1855 - 1910	0.470	26.72	9M02G7D	QPSK
LTE Band 25	1855 - 1910	0.374	25.73	9M04W7D	16QAM
LTE Band 25	1857.5 - 1907.5	0.483	26.84	13M5G7D	QPSK
LTE Band 25	1857.5 - 1907.5	0.372	25.71	13M5W7D	16QAM
LTE Band 25	1860 - 1905	0.490	26.90	18M0G7D	QPSK
LTE Band 25	1860 - 1905	0.418	26.21	18M0W7D	16QAM
LTE Band 30	2307.5 - 2312.5	0.209	23.20	4M52G7D	QPSK
LTE Band 30	2307.5 - 2312.5	0.164	22.16	4M51W7D	16QAM
LTE Band 30	2310	0.209	23.20	9M01G7D	QPSK
LTE Band 30	2310	0.164	22.16	9M01W7D	16QAM
LTE Band 7	2502.5 - 2567.5	0.290	24.62	4M57G7D	QPSK
LTE Band 7	2502.5 - 2567.5	0.238	23.76	4M52W7D	16QAM
LTE Band 7	2505 - 2565	0.281	24.48	9M03G7D	QPSK
LTE Band 7	2505 - 2565	0.241	23.82	9M04W7D	16QAM
LTE Band 7	2507.5 - 2562.5	0.284	24.53	13M5G7D	QPSK
LTE Band 7	2507.5 - 2562.5	0.254	24.05	13M5W7D	16QAM
LTE Band 7	2510 - 2560	0.302	24.80	18M0G7D	QPSK
LTE Band 7	2510 - 2560	0.237	23.74	18M0W7D	16QAM
LTE Band 41	2498.5 - 2687.5	0.264	24.21	4M50G7D	QPSK
LTE Band 41	2498.5 - 2687.5	0.209	23.21	4M51W7D	16QAM
LTE Band 41	2501 - 2685	0.262	24.19	8M98G7D	QPSK
LTE Band 41	2501 - 2685	0.209	23.21	8M99W7D	16QAM
LTE Band 41	2503.5 - 2682.5	0.251	23.99	13M5G7D	QPSK
LTE Band 41	2503.5 - 2682.5	0.202	23.05	13M5W7D	16QAM
LTE Band 41	2506 - 2680	0.264	24.21	18M0G7D	QPSK
LTE Band 41	2506 - 2680	0.202	23.06	17M9W7D	16QAM

EUT Overview (>1GHz)

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1.0 INTRODUCTION

1.1 Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission and the Innovation, Science and Economic Development Canada.

1.2 PCTEST Test Location

Measurements were performed at the PCTEST Engineering Lab, Inc. facility located in 18855 Adams Court, Morgan Hill, CA 95037.

1.3 Test Facility / Accreditations

Measurements were performed at PCTEST Engineering Lab located in Morgan Hill, CA 95037, U.S.A.

- PCTEST is an ISO 17025-2005 accredited test facility under the American Association for Laboratory Accreditation (A2LA) with Certificate number 2041.02 for Specific Absorption Rate (SAR), Hearing Aid Compatibility (HAC) testing, where applicable, and Electromagnetic Compatibility (EMC) testing for FCC and Innovation, Science, and Economic Development Canada rules.

- PCTEST TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC 17065-2012 by A2LA (Certificate number 2041.03) in all scopes of FCC Rules and ISED Standards (RSS).

- PCTEST facility is a registered (22831) test laboratory with the site description on file with ISED.

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2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **Apple Tablet Device FCC ID: BCGA1954**. The test data contained in this report pertains only to the emissions due to the EUT's LTE function.

Test Device Serial No.: F9FVT00LJM4W, F9FVT00RJM4W

2.2 Device Capabilities

This device contains the following capabilities:

850/1900 CDMA/EvDO Rev0/A, 1x Advanced (BC0, BC1, BC10), 850/1900 GSM/GPRS/EDGE, 850/1700/1900 WCDMA/HSPA, Multi-band LTE, 802.11b/g/n WLAN, 802.11a/n/ac UNII, Bluetooth (1x, EDR, LE),

2.3 Antenna Configuration

Following antennas were used for the testing.

Frequency (MHz)	Antenna Gain (dBi)
699-716	-1.44
777-787	-0.74
814-824	0.20
824-849	0.43
1710-1755	1.00
1850-1915	2.35
2305-2315	0.90
2496-2690	1.71
2500-2570	1.20
2570-2620	1.50

Table 2-1. Test Peak Antenna Gain

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2.4 Test Support Equipment

1	Apple MacBook	Model:	A1502	S/N:	C02P4004G1R8
	w/ AC/DC Adapter	Model:	A1435	S/N:	C04325505K1F288BG
2	Apple USB Cable	Model:	Kanzi	S/N:	3251F5
3	Apple Earphone	Model:	N/A	S/N:	N/A
4	USB Lightning Cable	Model:	N/A	S/N:	N/A
5	w/ 12 W AC Adapter	Model:	A1401	S/N:	N/A
6	DC Power Supply	Model:	EP20571-110V	S/N:	N/A

Table 2-2. Test Support Equipment Used

2.5 Test Configuration

The EUT was tested per the guidance of ANSI/TIA-603-E-2016 and KDB 971168 D01 v03. See Section 7.0 of this test report for a description of the radiated and antenna port conducted emissions tests.

There are two vendors of the radio modules, variant 1 and variant 2. Both radio modules have the same mechanical outline, same on-board antenna matching circuit, identical antenna structure, and are built and tested to conform to the same specifications and to operate within the same tolerances. The worst case configuration was found between the two variants. The EUT was also investigated with and without charger.

The emissions below 1GHz and above 18GHz were tested with the highest transmitting power channel and the worst case configuration.

The EUT was manipulated through three orthogonal planes of X-orientation (flatbed), Y-orientation (landscape), and Z-orientation (portrait) during the testing. Only the worst case emissions were reported in this test report. The worst orientation was found to be Y-orientation (landscape).

2.6 Software and Firmware

The test was conducted with firmware version 15E61570I installed on the EUT.

For conducted spurious emissions, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance.

2.7 EMI Suppression Device(s)/Modifications

No EMI suppression device(s) were added and no modifications were made during testing.

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3.0 DESCRIPTION OF TESTS

3.1 Measurement Procedure

The measurement procedures described in the document titled "Land Mobile FM or PM – Communications Equipment – Measurements and Performance Standards" (ANSI/TIA-603-E-2016) and "Procedures for Compliance Measurement of the Fundamental Emission Power of Licensed Wideband (> 1 MHz) Digital Transmission Systems" (KDB 971168 D01 v03) were used in the measurement of the EUT**.**

3.2 Block C Frequency Range

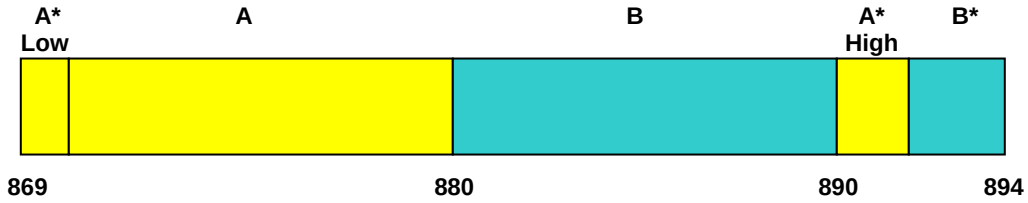
Two paired channels of 11 megahertz each are available for assignment in Block C in the 746-757 MHz and 776-787 MHz bands. In the event that no licenses for two channels in this Block C are assigned based on the results of the first auction in which such licenses were offered because the auction results do not satisfy the applicable reserve price, the spectrum in the 746-757 MHz and 776-787 MHz bands will instead be made available for assignment at a subsequent auction as follows: (i) Two paired channels of 6 megahertz each available for assignment in Block C1 in the 746-752 MHz and 776-782 MHz bands. (ii) Two paired channels of 5 megahertz each available for assignment in Block C2 in the 752-757 MHz and 782-787 MHz bands.

3.3 Block A Frequency Range

698-746 MHz band. The following frequencies are available for licensing pursuant to this part in the 698-746 MHz band: (1) Three paired channel blocks of 12 megahertz each are available for assignment as follows:

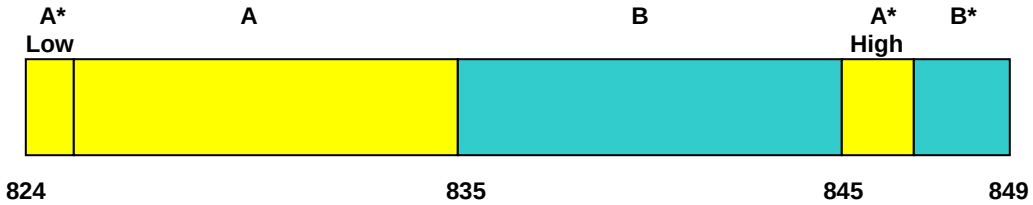
Block A: 698-704 MHz and 728-734 MHz;
Block B: 704-710 MHz and 734-740 MHz; and
Block C: 710-716 MHz and 740-746 MHz.

3.4 Cellular - Base Frequency Blocks



BLOCK 1: 869 – 880 MHz (A* Low + A)
BLOCK 2: 880 – 890 MHz (B)
BLOCK 3: 890 – 891.5 MHz (A* High)
BLOCK 4: 891.5 – 894 MHz (B*)

3.5 Cellular - Mobile Frequency Blocks



BLOCK 1: 824 – 835 MHz (A* Low + A)
BLOCK 2: 835 – 845 MHz (B)
BLOCK 3: 845 – 846.5 MHz (A* High)
BLOCK 4: 846.5 – 849 MHz (B*)

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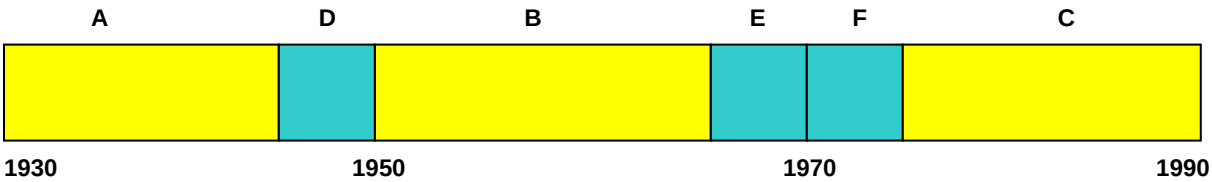
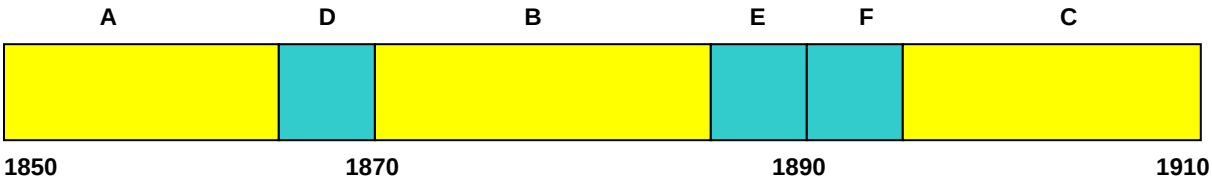
3.6 PCS - Base Frequency Blocks



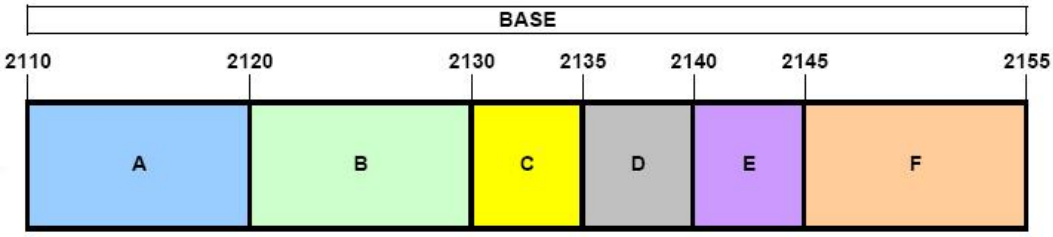
BLOCK 1: 1930 – 1945 MHz (A)
BLOCK 2: 1945 – 1950 MHz (D)
BLOCK 3: 1950 – 1965 MHz (B)
BLOCK 4: 1965 – 1970 MHz (E)
BLOCK 5: 1970 – 1975 MHz (F)
BLOCK 6: 1975 – 1990 MHz (C)

3.7 PCS - Mobile Frequency Blocks



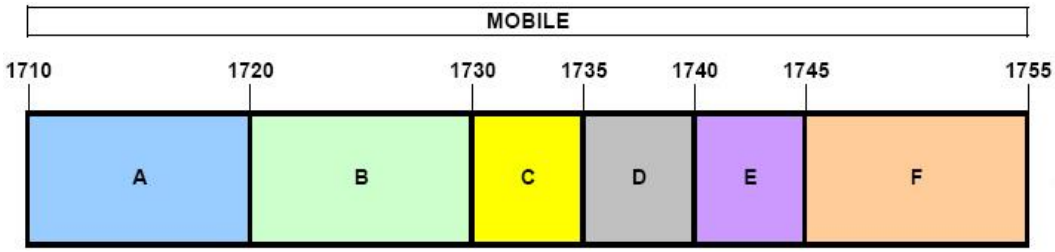
BLOCK 1: 1850 – 1865 MHz (A)
BLOCK 2: 1865 – 1870 MHz (D)
BLOCK 3: 1870 – 1885 MHz (B)
BLOCK 4: 1885 – 1890 MHz (E)
BLOCK 5: 1890 – 1895 MHz (F)
BLOCK 6: 1895 – 1910 MHz (C)

3.8 AWS - Base Frequency Blocks



BLOCK 1: 2110 – 2120 MHz (A)
BLOCK 2: 2120 – 2130 MHz (B)
BLOCK 3: 2130 – 2135 MHz (C)
BLOCK 4: 2135 – 2140 MHz (D)
BLOCK 5: 2140 – 2145 MHz (E)
BLOCK 6: 2145 – 2155 MHz (F)

3.9 AWS - Mobile Frequency Blocks



BLOCK 1: 1710 – 1720 MHz (A)
BLOCK 2: 1720 – 1730 MHz (B)
BLOCK 3: 1730 – 1735 MHz (C)
BLOCK 4: 1735 – 1740 MHz (D)
BLOCK 5: 1740 – 1745 MHz (E)
BLOCK 6: 1745 – 1755 MHz (F)

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3.10 WCS – Mobile/Base Frequency Blocks

The following frequencies are available for WCS in the 2305-2320 MHz and 2345-2360 MHz bands:

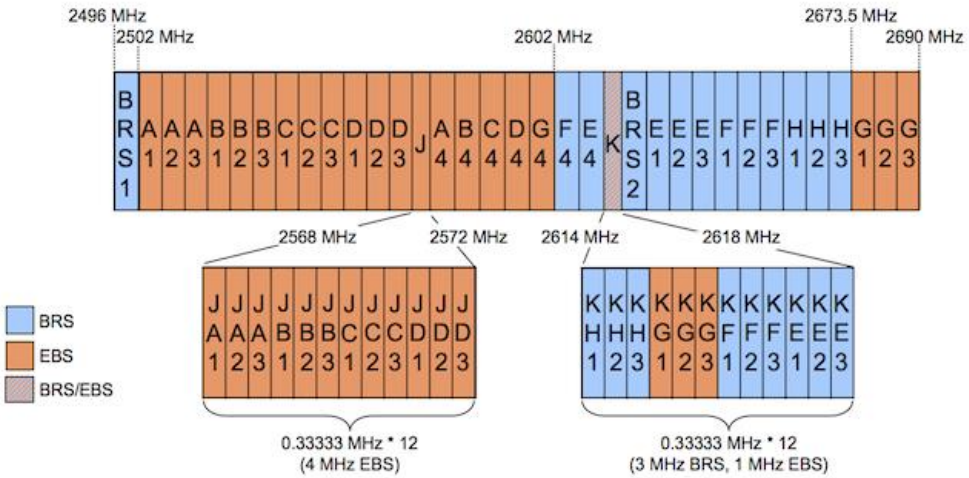
BLOCK 1: 2305-2310 and 2350-2355 MHz (A)

BLOCK 2: 2310-2315 and 2355-236 MHz (B)

BLOCK 3: 2315-2320 MHz (C)

BLOCK 4: 2345-2350 MHz (D)

3.11 BRS/EBS Frequency Block



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3.12 Radiated Power and Radiated Spurious Emissions

§2.1053 §22.913(a.2) §22.917(a) §24.232(c) §24.238(a) §27.50(b.10) §27.50(c.10) §27.50(d.4) §27.53(f) §27.53(g) §27.53(h) §27.53(m)

The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. The test site inside the chamber is a 6m x 5.2m elliptical, obstruction-free area in accordance with Figure 5.7 of Clause 5 in ANSI C63.4-2014. Absorbers are arranged on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections for measurements above 1GHz. For measurements below 1GHz, the absorbers are removed. A raised turntable is used for radiated measurement. The turn table is a continuously rotatable, remote-controlled, metallic turntable and 2 meters (6.56 ft.) in diameter. The turn table is flush with the raised floor of the chamber in order to maintain its function as a ground plane. An 80cm tall test table made of Styrodur is placed on top of the turn table. A Styrodur pedestal is placed on top of the test table to bring the total table height to 1.5m.

The equipment under test was transmitting while connected to its integral antenna and is placed on a turntable 3 meters from the receive antenna. The receive antenna height is adjusted between 1 and 4 meter height, the turntable is rotated through 360 degrees, and the EUT is manipulated through all orthogonal planes representative of its typical use to achieve the highest reading on the receive spectrum analyzer. Per the guidelines of KDB 412172 D01 v01r01, radiated power levels are measured using the following formula:

$$\text{ERP or EIRP} = P_T + G_T - L_C$$

Where P_T is the transmitter output power, expressed in dBm, G_T is the gain of the transmitting antenna, in dBd (ERP) or dBi (EIRP), and L_C signal attenuation in the connecting cable between the transmitter and antenna in dB.

Per the guidance of ANSI/TIA-603-E-2016, a half-wave dipole is substituted in place of the EUT. For emissions above 1GHz, a horn antenna is substituted in place of the EUT. The substitute antenna is driven by a signal generator with the level of the signal generator being adjusted to obtain the same receive spectrum analyzer level previously recorded from the spurious emission from the EUT. The power of the emission is calculated using the following formula:

$$P_{d\,[dBm]} = P_{g\,[dBm]} - \text{cable loss}_{\,[dB]} + \text{antenna gain}_{\,[dBd/dBi]}$$

Where, P_d is the dipole equivalent power, P_g is the generator output into the substitution antenna, and the antenna gain is the gain of the substitute antenna used relative to either a half-wave dipole (dBd) or an isotropic source (dBi). The substitute level is equal to $P_{g\,[dBm]}$ – cable loss $_{[dB]}$.

The calculated P_d levels are then compared to the absolute spurious emission limit of -13dBm which is equivalent to the required minimum attenuation of 43 + $10\log_{10}$(Power $_{[Watts]}$). For Band 7 and 41, the calculated P_d levels are compared to the absolute spurious emission limit of -25dBm which is equivalent to the required minimum attenuation of 55 + $10\log_{10}$(Power $_{[Watts]}$). For Band 30, the calculated P_d levels are compared to the absolute spurious emission limit of -40dBm which is equivalent to the required minimum attenuation of 70 + $10\log_{10}$(Power $_{[Watts]}$).

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4.0 MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.4-2014. All measurement uncertainty values are shown with a coverage factor of k = 2 to indicate a 95% level of confidence. The measurement uncertainty shown below meets or exceeds the $\mathbf{U}_{CISPR}$ measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Contribution	Expanded Uncertainty (±dB)
Conducted Bench Top Measurements	1.13
Radiated Disturbance (<1GHz)	4.98
Radiated Disturbance (>1GHz)	5.07
Radiated Disturbance (>18GHz)	5.09

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5.0 TEST EQUIPMENT CALIBRATION DATA

Test Equipment Calibration is traceable to the National Institute of Standards and Technology (NIST). Measurements antennas used during testing were calibrated in accordance to the requirements of ANSI C63.5-2017.

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
ATM	180-442A-KF	20dB Nominal Gain Horn Antenna (18-40GHz)	2/24/2017	Annual	2/24/2018	T058701-03
-	AM LTX1	Licensed Tramsmitter Cable Set	3/17/2017	Annual	3/17/2018	AM LTX1
-	EMI 3117-ESW1	Radiated Cable Set	3/1/2017	Biennial	3/1/2018	N/A
-	EMI HL562E-ESW1	Radiated Cable Set	2/28/2017	Biennial	2/28/2018	N/A
ESPEC	SU-241	Temperature Chamber	3/10/2017	Annual	3/10/2018	92009574
Keysight Technologies	N9030A	3Hz-44Ghz PXA Signal Analyzer	3/13/2017	Annual	3/13/2018	MY49430244
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	11/9/2016	Annual	11/9/2018	152026
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	5/8/2017	Annual	5/8/2018	161616-DF
Rohde & Schwarz	ESW26	ESW26 EMI Test Receiver	7/15/2017	Annual	7/15/2018	101299
Rohde & Schwarz	ESW44	EMI Test Receiver	11/14/2017	Annual	11/14/2018	101570
Rohde & Schwarz	OSP130	Open Switch and Control Unit	1/18/2017	Annual	1/18/2018	100970
Rohde & Schwarz	SFUNIT-RX	TS-SFUNIT SHIELDED FILTER UNIT	2/3/2017	Annual	2/3/2018	102131
Rohde & Schwarz	TS-PR1840	Pre-Amplifier (18GHz - 40GHz)	1/3/2017	Annual	1/3/2018	100052
Rohde & Schwarz	TS-PR8	Pre-amplifer (30MHz - 8GHz)	2/3/2017	Annual	2/3/2018	102325
Rohde & Schwarz	TC-TA18	CROSS POL. VIVALDI ANT (400MHz - 18GHz)	11/13/2017	Annual	11/13/2018	101056-AE

Table 5-1. Test Equipment

Notes:

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

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6.0 SAMPLE CALCULATIONS

Emission Designator

QPSK Modulation

Emission Designator = 8M62G7D

LTE BW = 8.62 MHz
G = Phase Modulation
7 = Quantized/Digital Info
D = Data transmission, telemetry, telecommand

QAM Modulation

Emission Designator = 8M45W7D

LTE BW = 8.45 MHz
W = Amplitude/Angle Modulated
7 = Quantized/Digital Info
D = Data transmission, telemetry, telecommand

Spurious Radiated Emission – LTE Band

Example: Middle Channel LTE Mode 2nd Harmonic (1564 MHz)

The average spectrum analyzer reading at 3 meters with the EUT on the turntable was –81.0 dBm. The gain of the substituted antenna is 8.1 dBi. The signal generator connected to the substituted antenna terminals is adjusted to produce a reading of –81.0 dBm on the spectrum analzyer. The loss of the cable between the signal generator and the terminals of the substituted antenna is 2.0 dB at 1564 MHz. So 6.1 dB is added to the signal generator reading of –30.9 dBm yielding –24.80 dBm. The fundamental EIRP was 25.501 dBm so this harmonic was 25.501 dBm – (-24.80).

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7.0 TEST RESULTS

7.1 Summary

Company Name: Apple Inc.

FCC ID: BCGA1954

FCC Classification: PCS Licensed Transmitter (PCB)

Mode(s): LTE

FCC Part Section(s)	RSS Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
2.1049	RSS-Gen(4.6.1) RSS-133(2.3) RSS-139(2.3)	Occupied Bandwidth	N/A	CONDUCTED	PASS	Section 7.2
2.1051 2.917(a) 24.238(a) 27.53(c) 27.53(g) 27.53(h)	RSS-130(4.6) RSS-132(5.5) RSS-133(6.5) RSS-139(6.6)	Out of Band Emissions	> 43 + 10log$_{10}$ (P[Watts]) at Band Edge and for all out-of-band emissions		PASS	Section 7.3, 7.4
27.53(m)	RSS-199(4.5)	Out of Band Emissions	Undesirable emissions must meet the limits detailed in 27.53(m) (RSS-199)		PASS	Section 7.3, 7.4
27.53(a)	RSS-195(5.6)	Out of Band Emissions	Undesirable emissions must meet the limits detailed in 27.53(a)		PASS	Section 7.3, 7.4
24.232(d)	RSS-130(4.4) RSS-132(5.4) RSS-133(6.4) RSS-139(6.5)	Peak-Average Ratio	< 13 dB		PASS	Section 7.5
2.1046	RSS-130(4.4) RSS-132(5.4) RSS-133(4.1) RSS-139(4.1) RSS-199(4.4)	Transmitter Conducted Output Power	N/A		PASS	See RF Exposure Report
2.1055 22.355 24.235 27.54	RSS-130(4.3) RSS-132(5.3) RSS-133(6.3) RSS-139(6.4) RSS-199(4.3)	Frequency Stability	< 2.5 ppm (Part 22) and fundamental emissions stay within authorized frequency block (Part 24, 27)		PASS	Section 7.8

Table 7-1. Summary of Conducted Test Results

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FCC Part Section(s)	RSS Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
22.913(a)(2)	RSS-132(5.4)	Effective Radiated Power / Equivalent Isotropic Radiated Power (Band 26, 5)	< 7 Watts max. ERP < 11.5 Watts max. EIRP (ISED)	RADIATED	PASS	Section 7.6
27.50(b)(10) 27.50(c)(10)	RSS-130(4.4)	Effective Radiated Power / Equivalent Isotropic Radiated Power (Band 12, 17, 13)	< 3 Watts max. ERP < 5 Watts max. EIRP (ISED)		PASS	Section 7.6
24.232(c) 27.50(h)(2)	RSS-133(6.4) RSS-199(4.4)	Equivalent Isotropic Radiated Power (Band 25, 2, 7, 41)	< 2 Watts max. EIRP		PASS	Section 7.6
27.50(d)(4)	RSS-139(6.5)	Equivalent Isotropic Radiated Power (Band 4)	< 1 Watts max. EIRP		PASS	Section 7.6
27.50(a)(3)	RSS-195(5.5)	Equivalent Isotropic Radiated Power (Band 30)	< 0.25 Watts max. EIRP		PASS	Section 7.6
2.1053 22.917(a) 24.238(a) 27.53(c) 27.53(g) 27.53(h)	RSS-130(4.6) RSS-132(5.5) RSS-133(6.5) RSS-139(6.6)	Undesirable Emissions (Band 12, 17, 26, 5, 4, 25, 2)	> 43 + $10\log_{10}$ (P[Watts]) for all out-of-band emissions		PASS	Section 7.7
27.53(f)	N/A	Undesirable Emissions (Band 13)	< -70 dBW/MHz (for wideband signals) < -80 dBW (for discrete emissions less than 700Hz BW) For all emissions in the band 1559 – 1610 MHz		PASS	Section 7.7
27.53(a)	RSS-195(5.6)	Undesirable Emissions (Band 30)	> 70 + $10\log_{10}$ (P[Watts])		PASS	Section 7.7
27.53(m)	RSS-199(4.5)	Undesirable Emissions (Band 7, 41)	Undesirable emissions must meet the limits detailed in 27.53(m) (RSS-199)		PASS	Section 7.7

Table 7-2. Summary of Radiated Test Results

Notes:

1) All modes of operation and data rates were investigated. The test results shown in the following sections represent the worst case emissions.
2) The analyzer plots (Sections 7.2, 7.3, 7.4, 7.5) were all taken with a correction table loaded into the analyzer. The correction table was used to account for the losses of the cables, directional couplers, and attenuators used as part of the system to maintain a link between the call box and the EUT at all frequencies of interest.
3) All antenna port conducted emissions testing was performed on a test bench with the antenna port of the EUT connected to the spectrum analyzer through calibrated cables, attenuators, and couplers.
4) For conducted spurious emissions, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is PCTEST "LTE Automation," Version 4.8.
5) For operation <1GHz, the EIRP limits in the table above are referenced to the specifications written in the relevant Radio Standards Specifications for Innovation, Science, and Economic Development Canada.

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7.2 Occupied Bandwidth

§2.1049

Test Overview

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured. All modes of operation were investigated and the worst case configuration results are reported in this section.

Test Procedure Used

KDB 971168 D01 v03 – Section 4.2

Test Settings

1. The signal analyzer's automatic bandwidth measurement capability was used to perform the 99% occupied bandwidth and the 26dB bandwidth. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. RBW = 1 – 5% of the expected OBW
3. VBW ≥ 3 x RBW
4. Detector = Peak
5. Trace mode = max hold
6. Sweep = auto couple
7. The trace was allowed to stabilize
8. If necessary, steps 2 – 7 were repeated after changing the RBW such that it would be within 1 – 5% of the 99% occupied bandwidth observed in Step 7

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

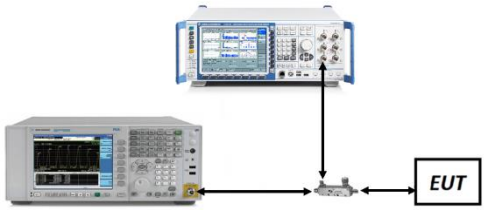

Figure 7-1. Test Instrument & Measurement Setup

Test Notes

None.

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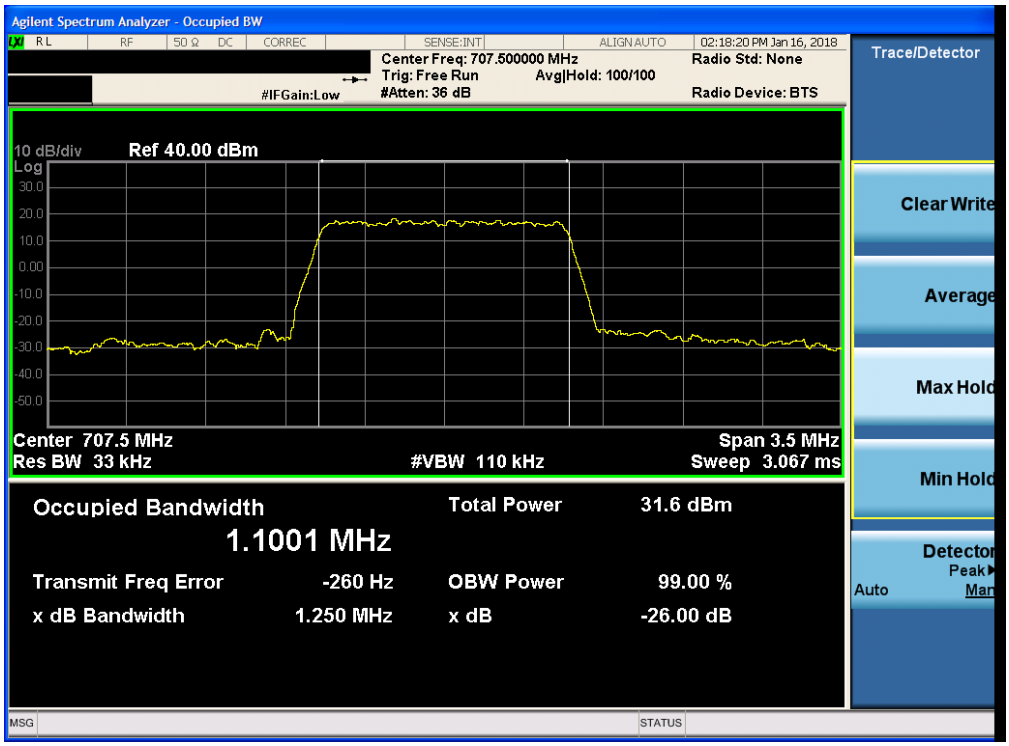
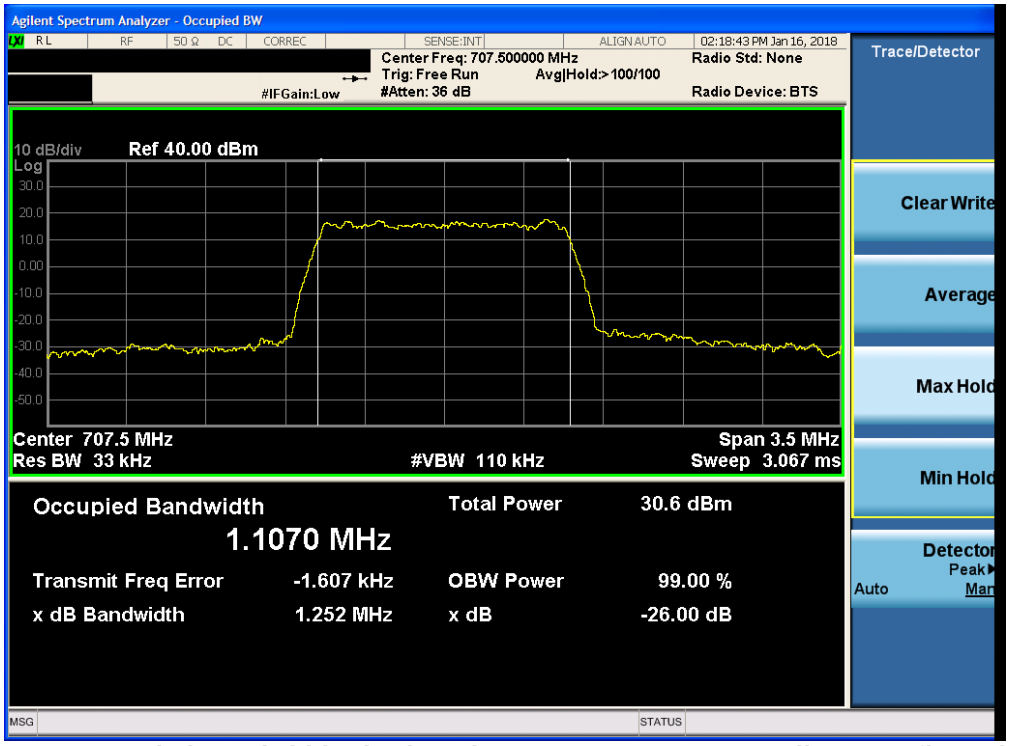
Band 12



Plot 7-1. Occupied Bandwidth Plot (Band 12 - 1.4MHz QPSK - Full RB Configuration)



Plot 7-2. Occupied Bandwidth Plot (Band 12 - 1.4MHz 16-QAM - Full RB Configuration)

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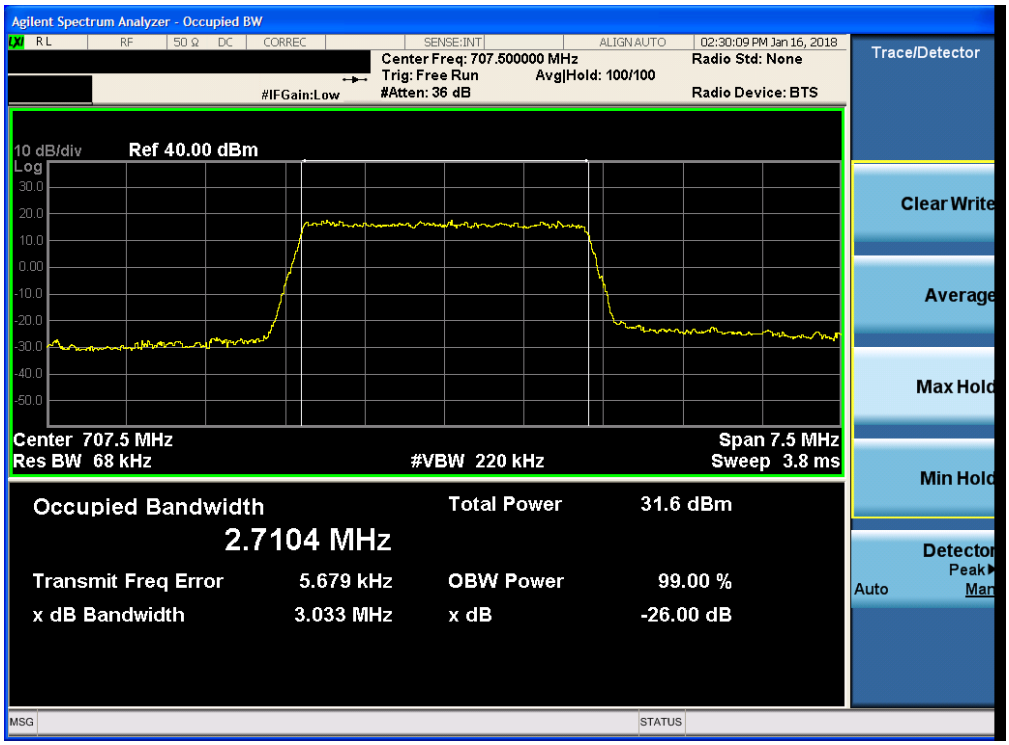

Plot 7-3. Occupied Bandwidth Plot (Band 12 - 3.0MHz QPSK - Full RB Configuration)

Plot 7-4. Occupied Bandwidth Plot (Band 12 - 3.0MHz 16-QAM - Full RB Configuration)

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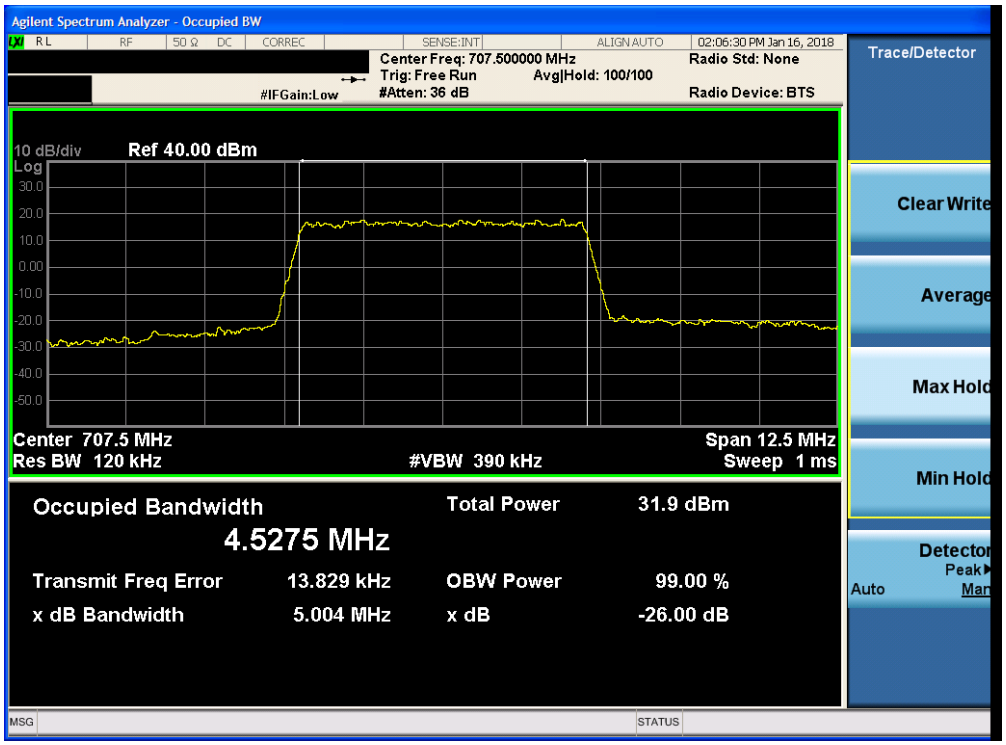
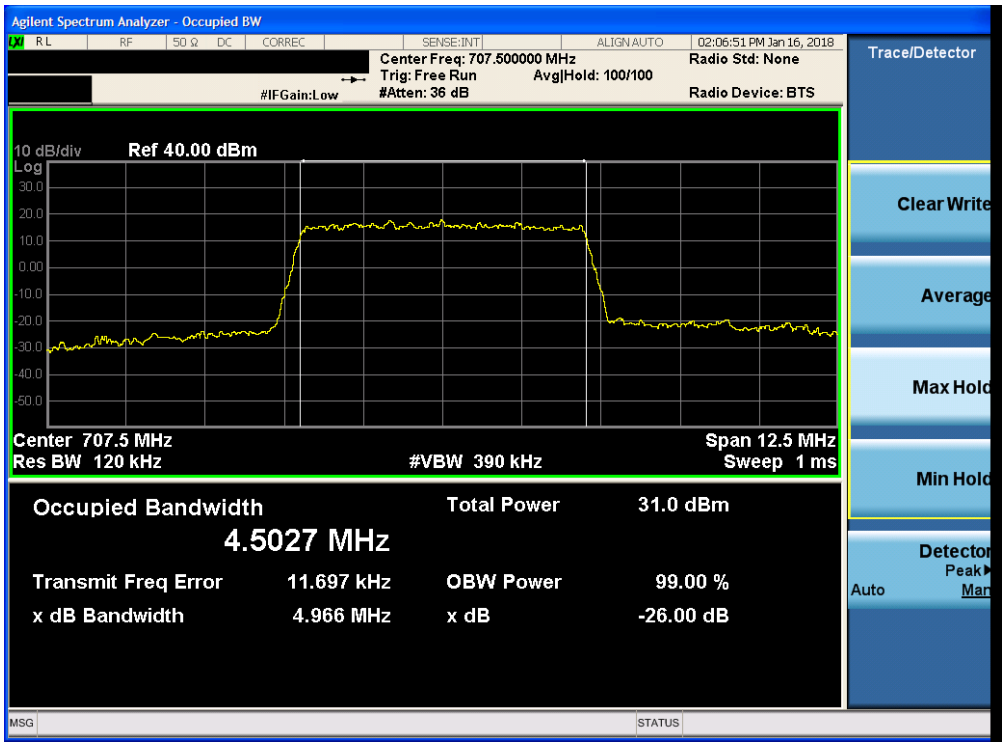


Plot 7-5. Occupied Bandwidth Plot (Band 12 - 5.0MHz QPSK - Full RB Configuration)



Plot 7-6. Occupied Bandwidth Plot (Band 12 - 5.0MHz 16-QAM - Full RB Configuration)

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Plot 7-7. Occupied Bandwidth Plot (Band 12 - 10.0MHz QPSK - Full RB Configuration)

Plot 7-8. Occupied Bandwidth Plot (Band 12 - 10.0MHz 16-QAM - Full RB Configuration)

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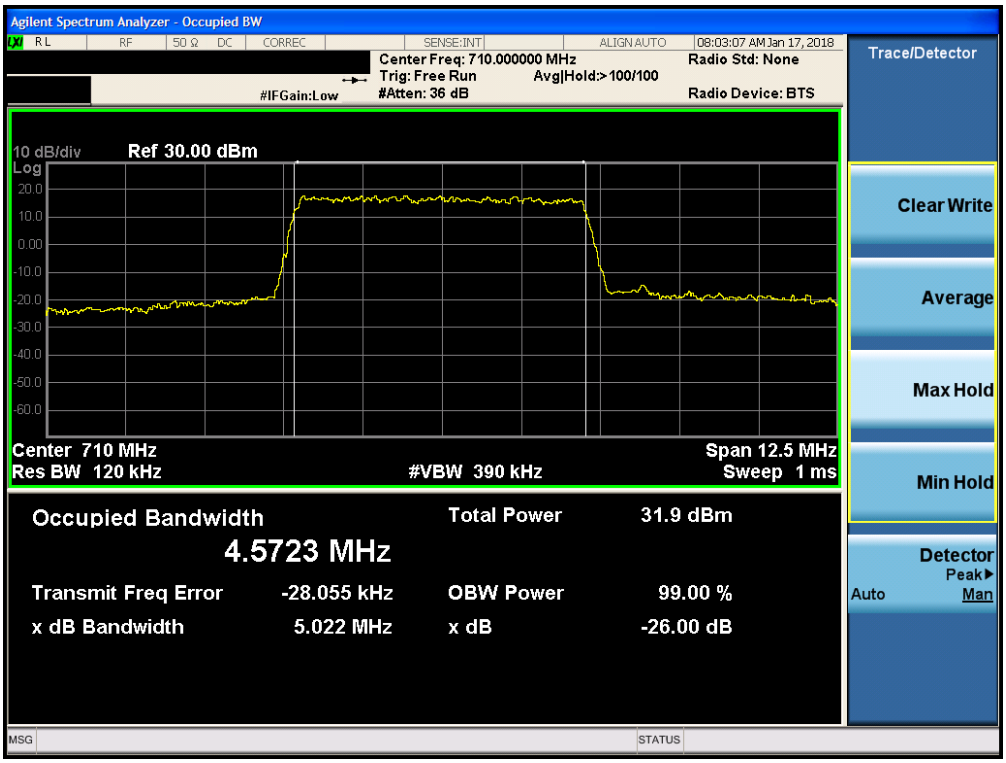
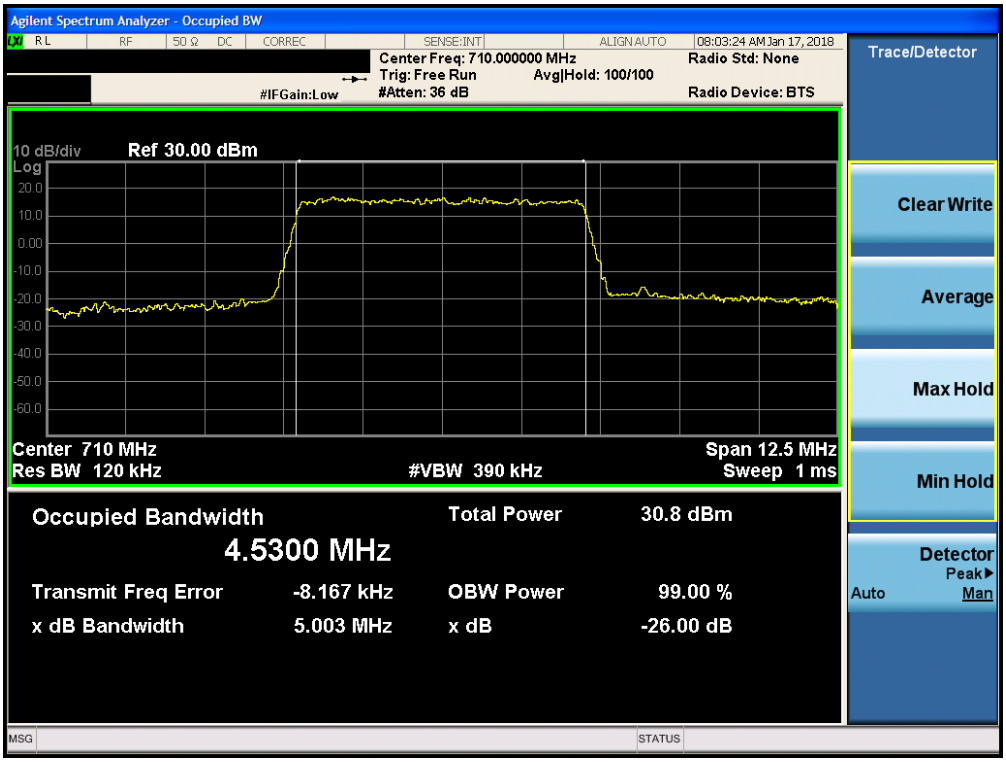
Band 17



Plot 7-9. Occupied Bandwidth Plot (Band 17 - 5.0MHz QPSK - Full RB Configuration)



Plot 7-10. Occupied Bandwidth Plot (Band 17 - 5.0MHz 16-QAM - Full RB Configuration)

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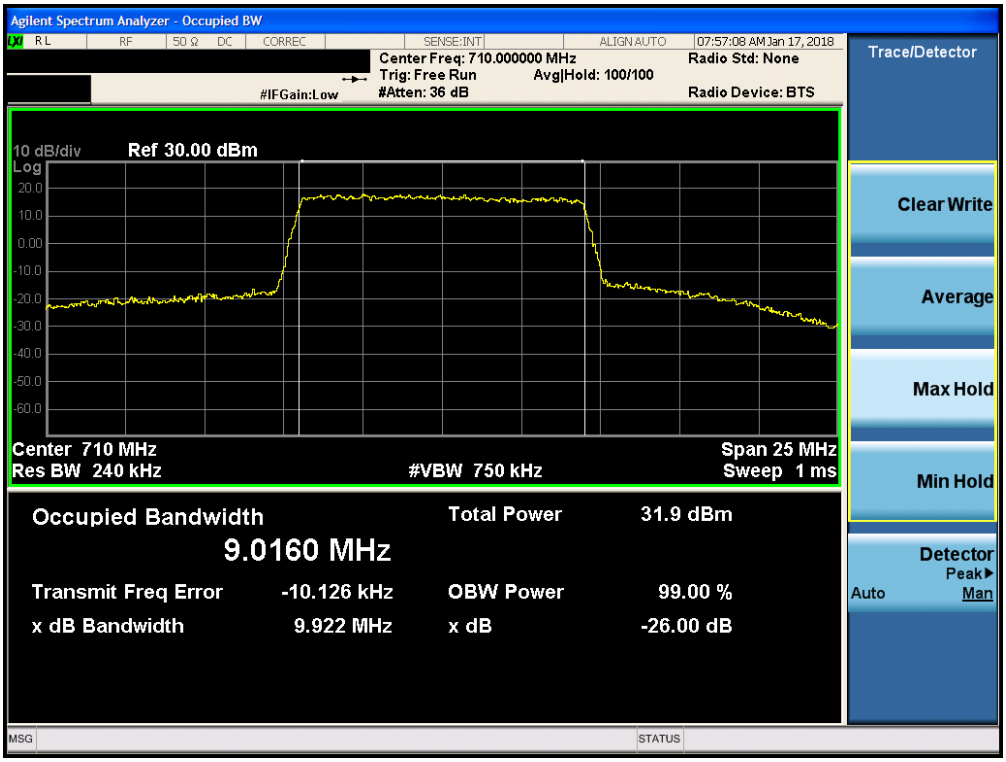
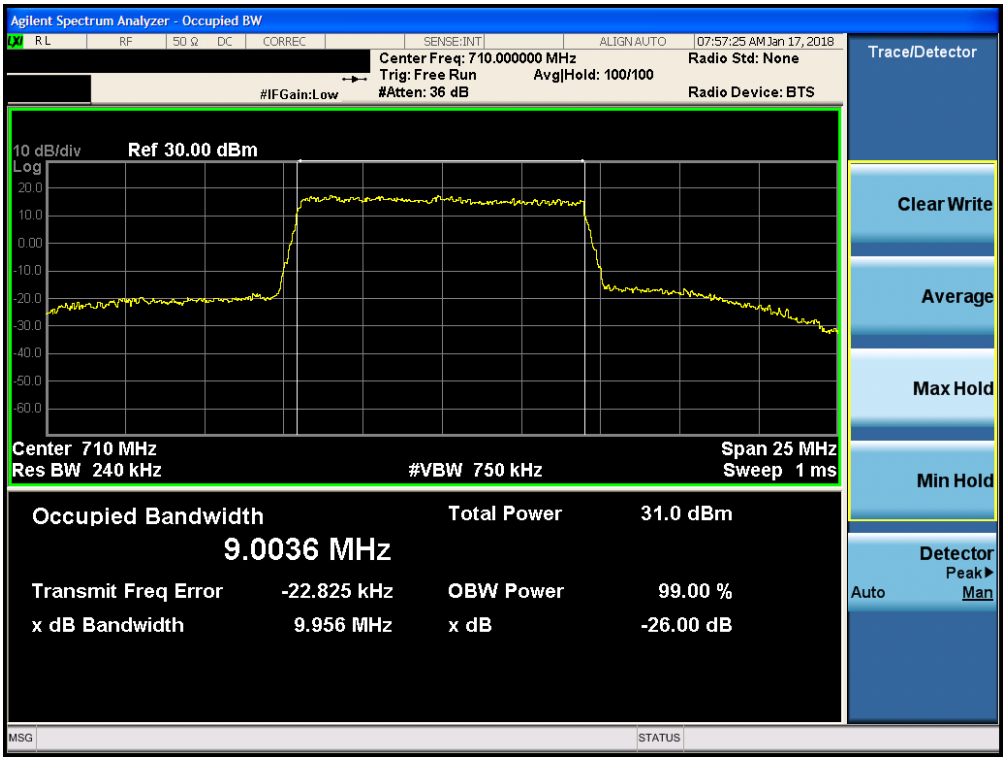


Plot 7-11. Occupied Bandwidth Plot (Band 17 - 10.0MHz QPSK - Full RB Configuration)



Plot 7-12. Occupied Bandwidth Plot (Band 17 - 10.0MHz 16-QAM - Full RB Configuration)

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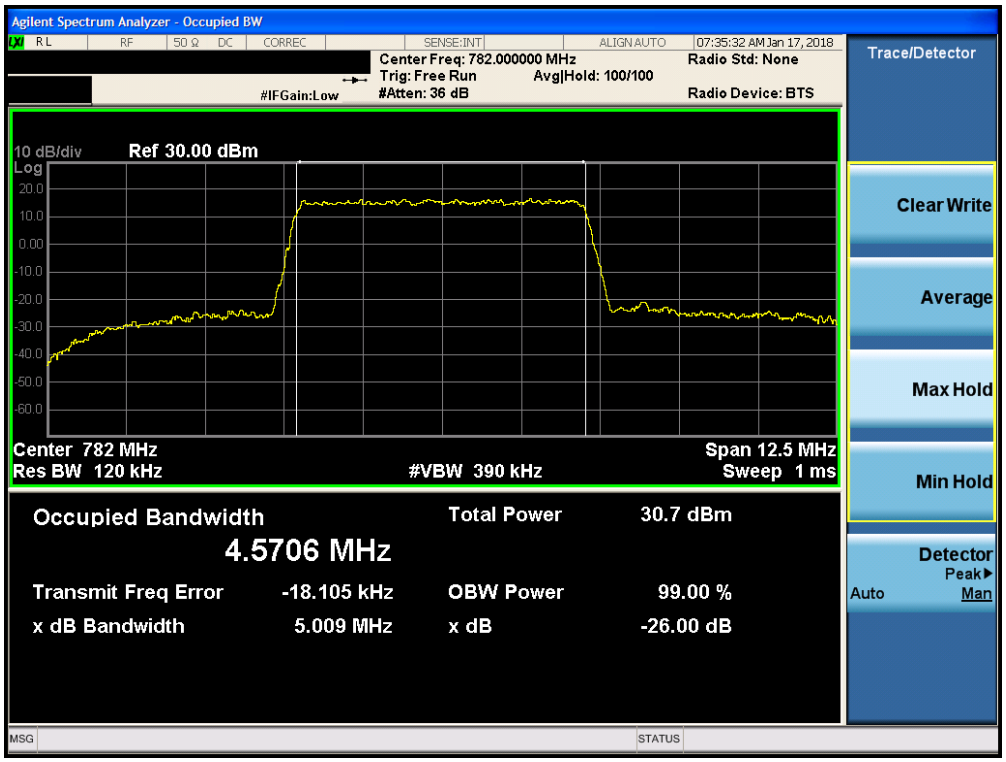
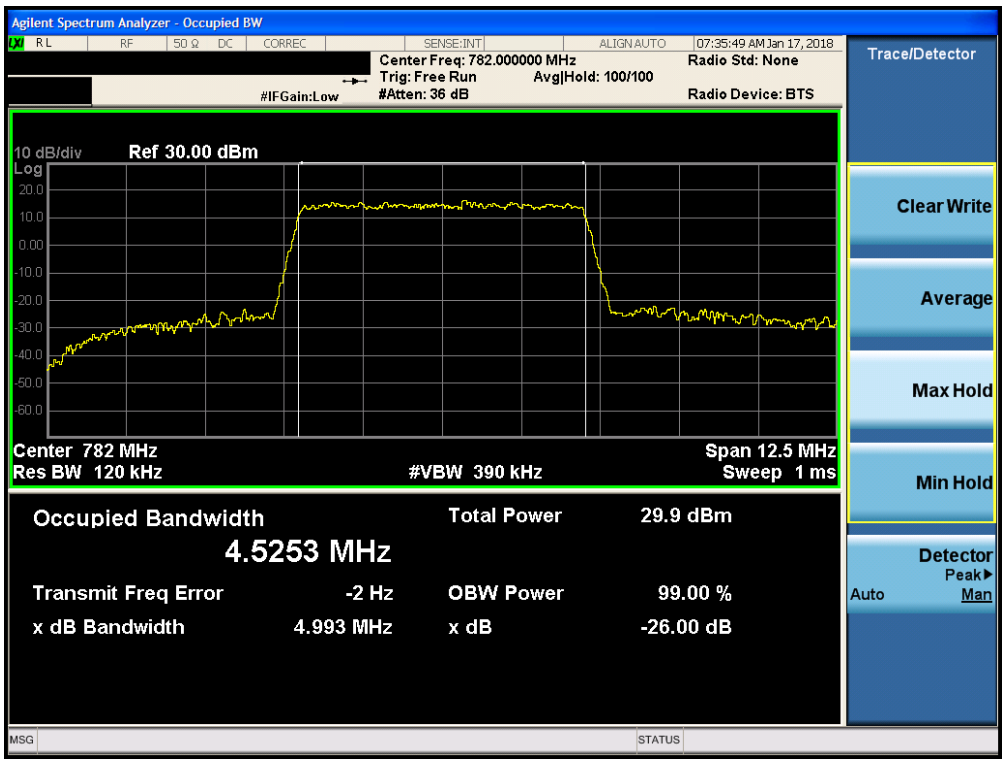
Band 13



Plot 7-13. Occupied Bandwidth Plot (Band 13 - 5.0MHz QPSK - Full RB Configuration)



Plot 7-14. Occupied Bandwidth Plot (Band 13 - 5.0MHz 16-QAM - Full RB Configuration)

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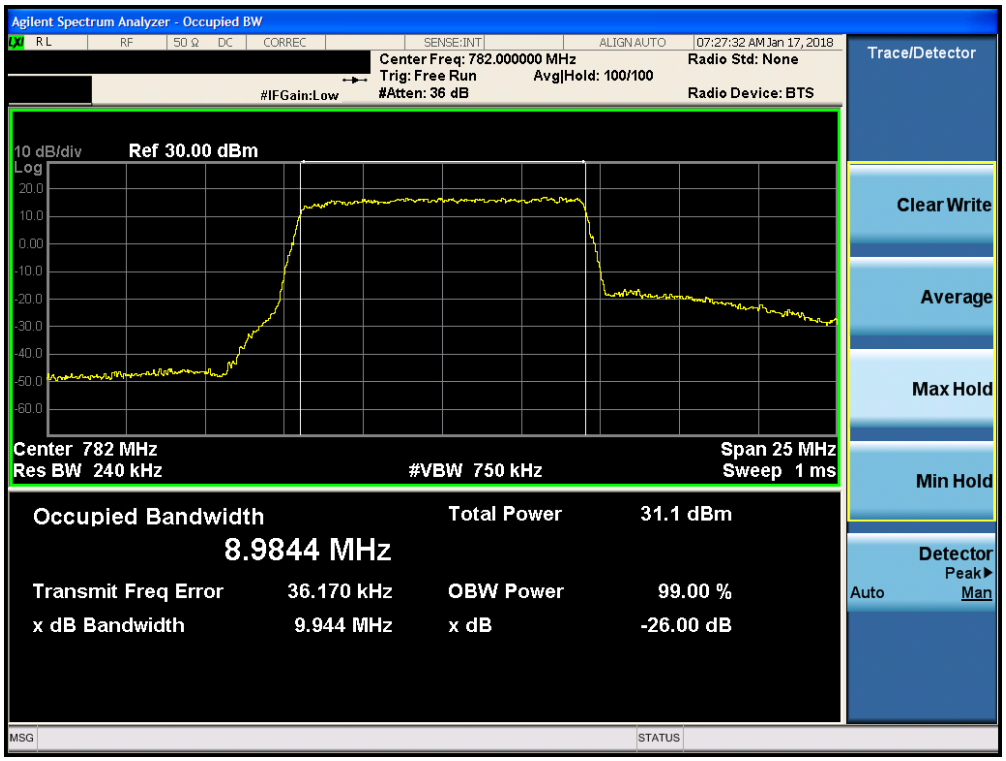
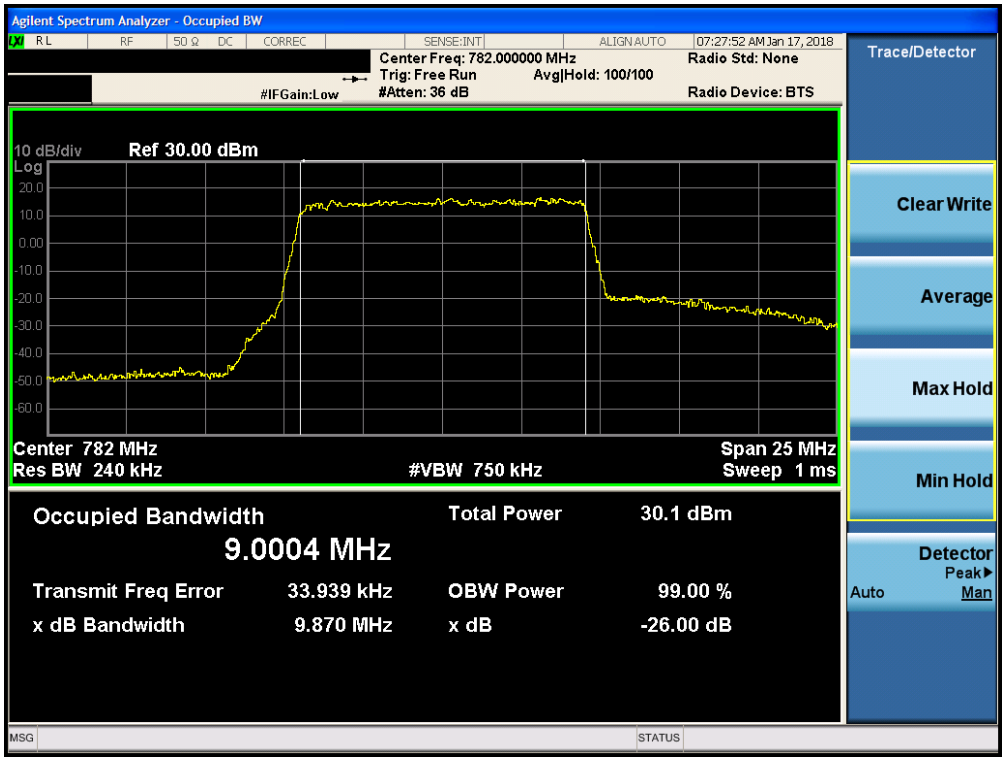


Plot 7-15. Occupied Bandwidth Plot (Band 13 - 10.0MHz QPSK - Full RB Configuration)



Plot 7-16. Occupied Bandwidth Plot (Band 13 - 10.0MHz 16-QAM - Full RB Configuration)

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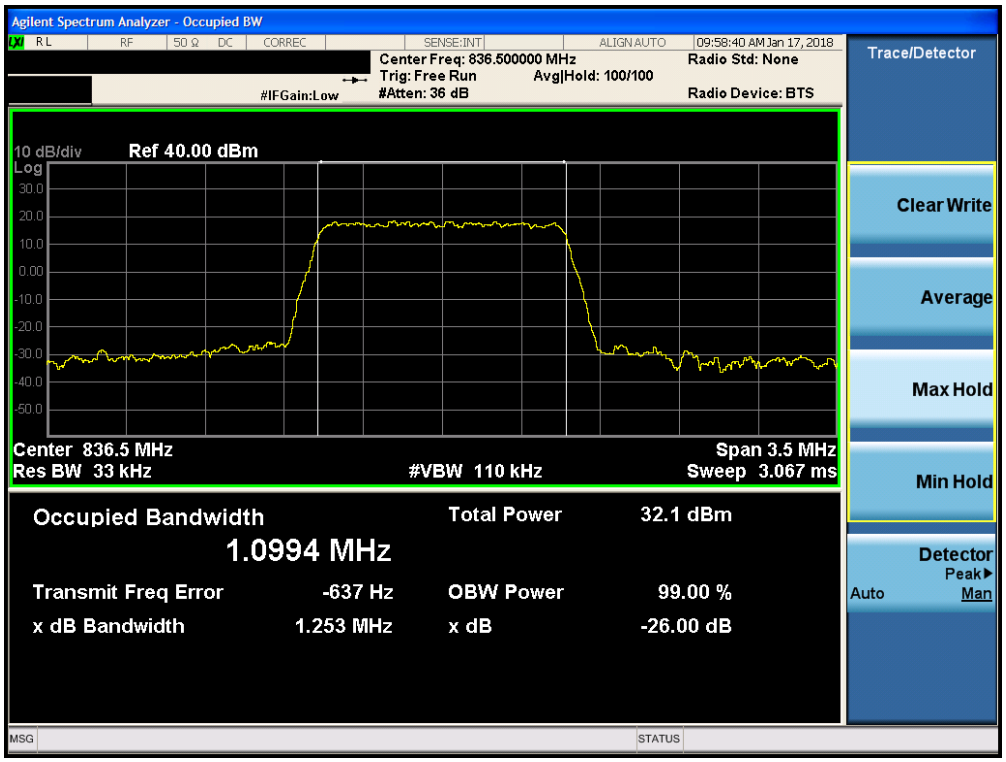
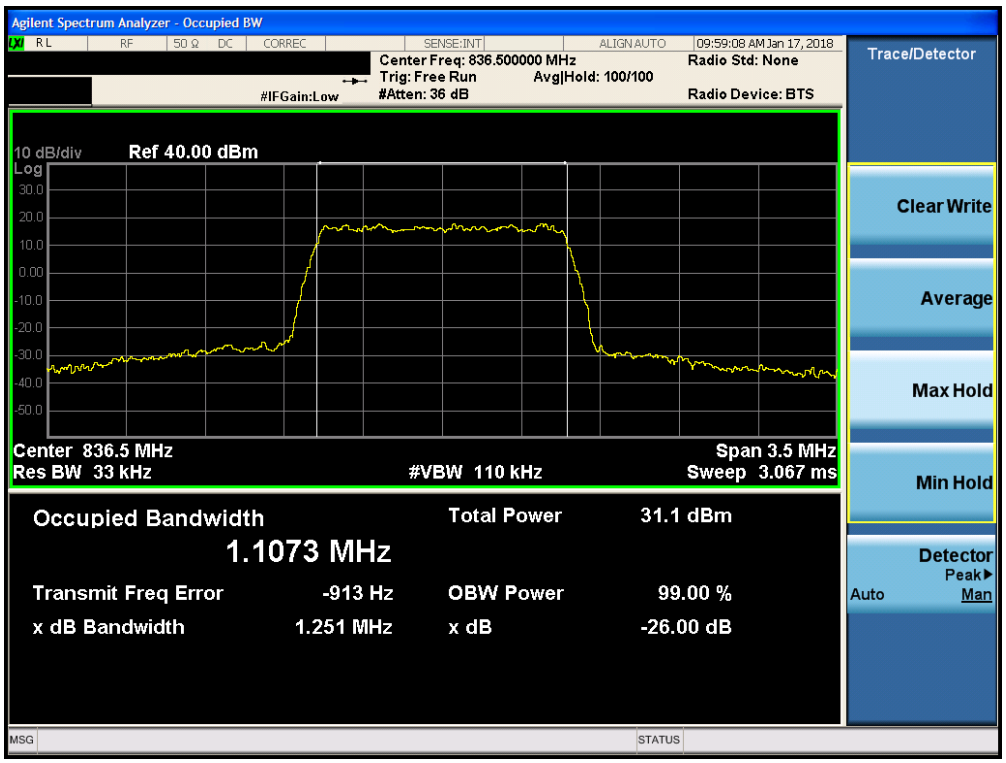
Band 26



Plot 7-17. Occupied Bandwidth Plot (Band 26 - 1.4MHz QPSK - Full RB Configuration)



Plot 7-18. Occupied Bandwidth Plot (Band 26 - 1.4MHz 16-QAM - Full RB Configuration)

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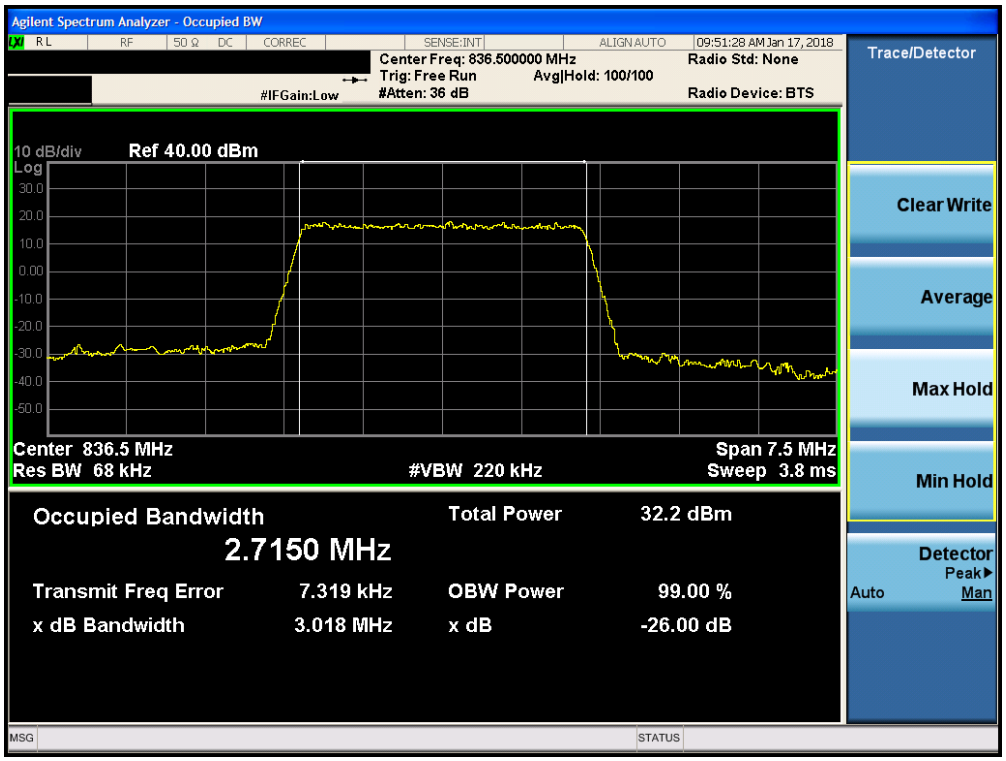
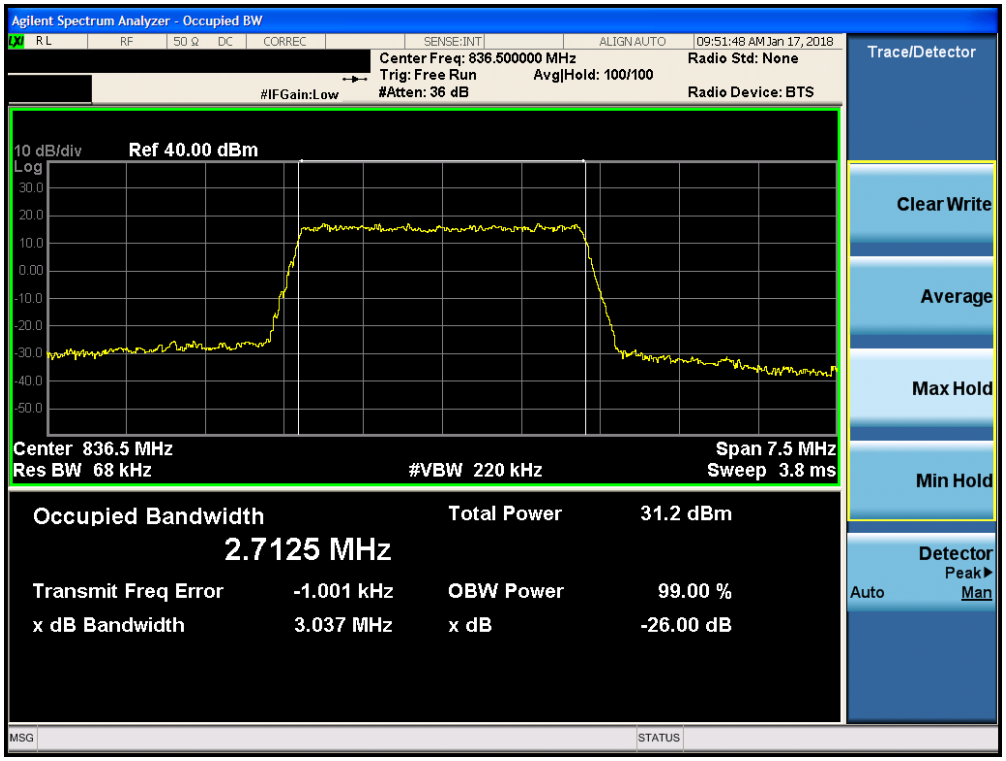


Plot 7-19. Occupied Bandwidth Plot (Band 26 - 3.0MHz QPSK - Full RB Configuration)



Plot 7-20. Occupied Bandwidth Plot (Band 26 - 3.0MHz 16-QAM - Full RB Configuration)

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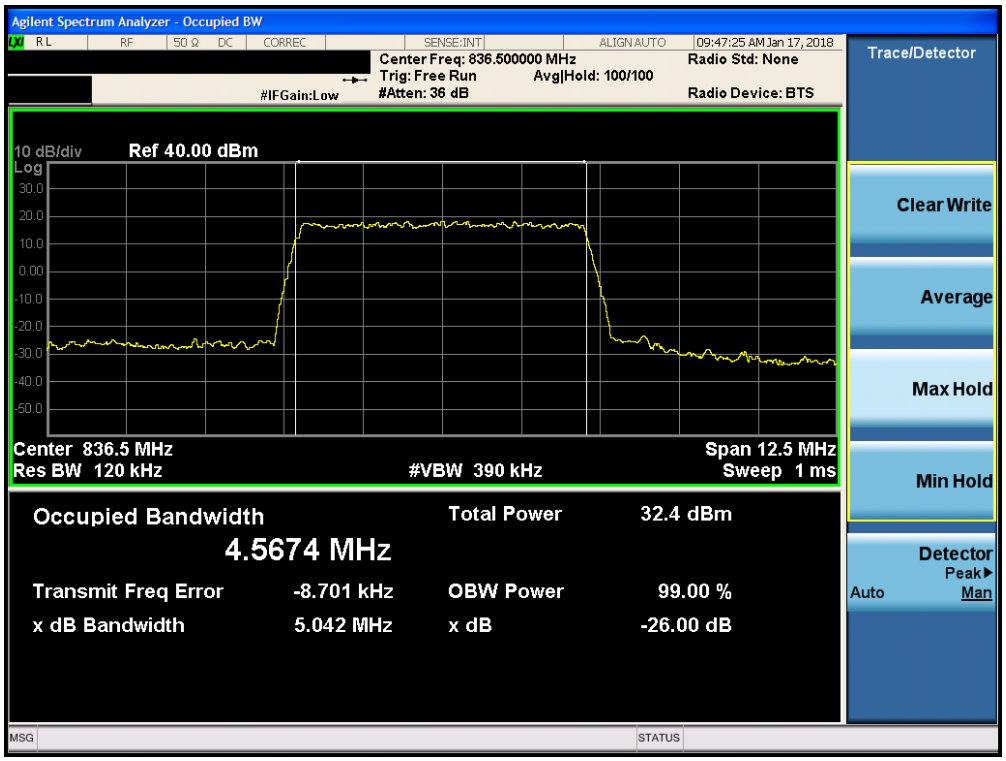
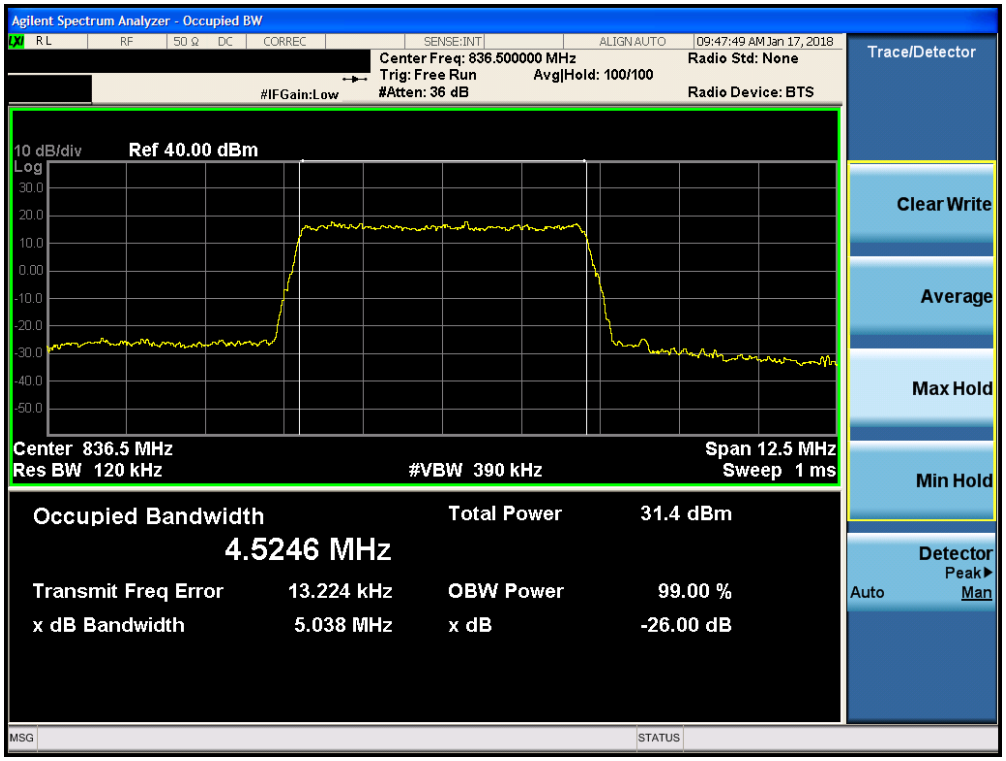


Plot 7-21. Occupied Bandwidth Plot (Band 26 - 5.0MHz QPSK - Full RB Configuration)



Plot 7-22. Occupied Bandwidth Plot (Band 26 - 5.0MHz 16-QAM - Full RB Configuration)

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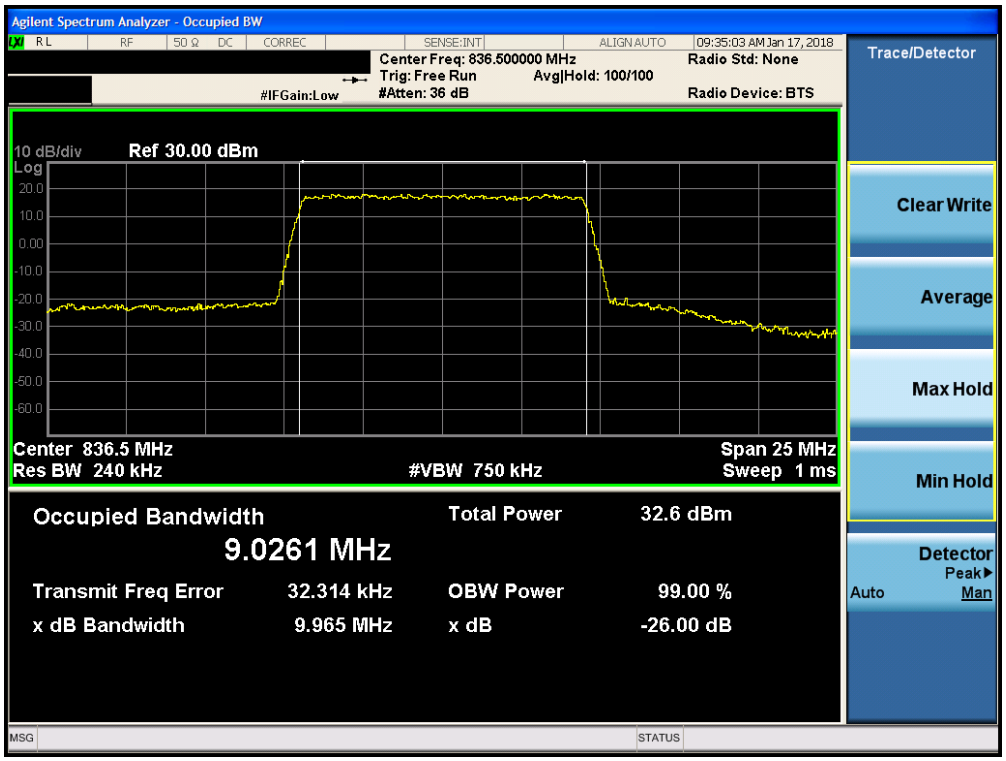
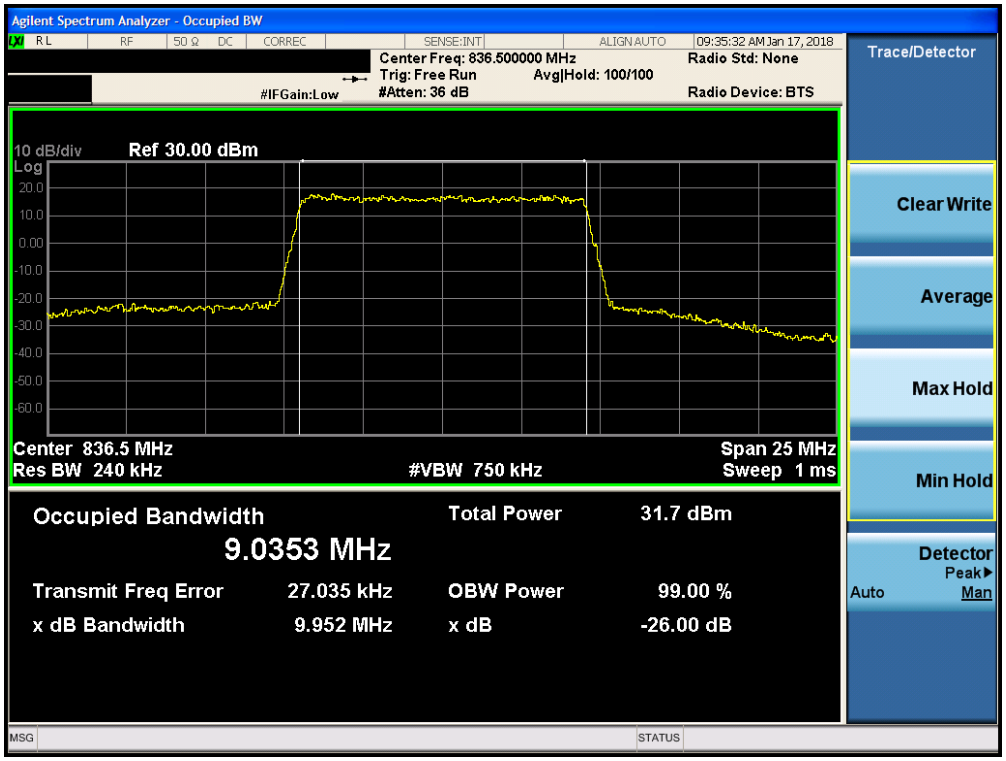


Plot 7-23. Occupied Bandwidth Plot (Band 26 - 10.0MHz QPSK - Full RB Configuration)



Plot 7-24. Occupied Bandwidth Plot (Band 26 - 10.0MHz 16-QAM - Full RB Configuration)

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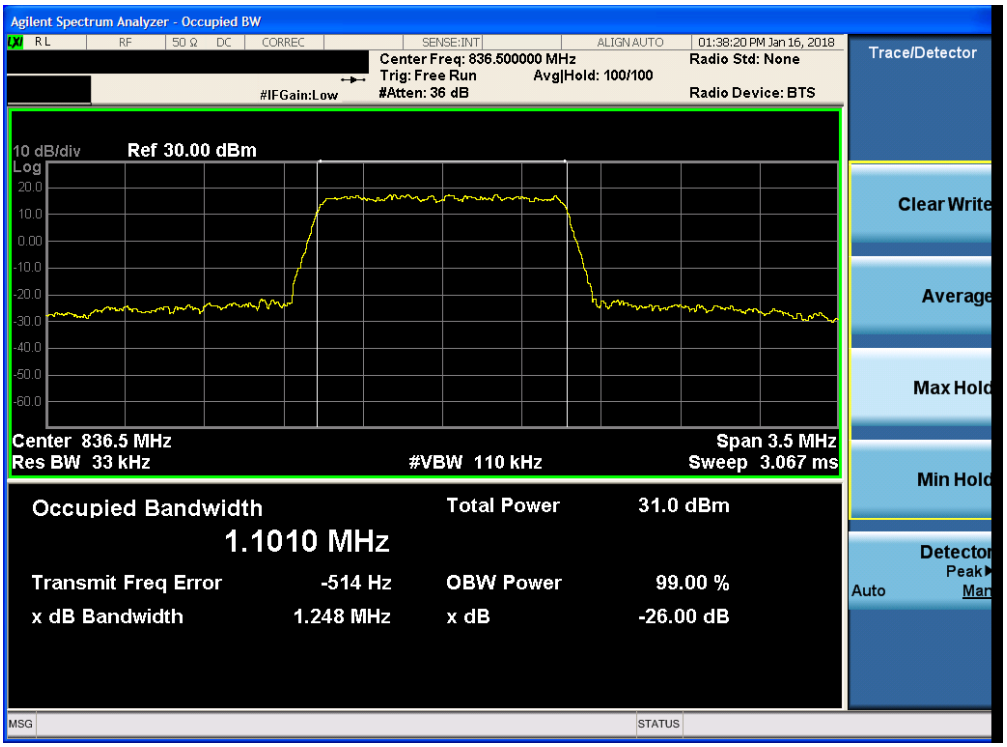
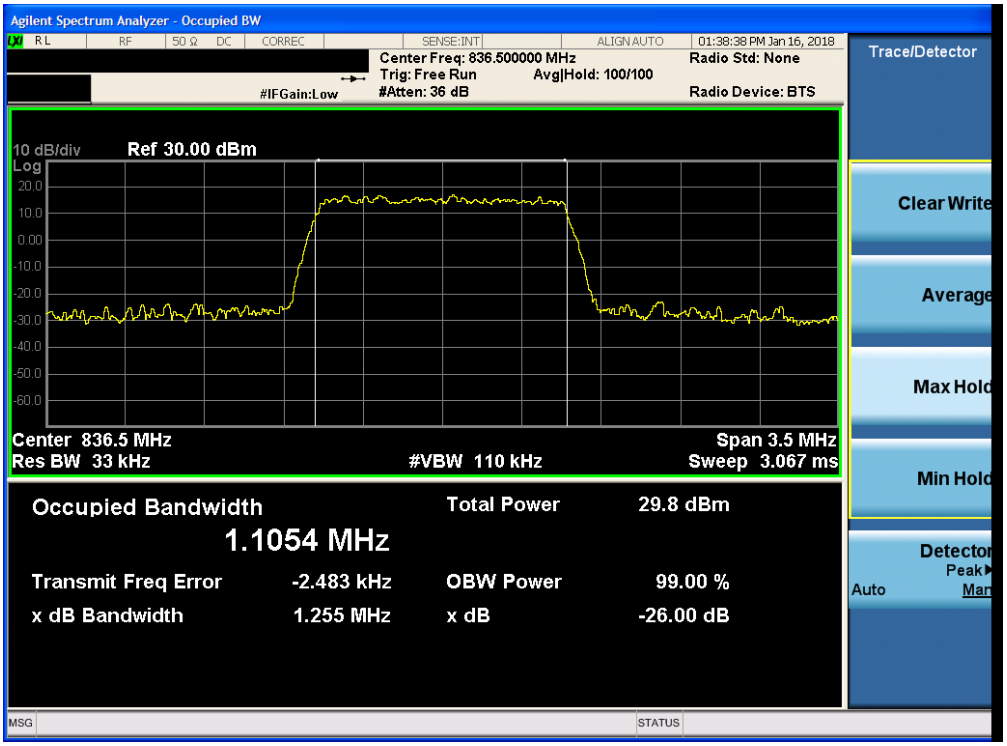
Band 5



Plot 7-25. Occupied Bandwidth Plot (Band 5 - 1.4MHz QPSK - Full RB Configuration)



Plot 7-26. Occupied Bandwidth Plot (Band 5 - 1.4MHz 16-QAM - Full RB Configuration)

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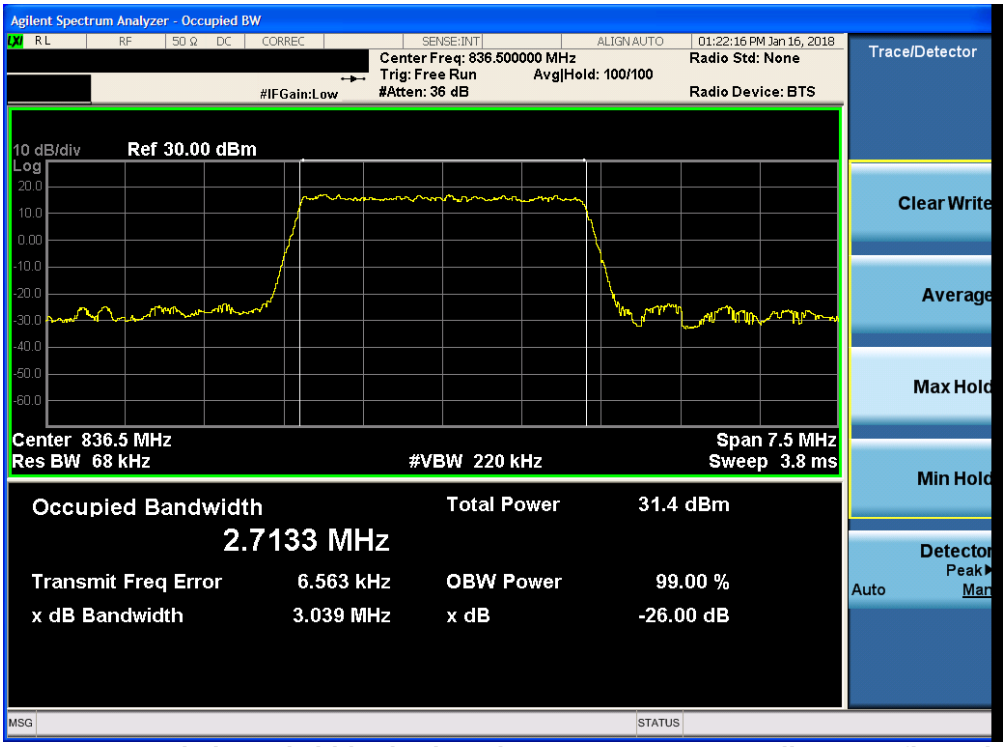
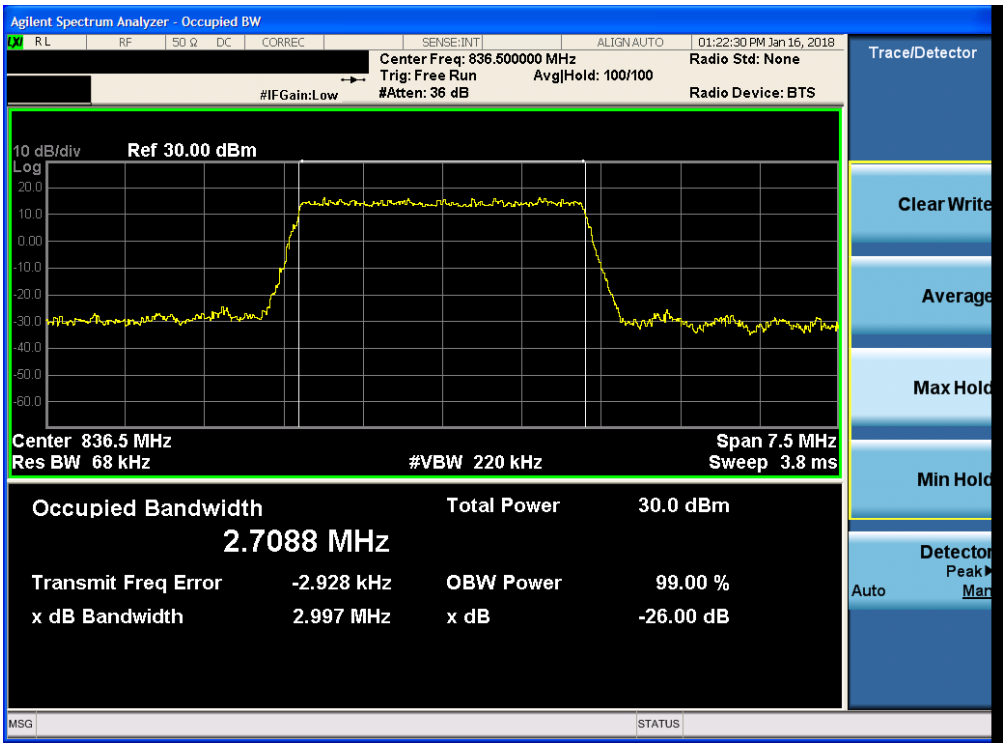


Plot 7-27. Occupied Bandwidth Plot (Band 5 - 3.0MHz QPSK - Full RB Configuration)



Plot 7-28. Occupied Bandwidth Plot (Band 5 - 3.0MHz 16-QAM - Full RB Configuration)

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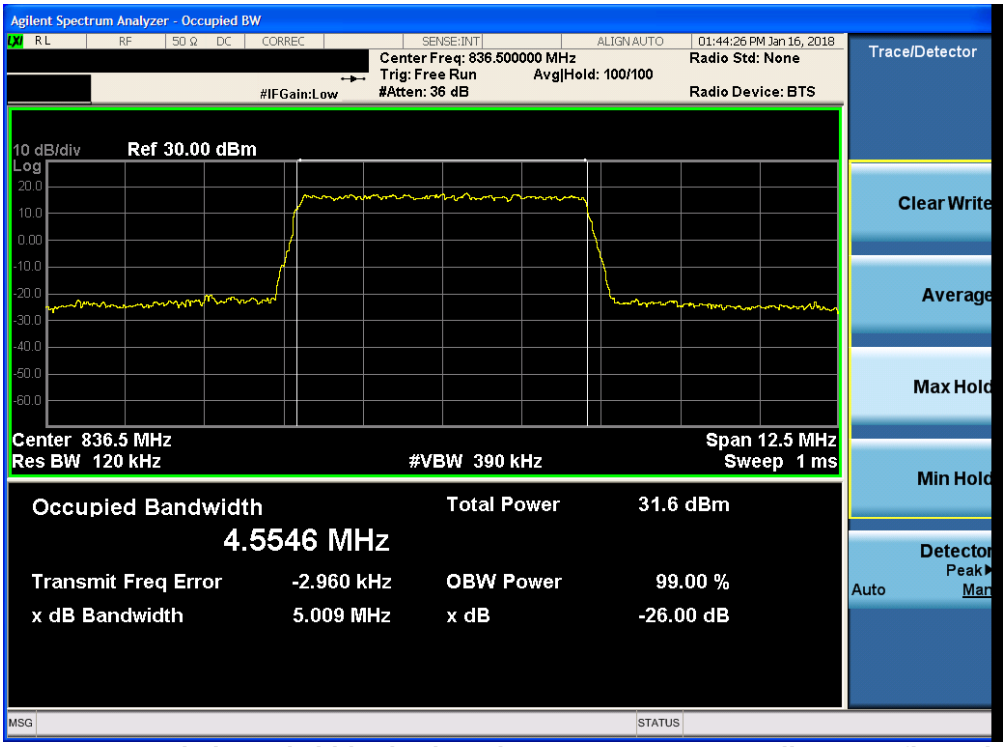
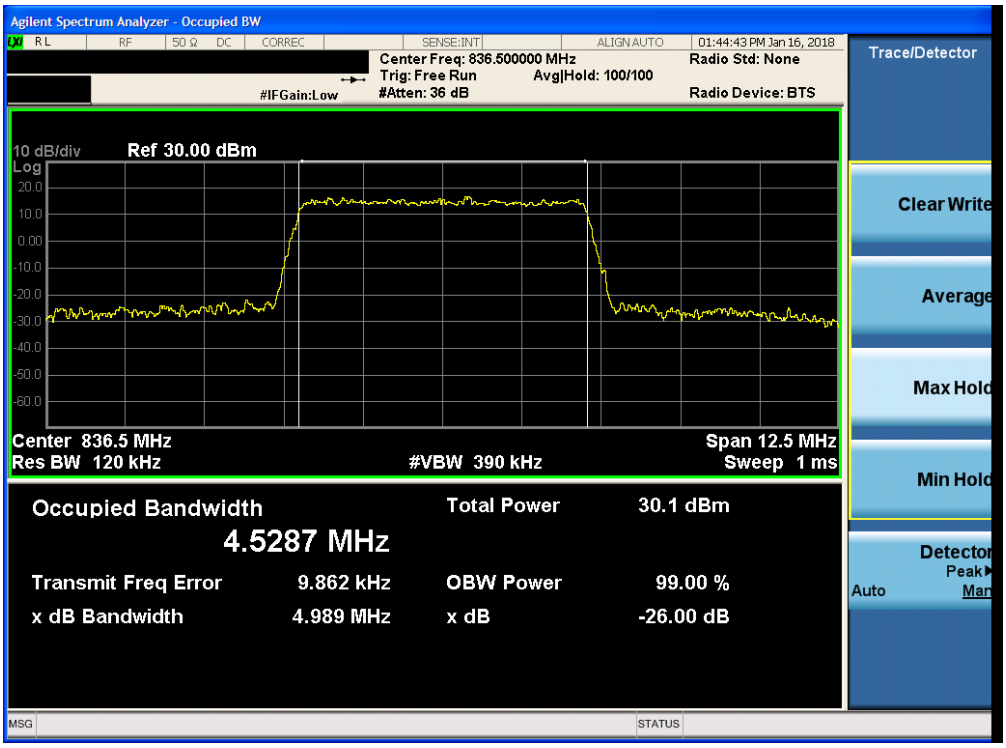


Plot 7-29. Occupied Bandwidth Plot (Band 5 - 5.0MHz QPSK - Full RB Configuration)



Plot 7-30. Occupied Bandwidth Plot (Band 5 - 5.0MHz 16-QAM - Full RB Configuration)

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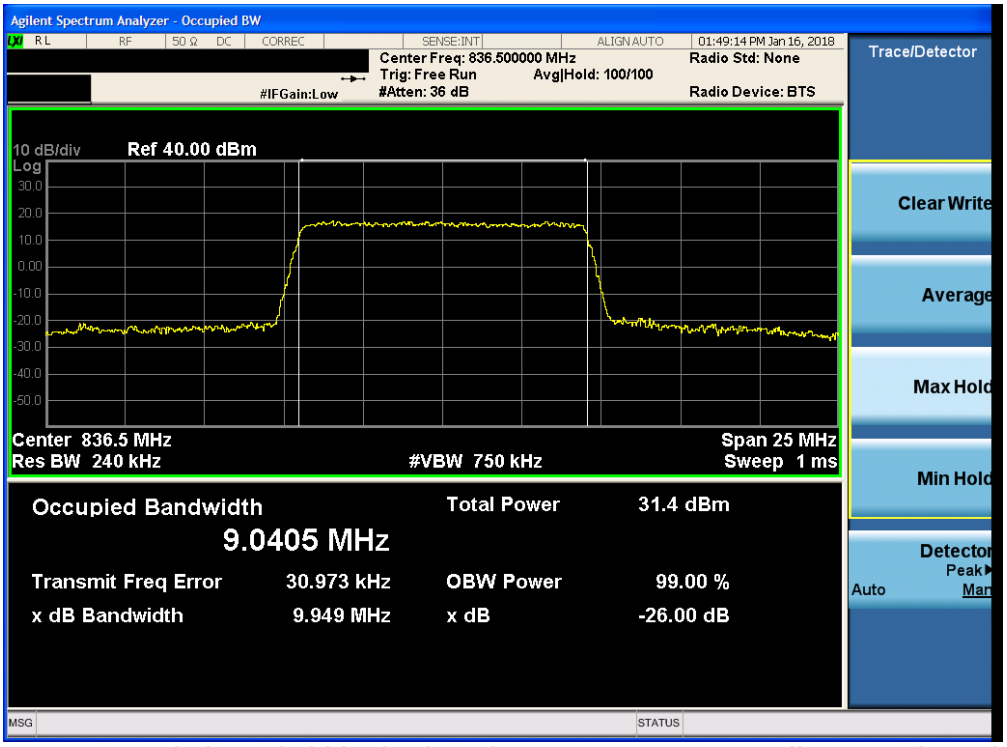

Plot 7-31. Occupied Bandwidth Plot (Band 5 - 10.0MHz QPSK - Full RB Configuration)

Plot 7-32. Occupied Bandwidth Plot (Band 5 - 10.0MHz 16-QAM - Full RB Configuration)

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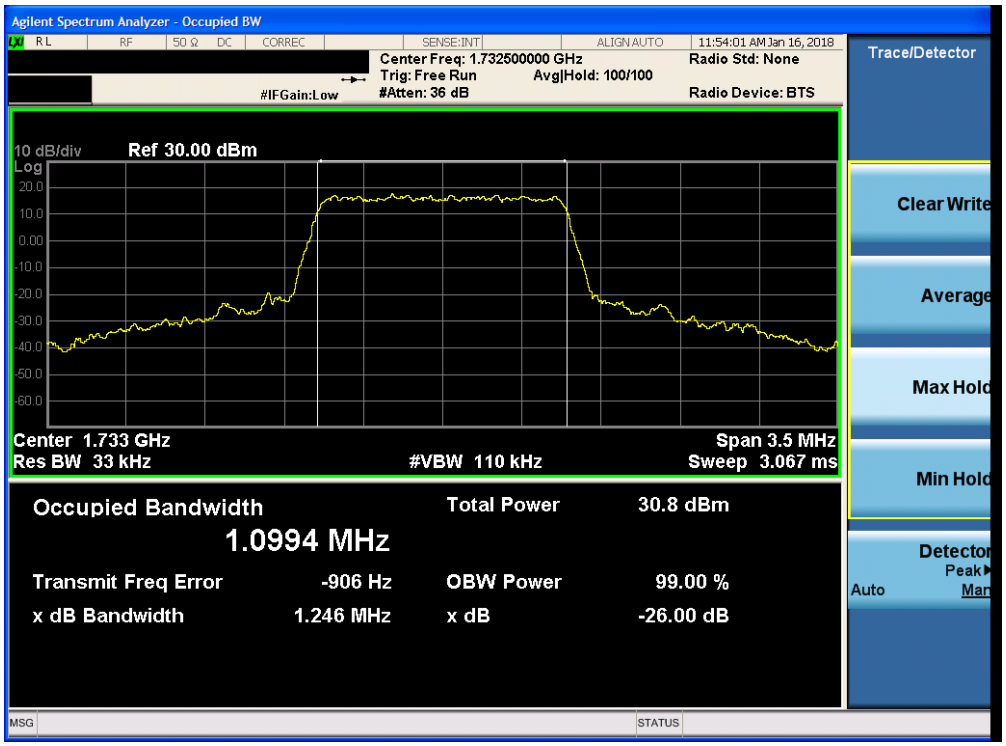
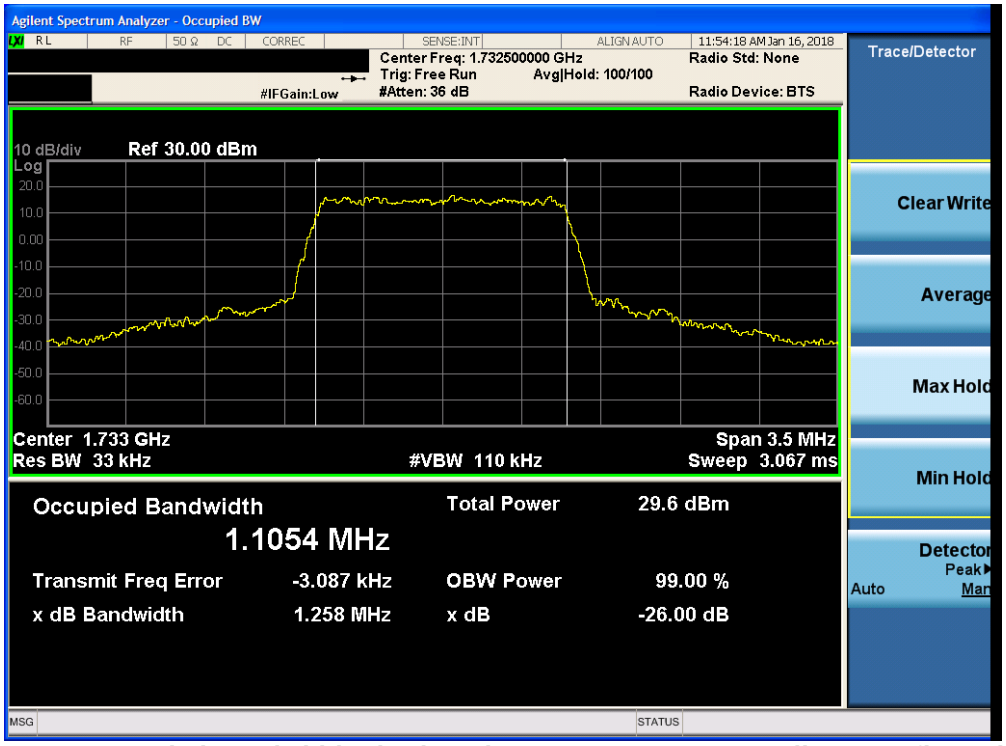
Band 4



Plot 7-33. Occupied Bandwidth Plot (Band 4 - 1.4MHz QPSK - Full RB Configuration)



Plot 7-34. Occupied Bandwidth Plot (Band 4 - 1.4MHz 16-QAM - Full RB Configuration)

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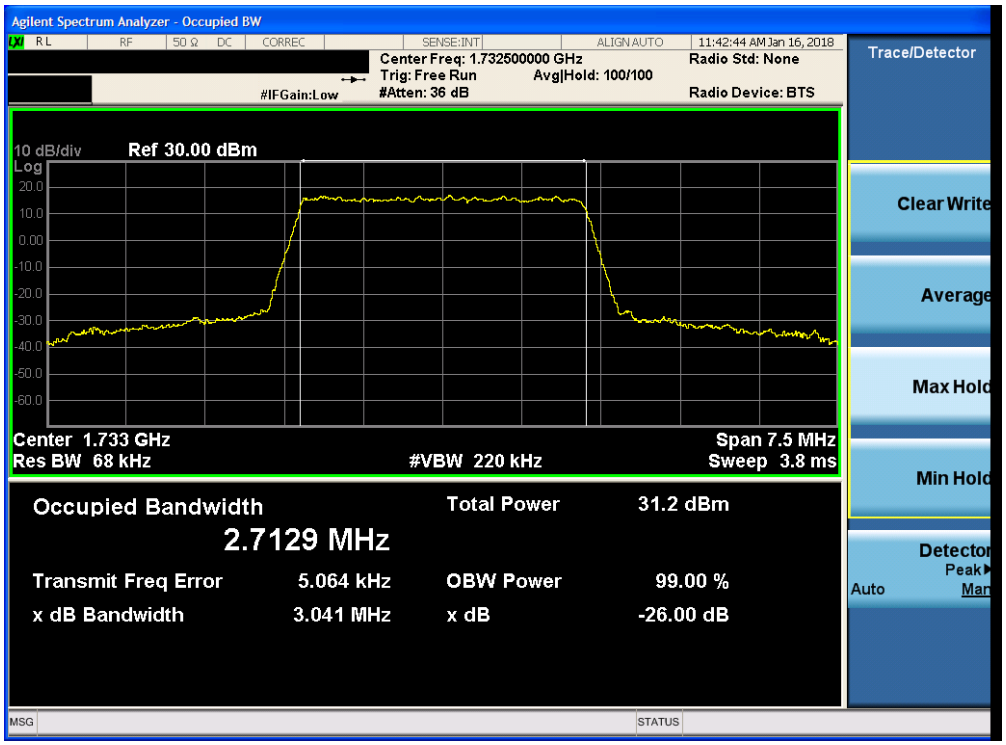
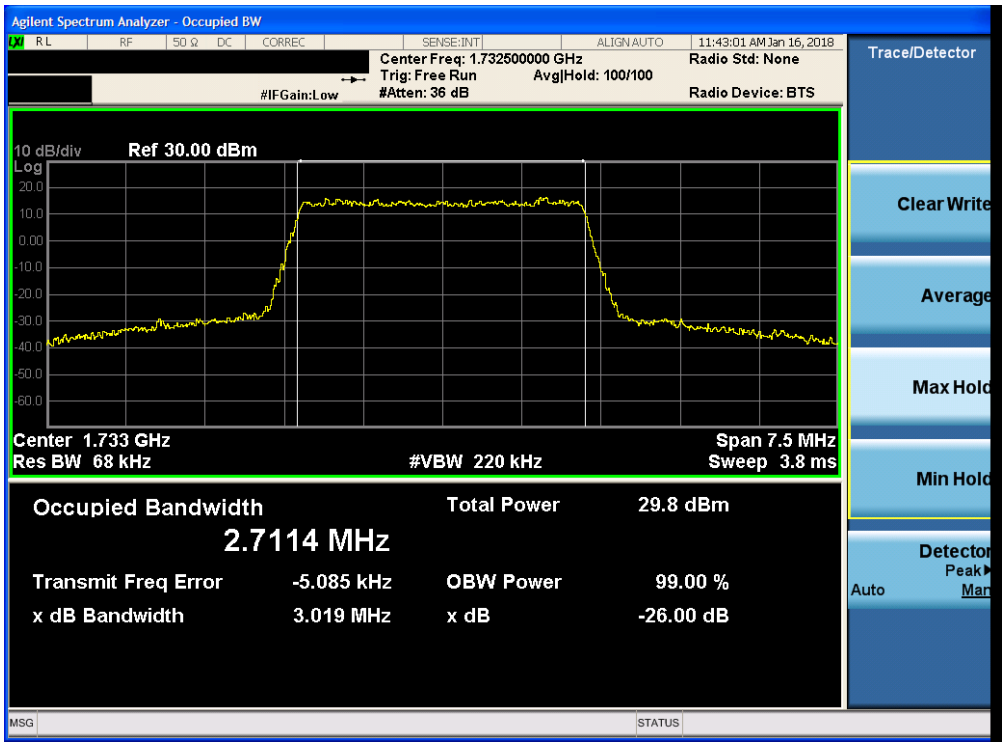


Plot 7-35. Occupied Bandwidth Plot (Band 4 - 3.0MHz QPSK - Full RB Configuration)



Plot 7-36. Occupied Bandwidth Plot (Band 4 - 3.0MHz 16-QAM - Full RB Configuration)

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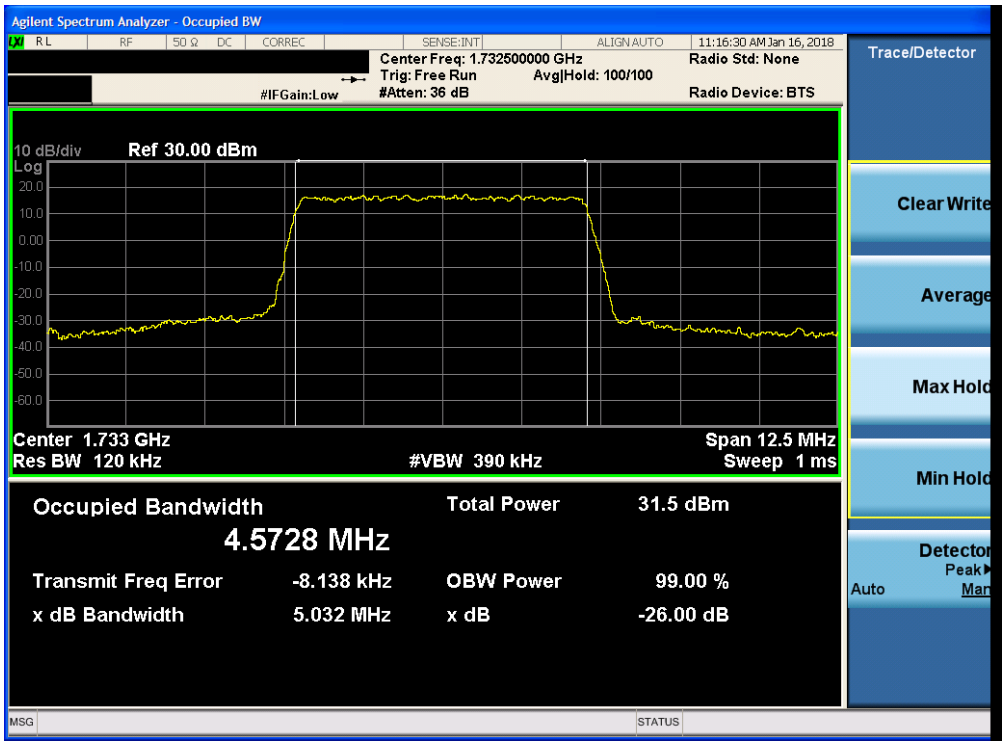
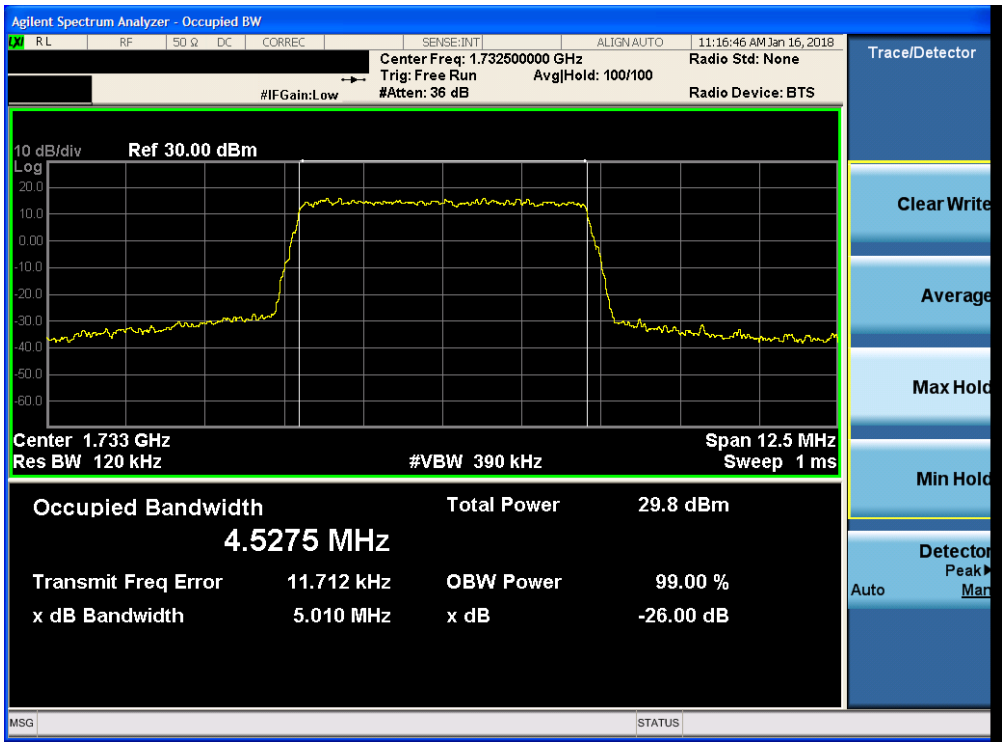


Plot 7-37. Occupied Bandwidth Plot (Band 4 - 5.0MHz QPSK - Full RB Configuration)



Plot 7-38. Occupied Bandwidth Plot (Band 4 - 5.0MHz 16-QAM - Full RB Configuration)

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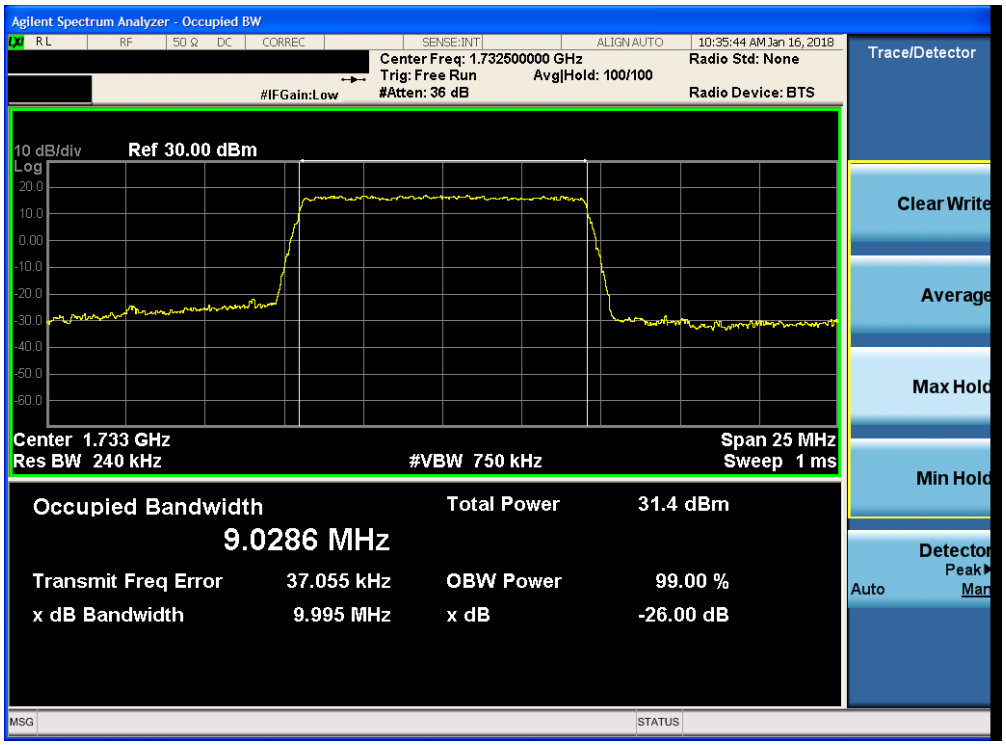
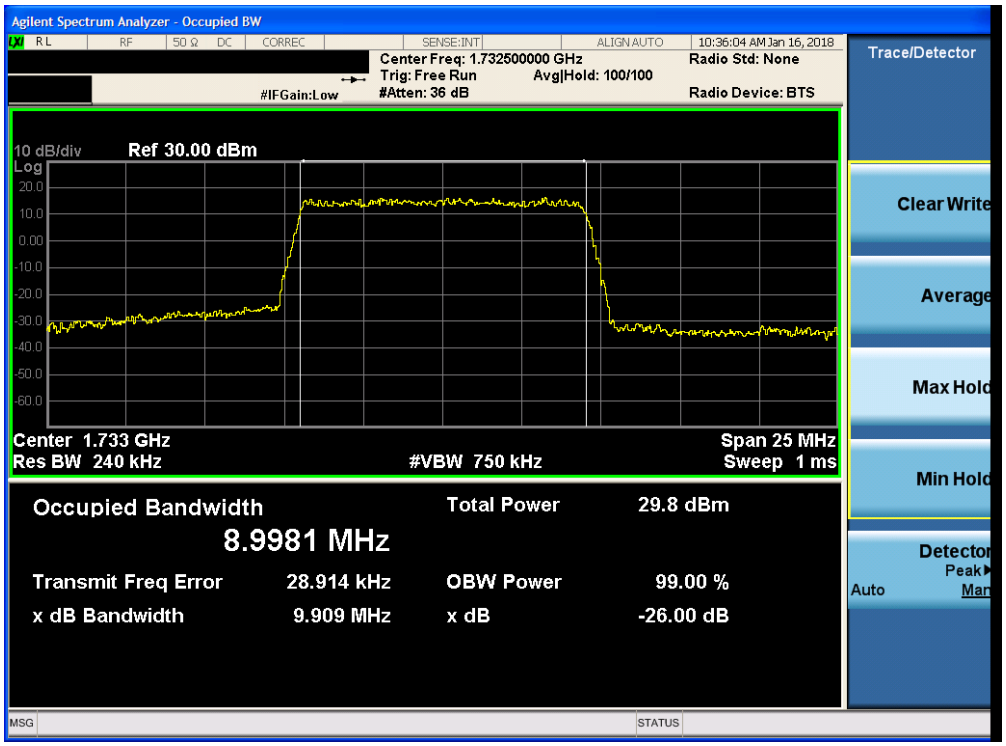


Plot 7-39. Occupied Bandwidth Plot (Band 4 - 10.0MHz QPSK - Full RB Configuration)



Plot 7-40. Occupied Bandwidth Plot (Band 4 - 10.0MHz 16-QAM - Full RB Configuration)

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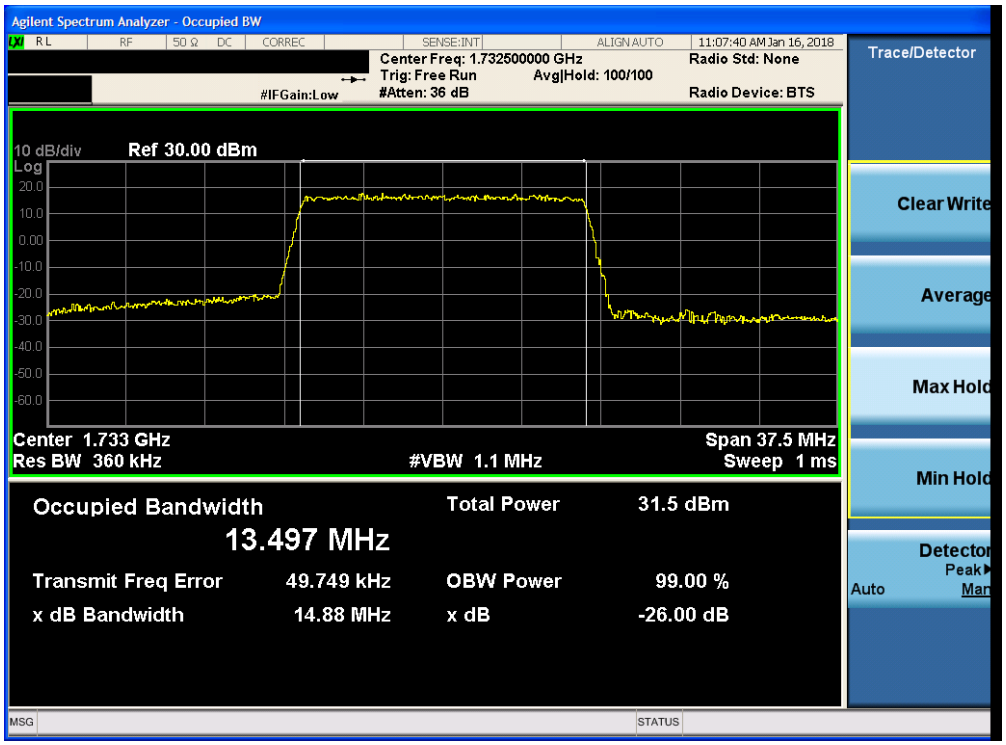
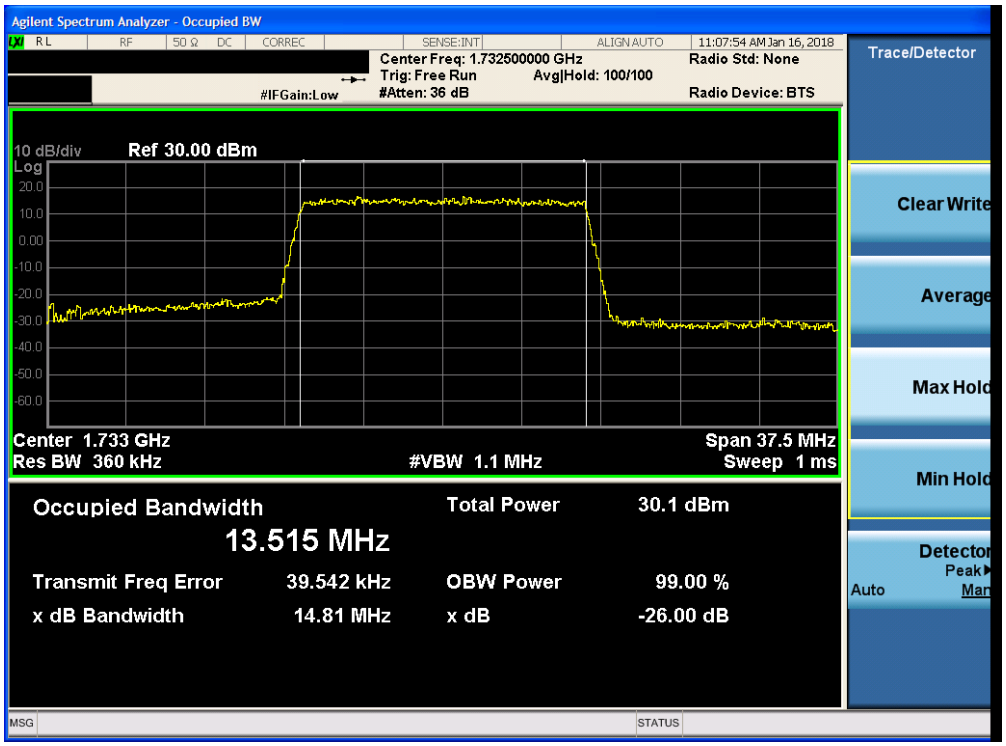


Plot 7-41. Occupied Bandwidth Plot (Band 4 - 15.0MHz QPSK - Full RB Configuration)



Plot 7-42. Occupied Bandwidth Plot (Band 4 - 15.0MHz 16-QAM - Full RB Configuration)

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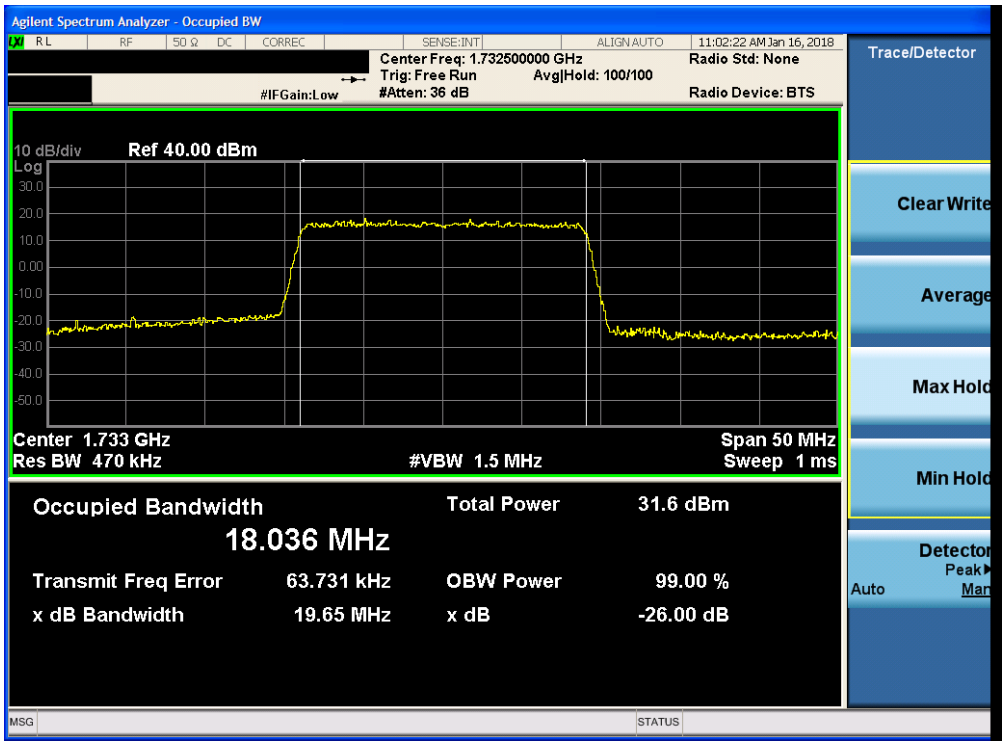
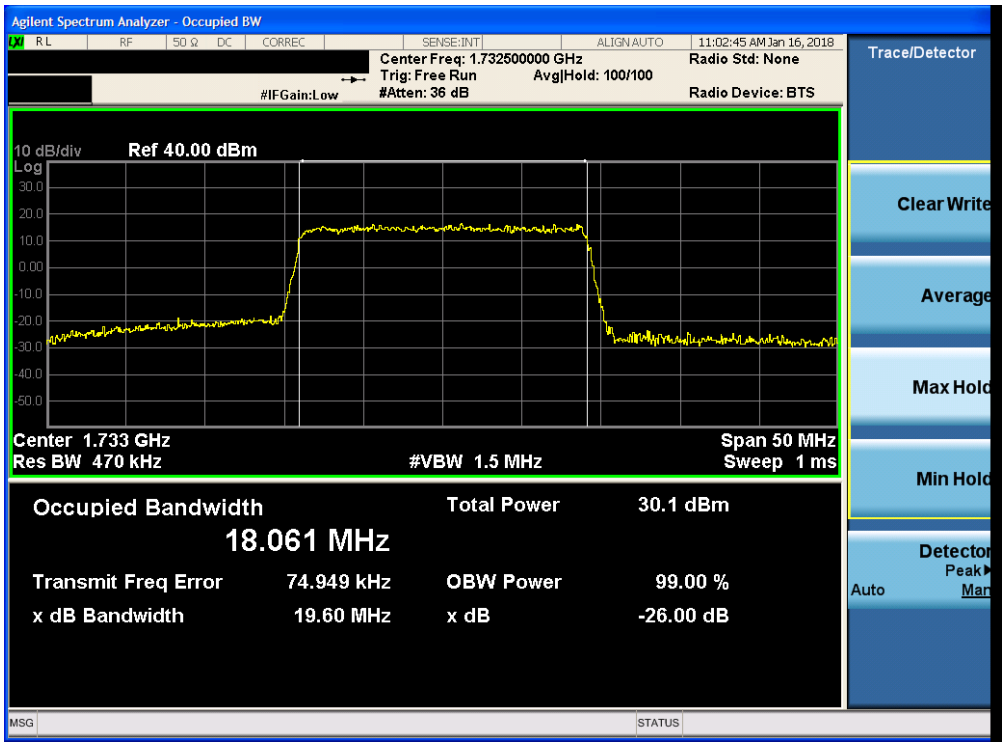


Plot 7-43. Occupied Bandwidth Plot (Band 4 - 20.0MHz QPSK - Full RB Configuration)



Plot 7-44. Occupied Bandwidth Plot (Band 4 - 20.0MHz 16-QAM - Full RB Configuration)

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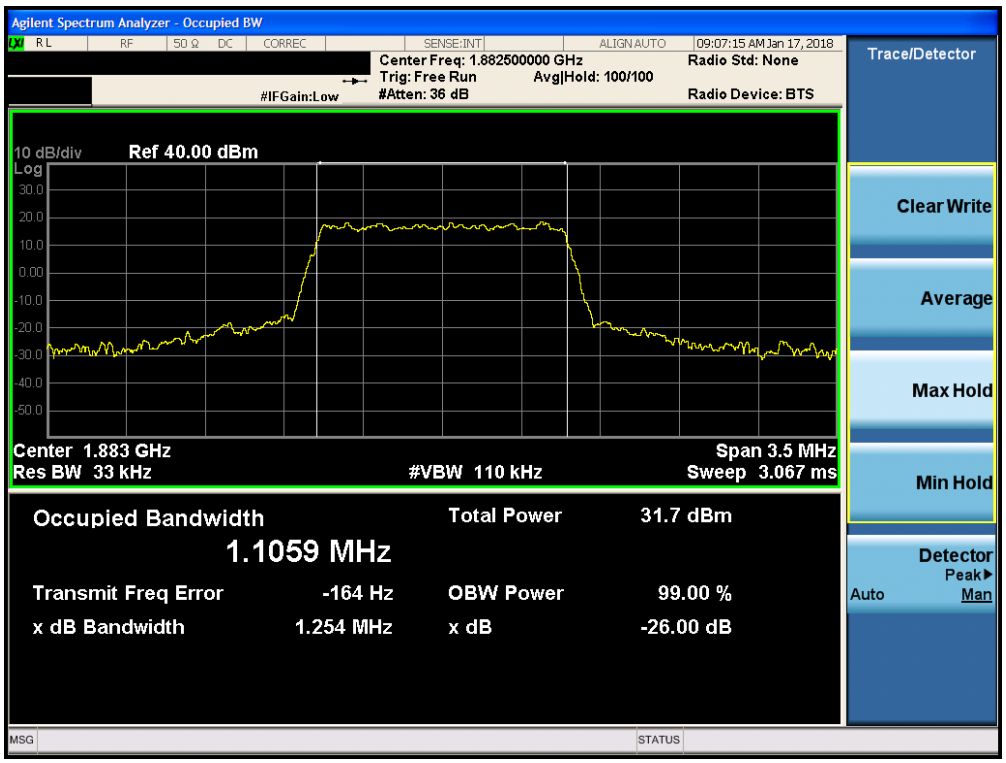
Band 25

Plot 7-45. Occupied Bandwidth Plot (Band 25 - 1.4MHz QPSK - Full RB Configuration)



Plot 7-46. Occupied Bandwidth Plot (Band 25 - 1.4MHz 16-QAM - Full RB Configuration)

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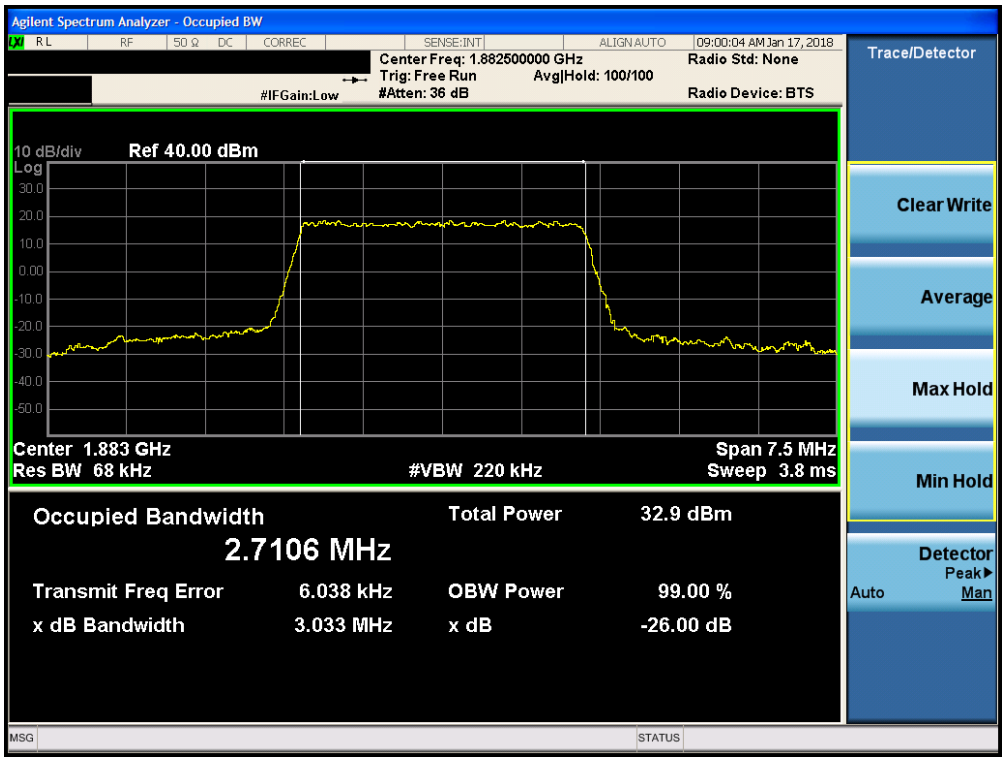
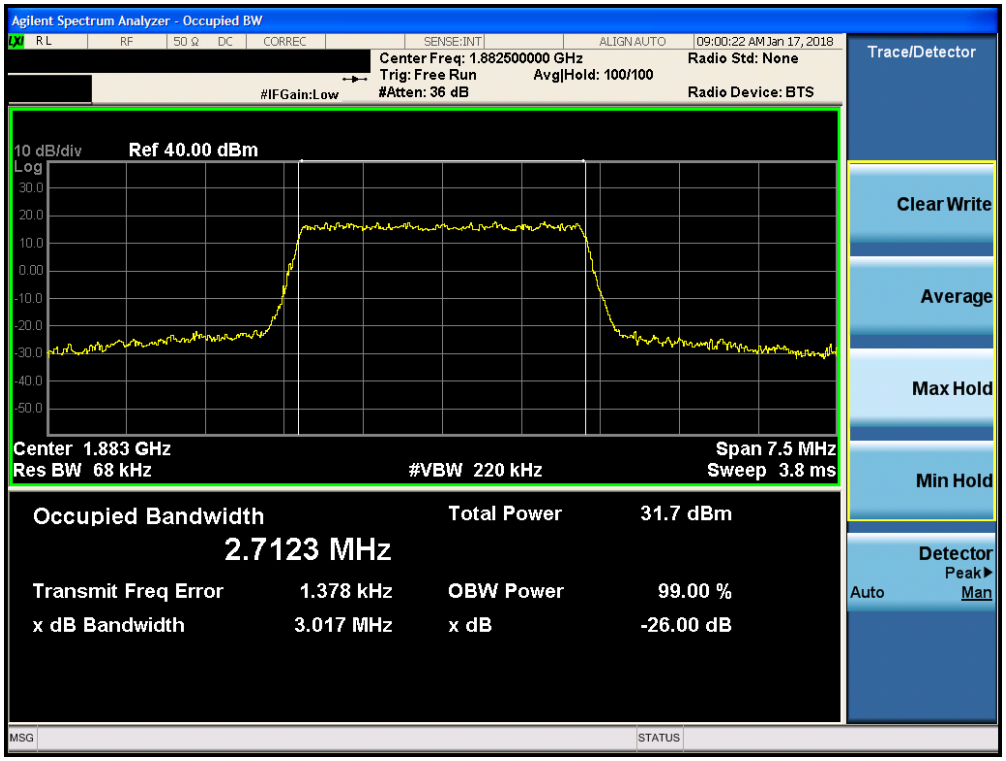


Plot 7-47. Occupied Bandwidth Plot (Band 25 - 3.0MHz QPSK - Full RB Configuration)



Plot 7-48. Occupied Bandwidth Plot (Band 25 - 3.0MHz 16-QAM - Full RB Configuration)

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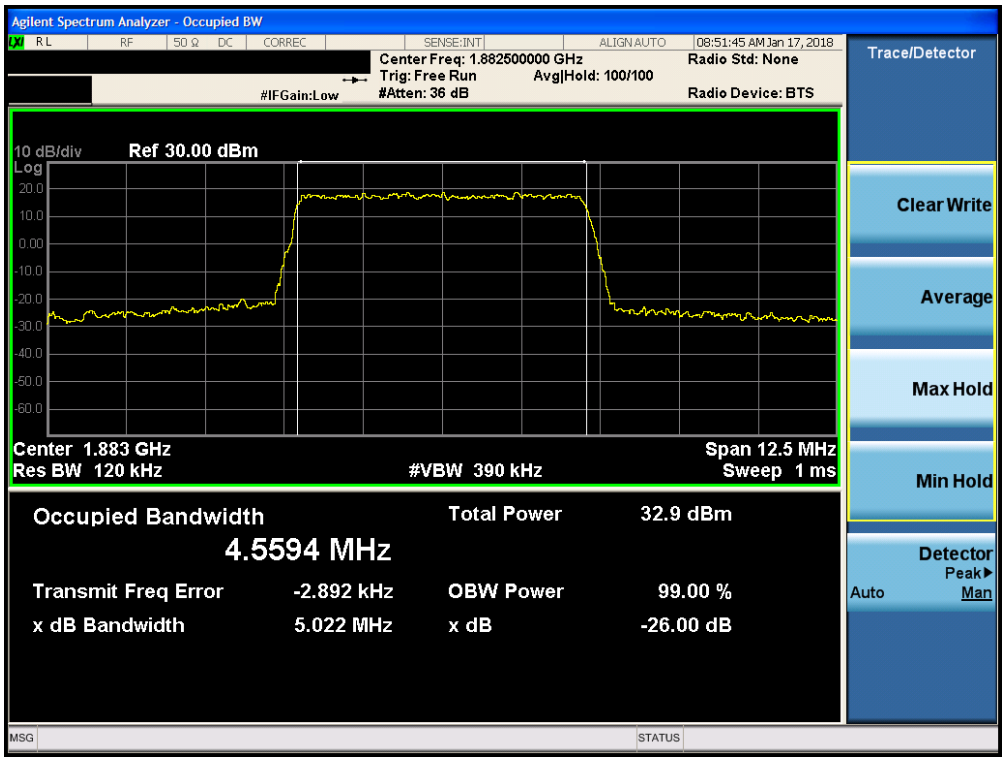
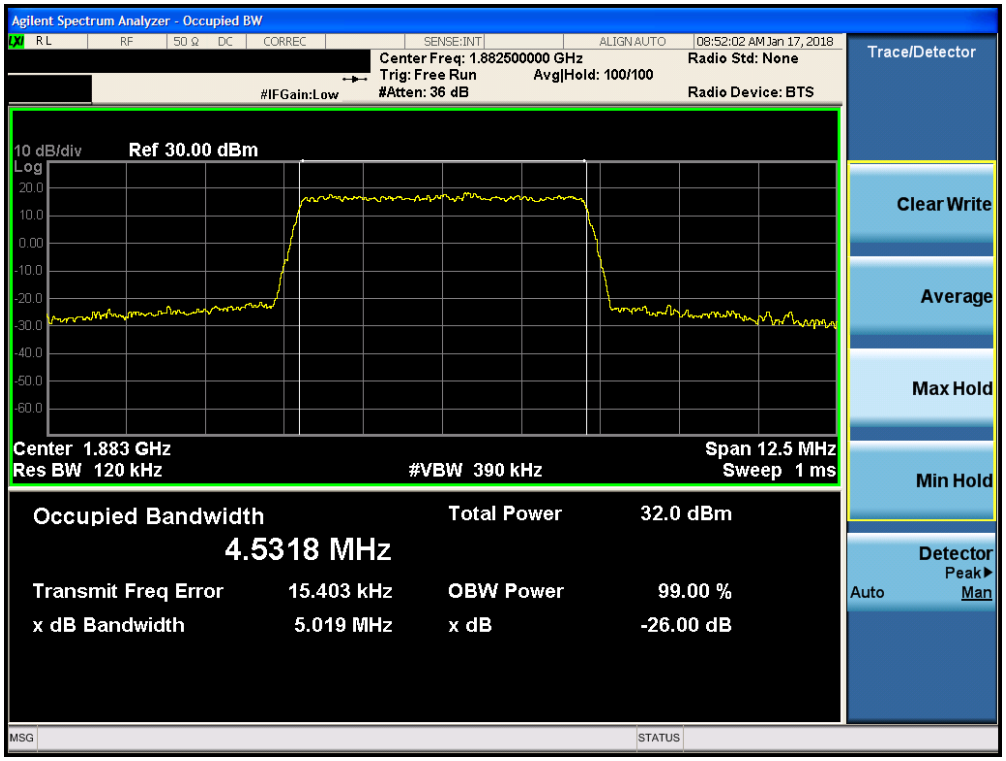


Plot 7-49. Occupied Bandwidth Plot (Band 25 - 5.0MHz QPSK - Full RB Configuration)



Plot 7-50. Occupied Bandwidth Plot (Band 25 - 5.0MHz 16-QAM - Full RB Configuration)

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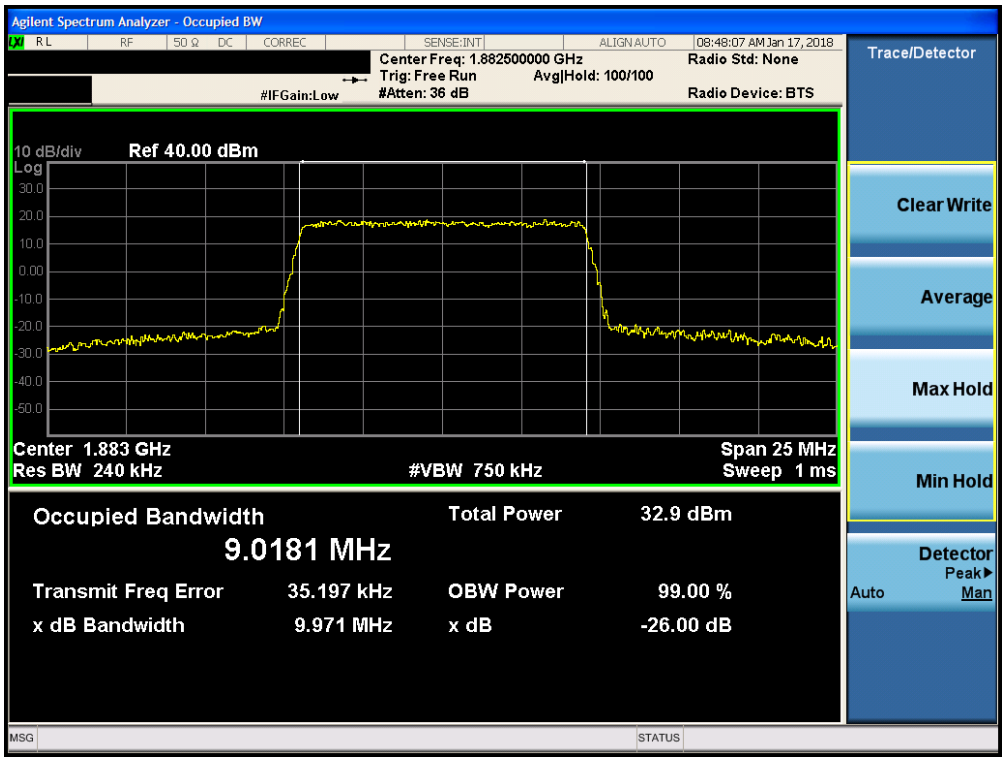
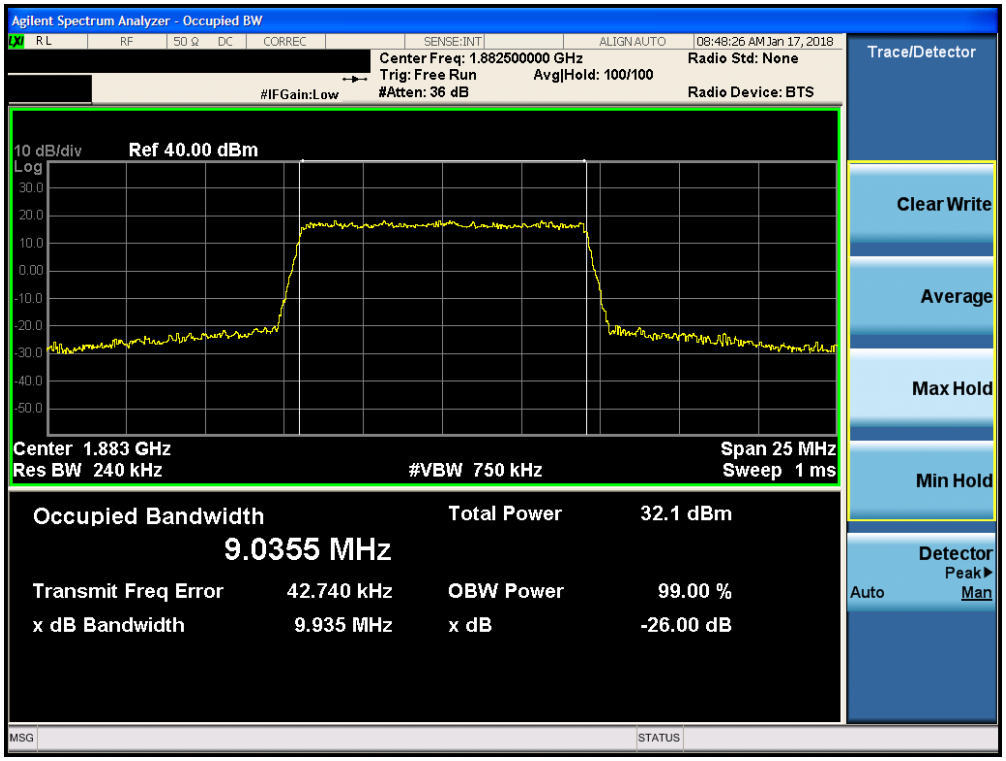


Plot 7-51. Occupied Bandwidth Plot (Band 25 - 10.0MHz QPSK - Full RB Configuration)



Plot 7-52. Occupied Bandwidth Plot (Band 25 - 10.0MHz 16-QAM - Full RB Configuration)

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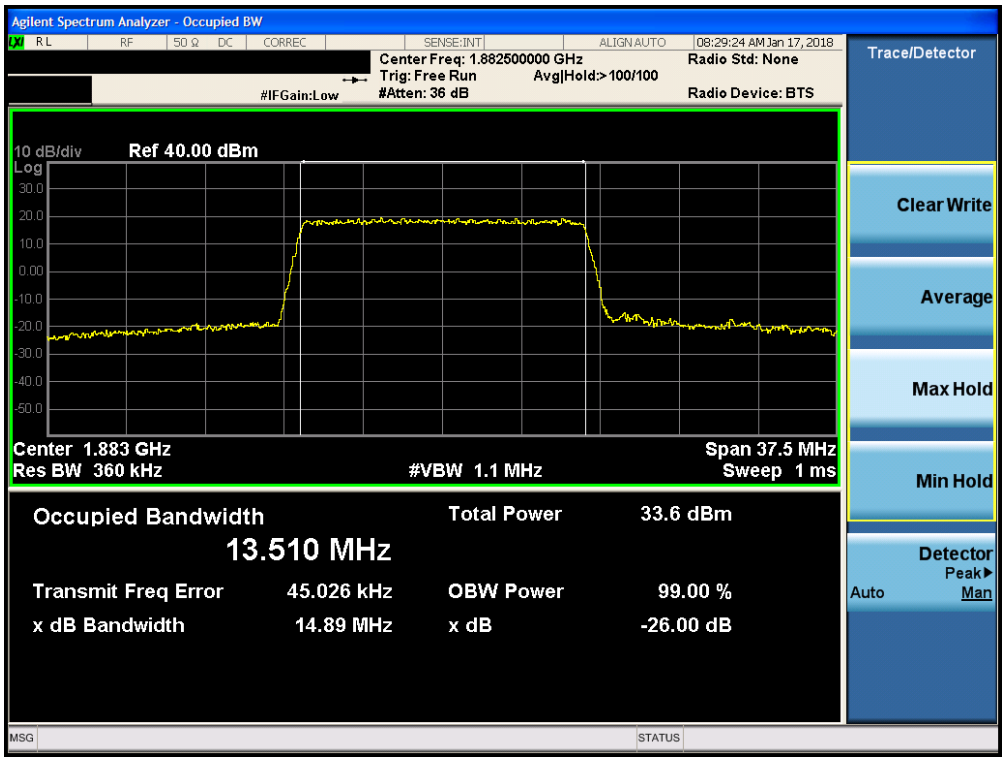
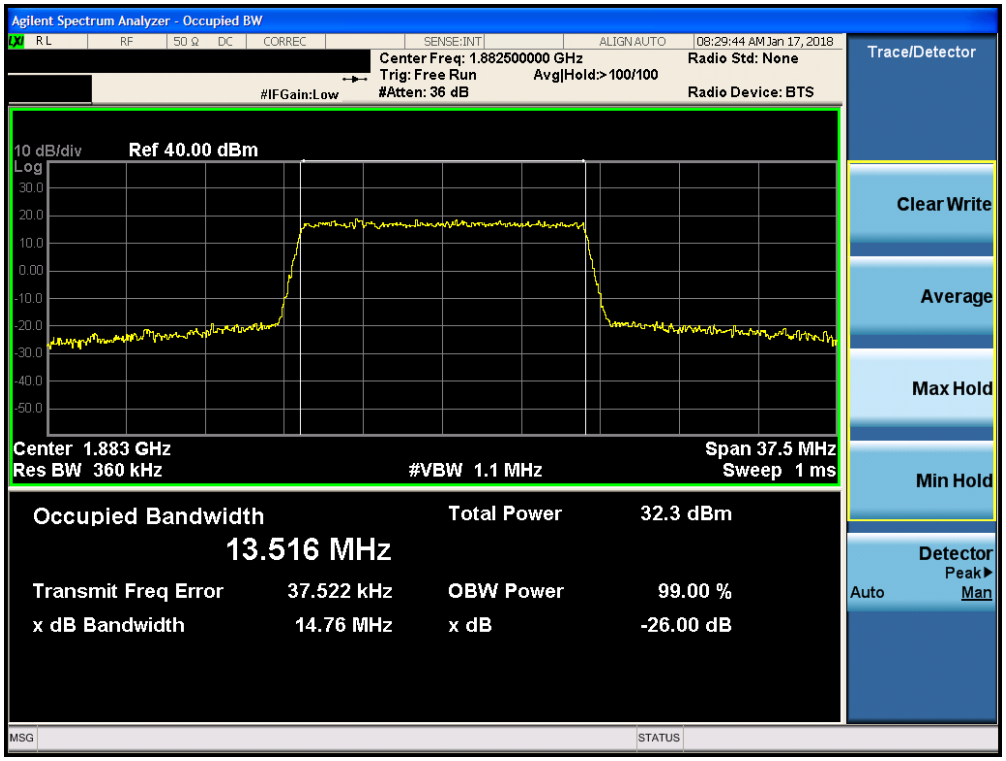


Plot 7-53. Occupied Bandwidth Plot (Band 25 - 15.0MHz QPSK - Full RB Configuration)



Plot 7-54. Occupied Bandwidth Plot (Band 25 - 15.0MHz 16-QAM - Full RB Configuration)

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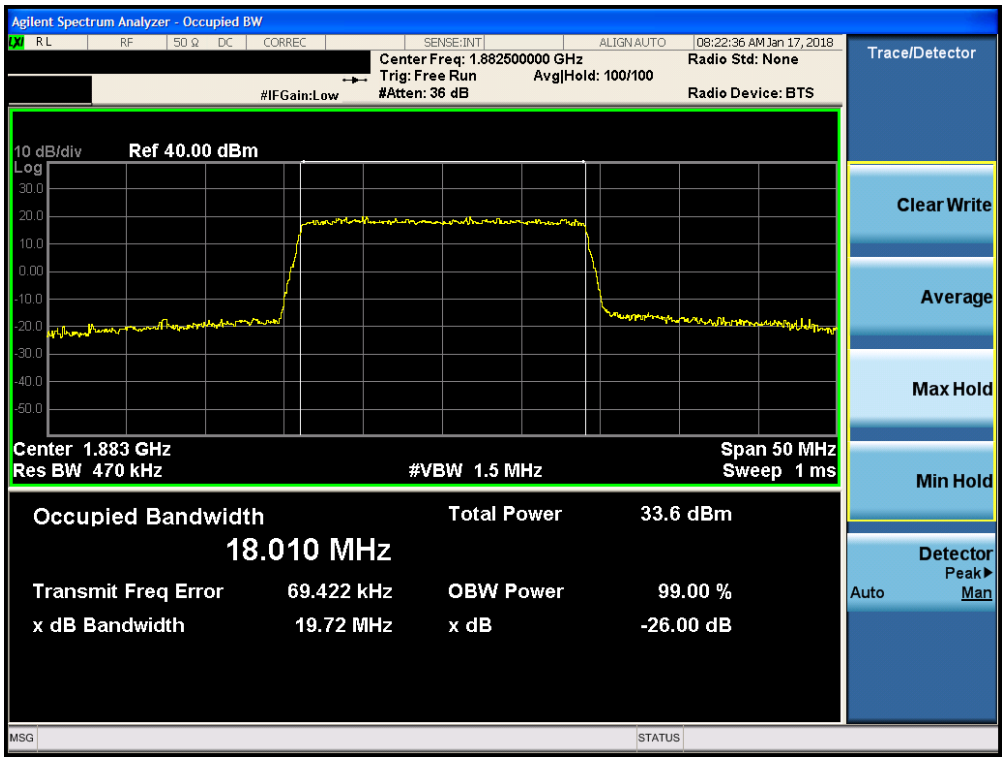
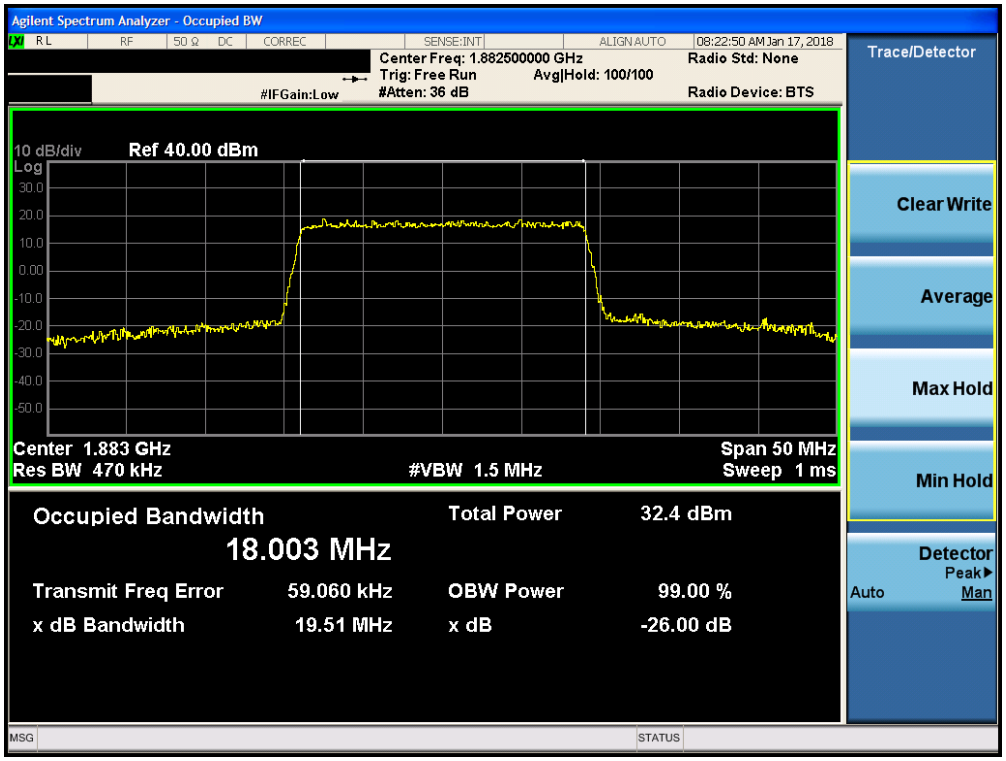


Plot 7-55. Occupied Bandwidth Plot (Band 25 - 20.0MHz QPSK - Full RB Configuration)



Plot 7-56. Occupied Bandwidth Plot (Band 25 - 20.0MHz 16-QAM - Full RB Configuration)

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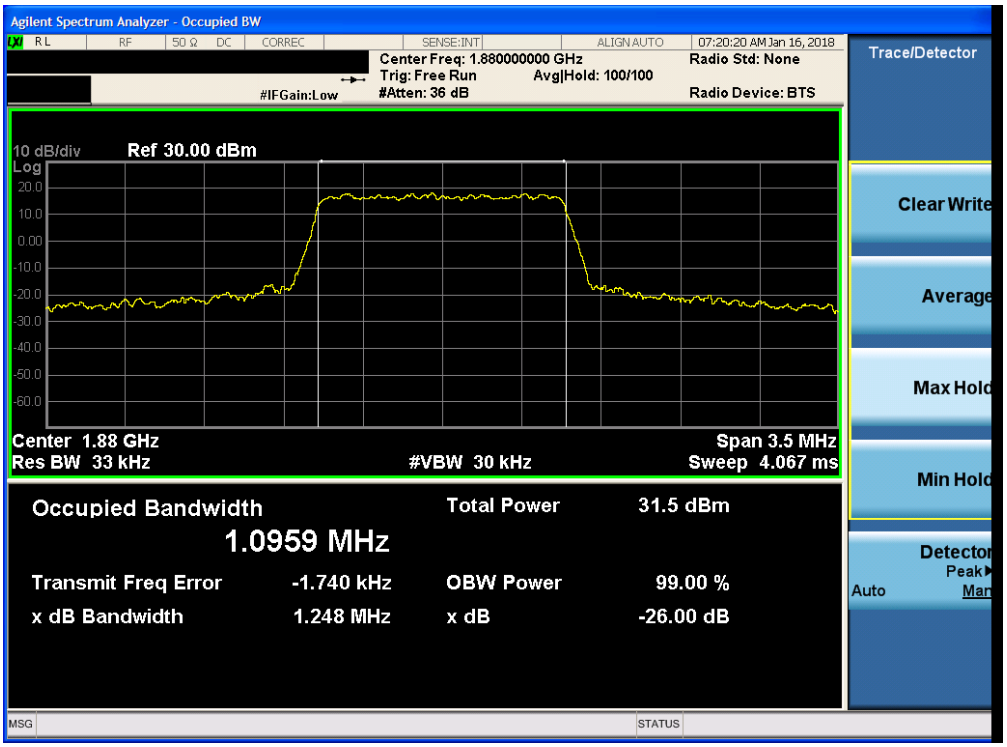
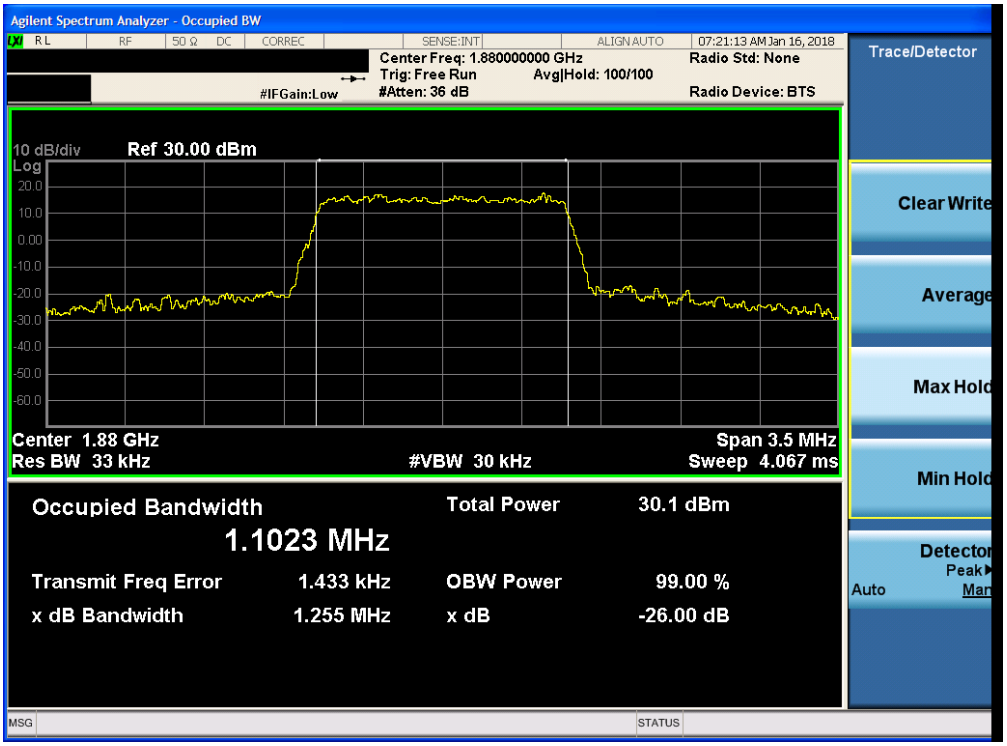
Band 2



Plot 7-57. Occupied Bandwidth Plot (Band 2 - 1.4MHz QPSK - Full RB Configuration)



Plot 7-58. Occupied Bandwidth Plot (Band 2 - 1.4MHz 16-QAM - Full RB Configuration)

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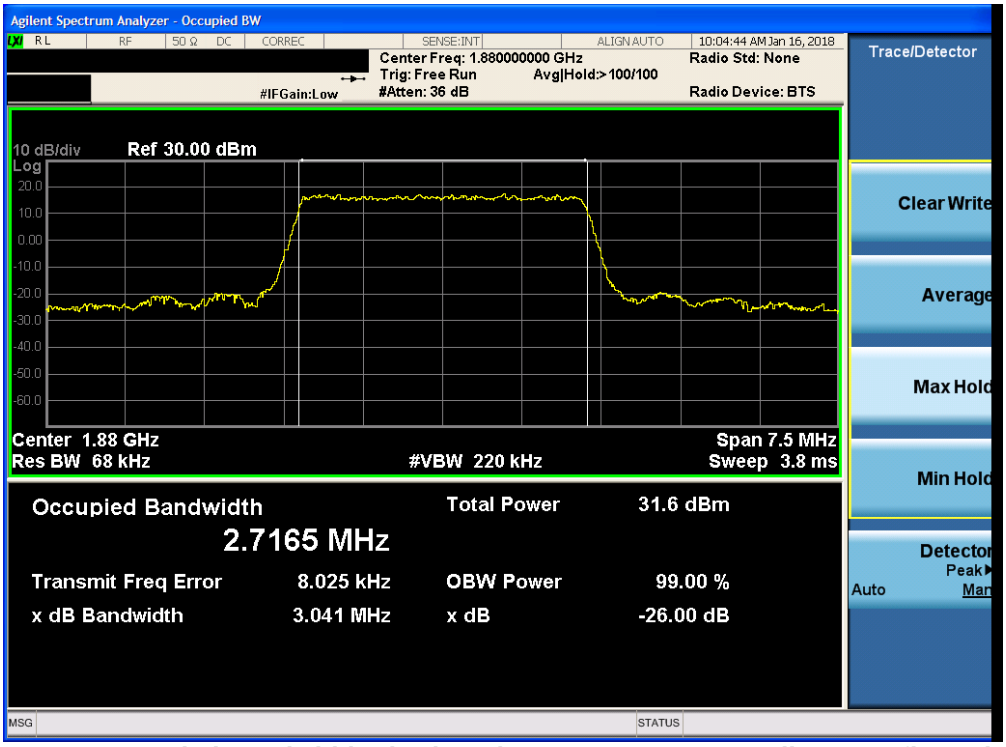
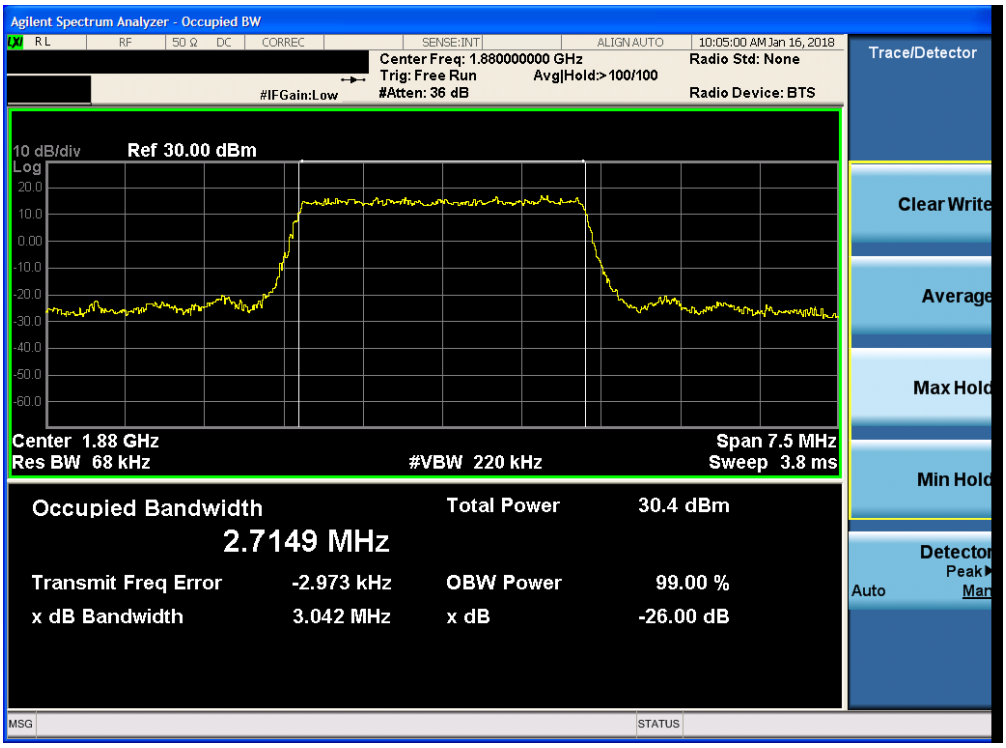


Plot 7-59. Occupied Bandwidth Plot (Band 2 - 3.0MHz QPSK - Full RB Configuration)



Plot 7-60. Occupied Bandwidth Plot (Band 2 - 3.0MHz 16-QAM - Full RB Configuration)

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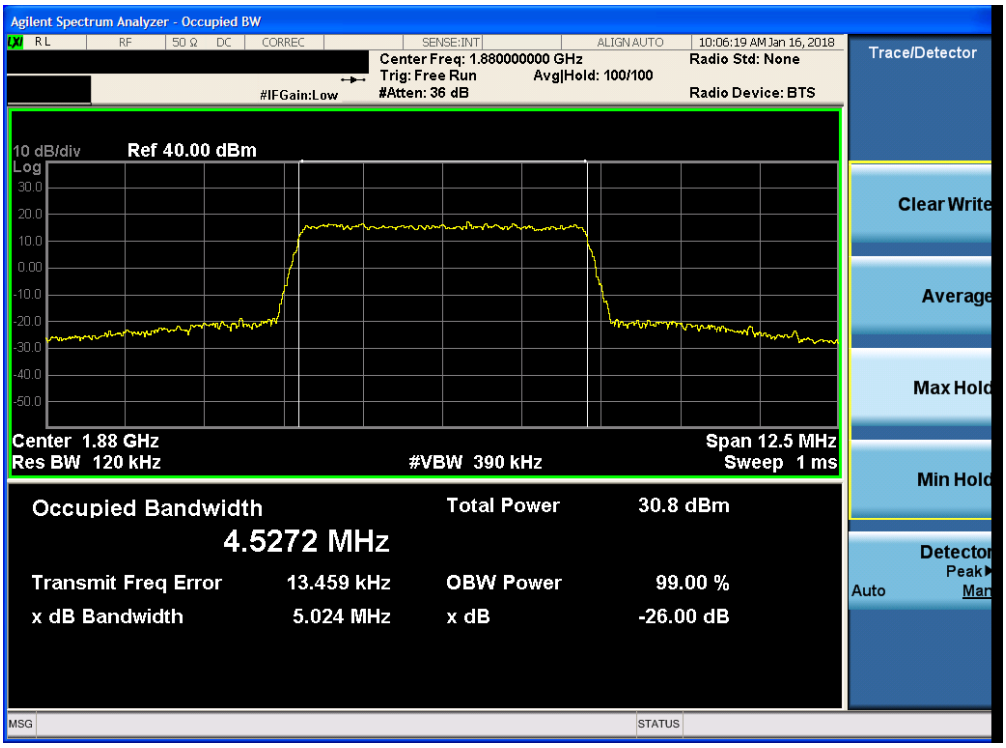
Plot 7-61. Occupied Bandwidth Plot (Band 2 - 5.0MHz QPSK - Full RB Configuration)



Plot 7-62. Occupied Bandwidth Plot (Band 2 - 5.0MHz 16-QAM - Full RB Configuration)

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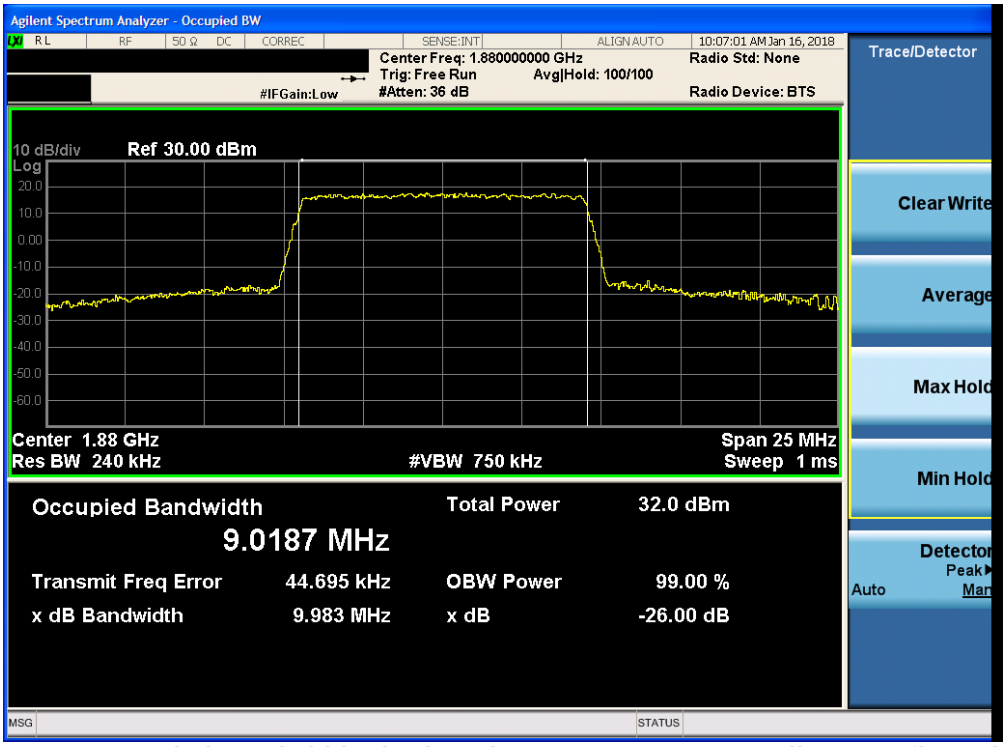
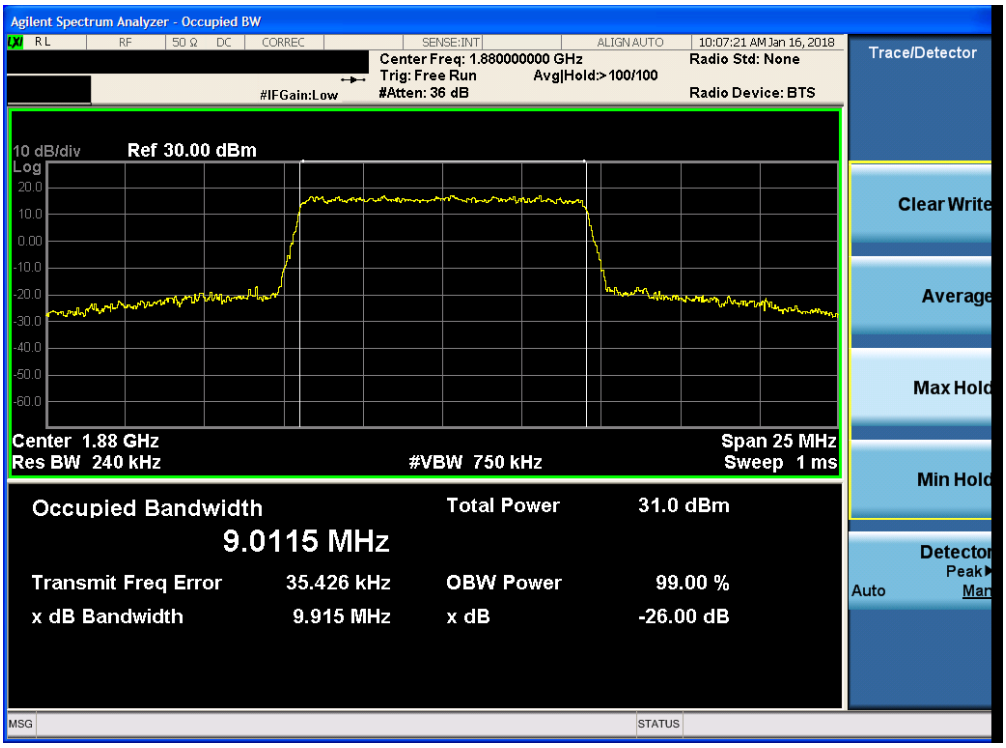


Plot 7-63. Occupied Bandwidth Plot (Band 2 - 10.0MHz QPSK - Full RB Configuration)



Plot 7-64. Occupied Bandwidth Plot (Band 2 - 10.0MHz 16-QAM - Full RB Configuration)

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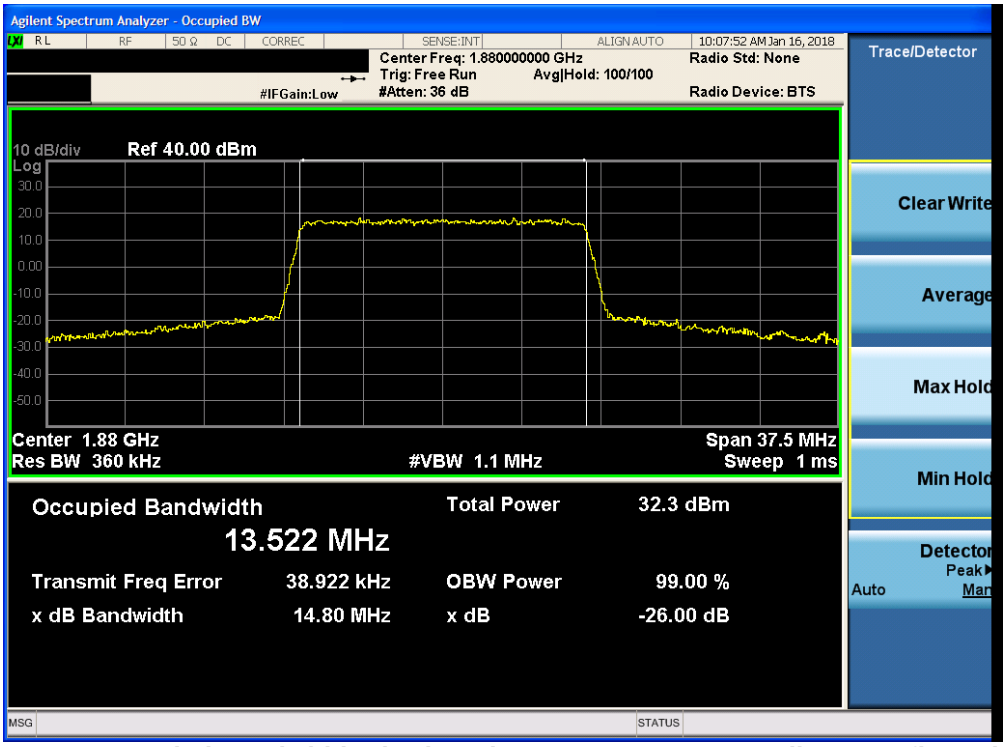
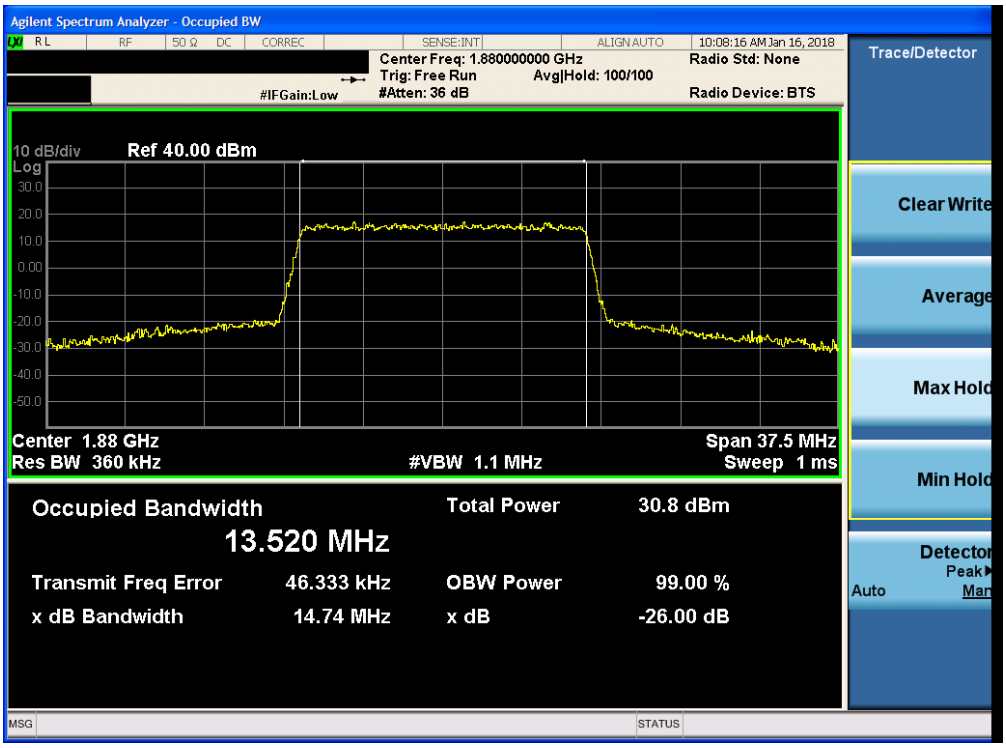


Plot 7-65. Occupied Bandwidth Plot (Band 2 - 15.0MHz QPSK - Full RB Configuration)



Plot 7-66. Occupied Bandwidth Plot (Band 2 - 15.0MHz 16-QAM - Full RB Configuration)

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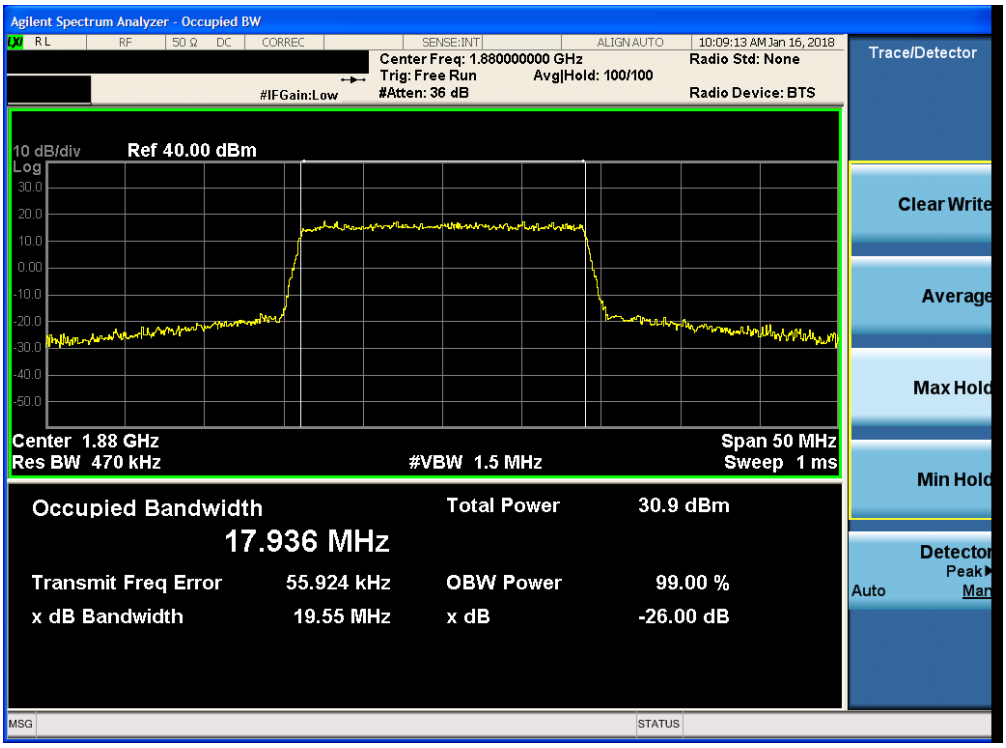
Plot 7-67. Occupied Bandwidth Plot (Band 2 - 20.0MHz QPSK - Full RB Configuration)



Plot 7-68. Occupied Bandwidth Plot (Band 2 - 20.0MHz 16-QAM - Full RB Configuration)

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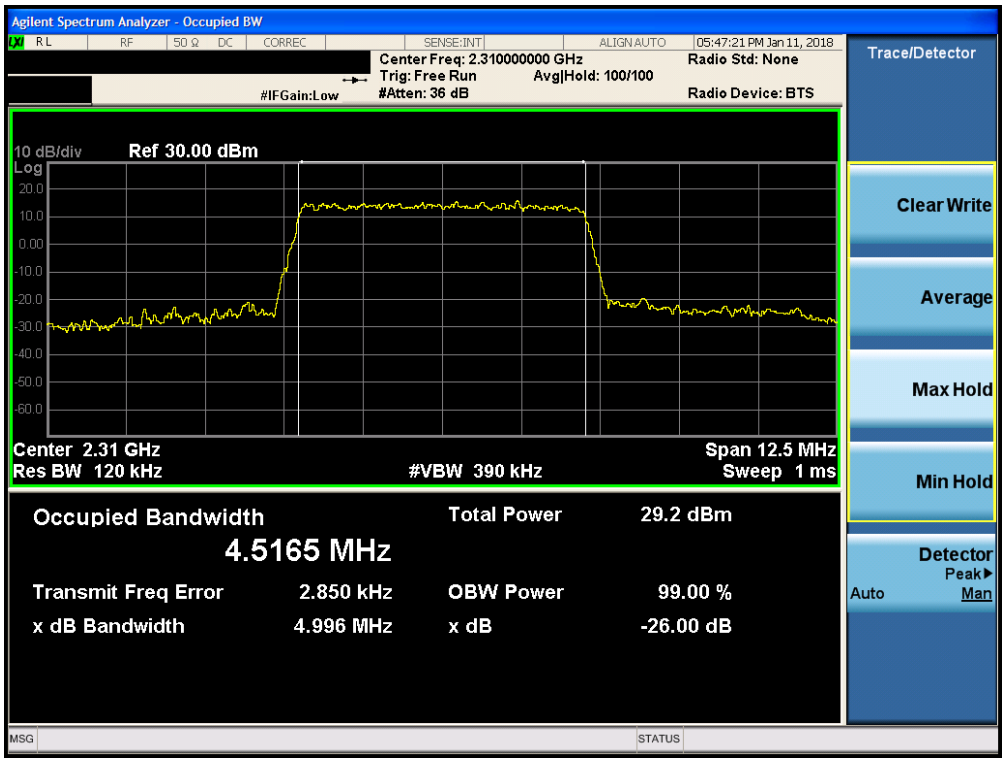
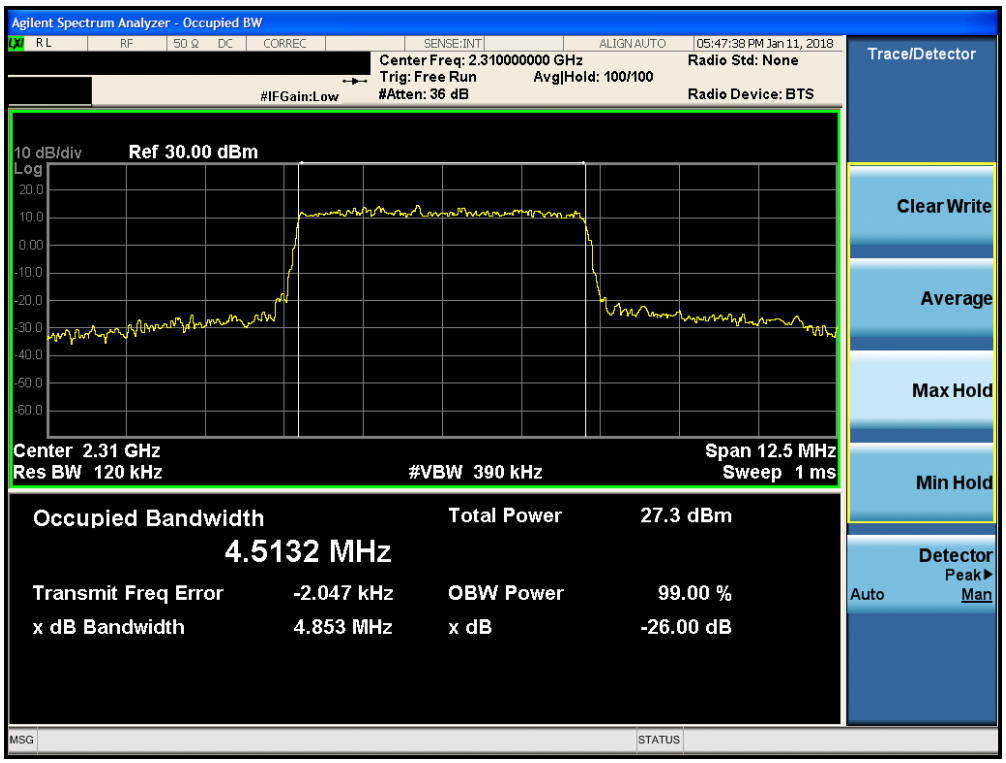
Band 30



Plot 7-69. Occupied Bandwidth Plot (Band 30 - 5.0MHz QPSK - Full RB Configuration)



Plot 7-70. Occupied Bandwidth Plot (Band 30 - 5.0MHz 16-QAM - Full RB Configuration)

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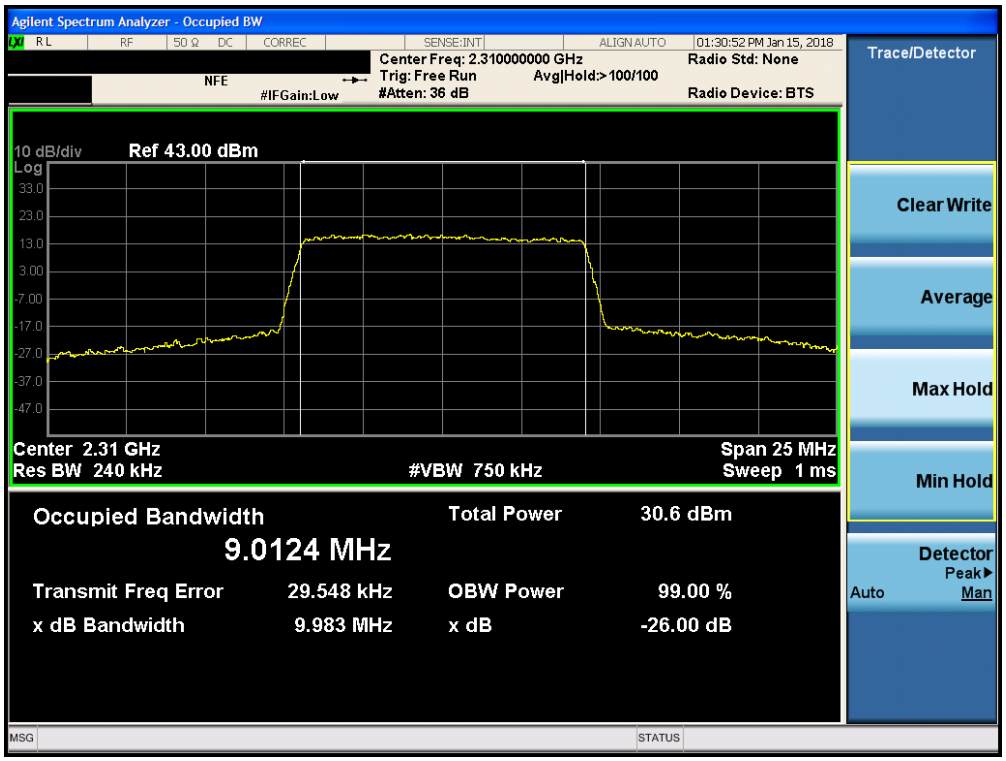
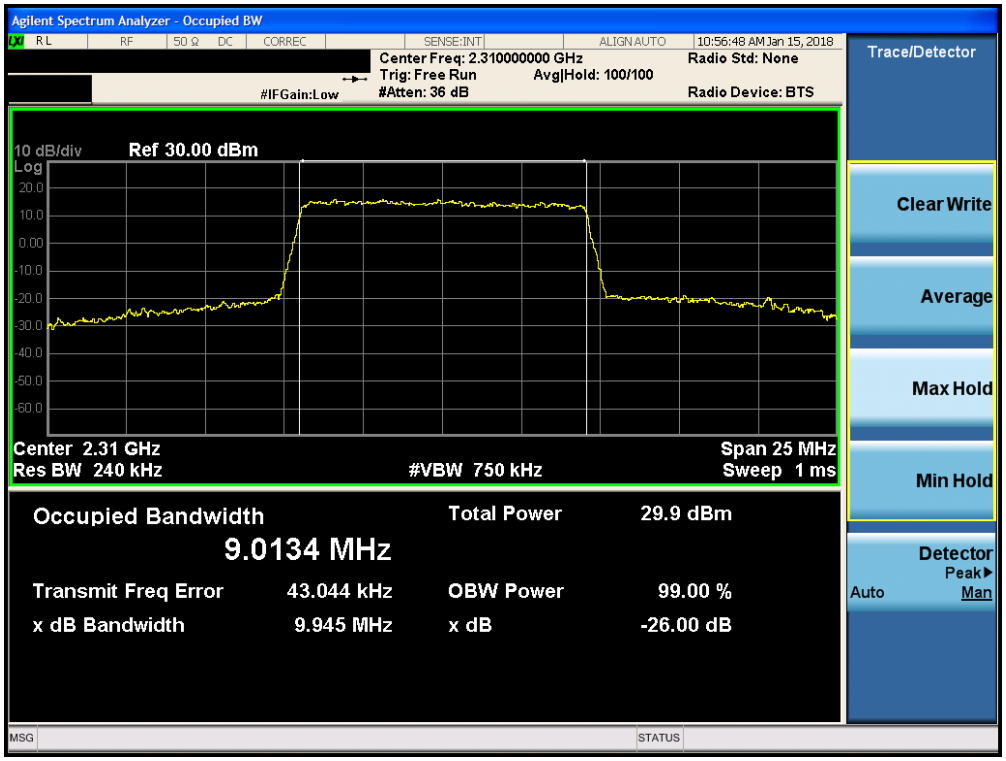


Plot 7-71. Occupied Bandwidth Plot (Band 30 - 10.0MHz QPSK - Full RB Configuration)



Plot 7-72. Occupied Bandwidth Plot (Band 30 - 10.0MHz 16-QAM - Full RB Configuration)

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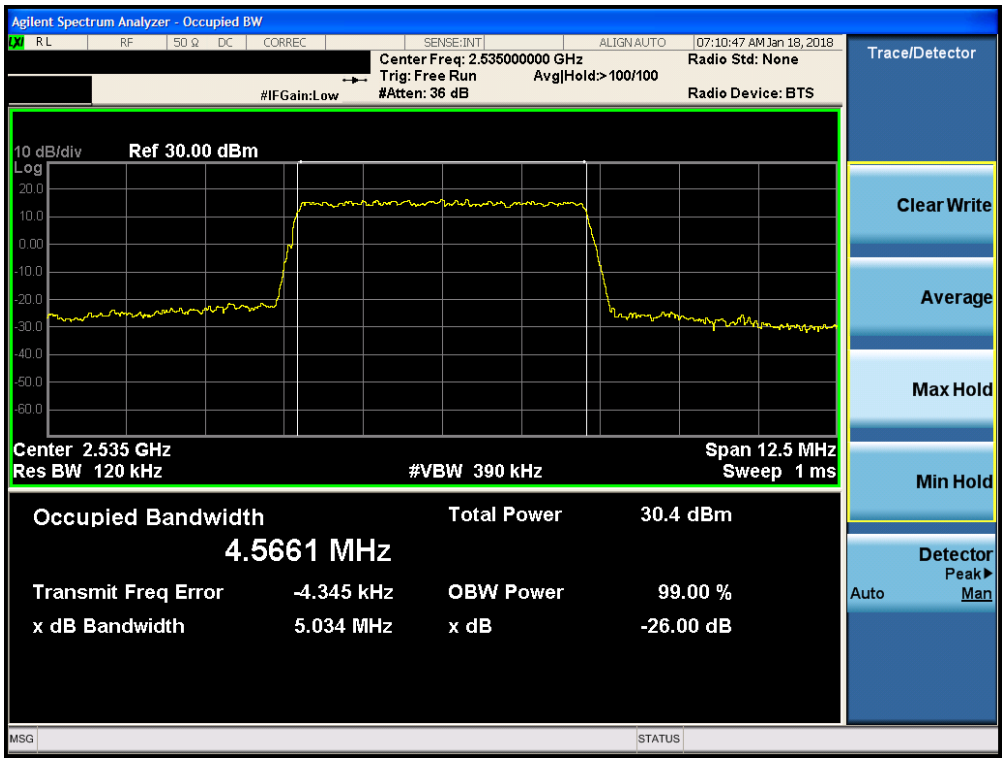
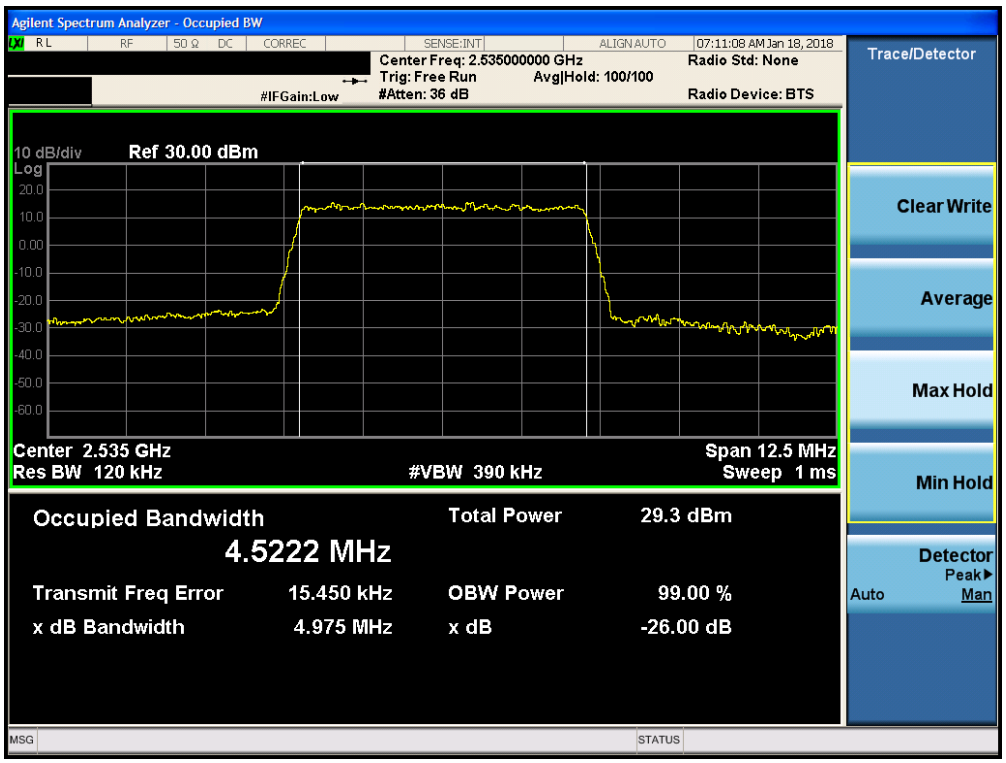
Band 7



Plot 7-73. Occupied Bandwidth Plot (Band 7 - 5.0MHz QPSK - Full RB Configuration)



Plot 7-74. Occupied Bandwidth Plot (Band 7 - 5.0MHz 16-QAM - Full RB Configuration)

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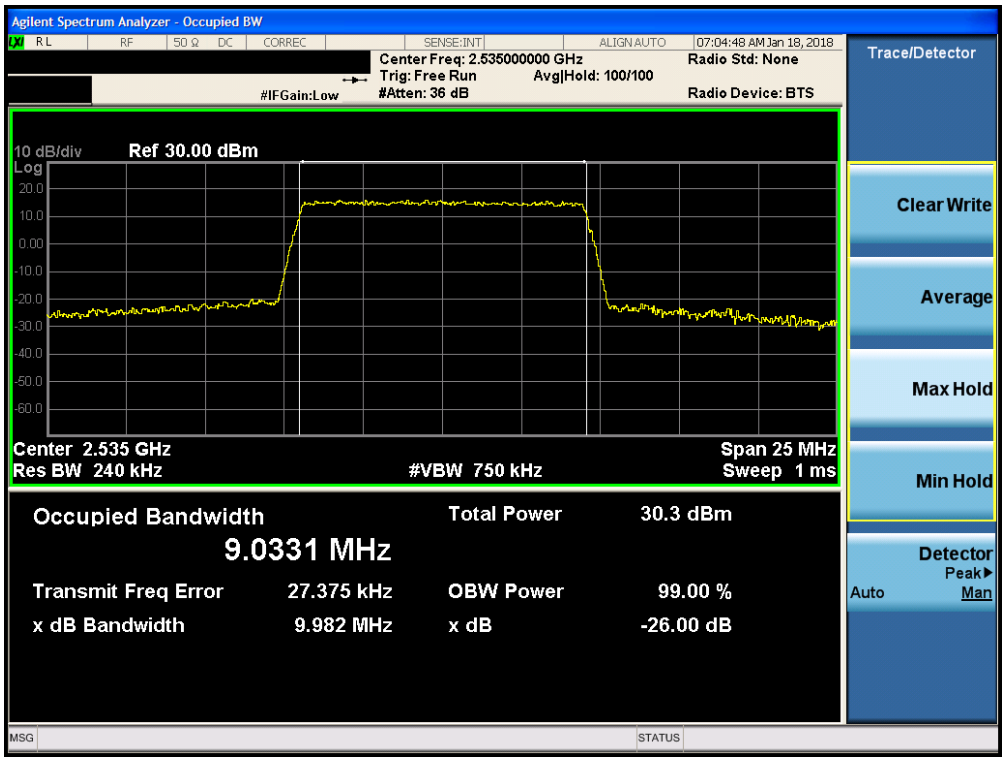

Plot 7-75. Occupied Bandwidth Plot (Band 7 - 10.0MHz QPSK - Full RB Configuration)

Plot 7-76. Occupied Bandwidth Plot (Band 7 - 10.0MHz 16-QAM - Full RB Configuration)

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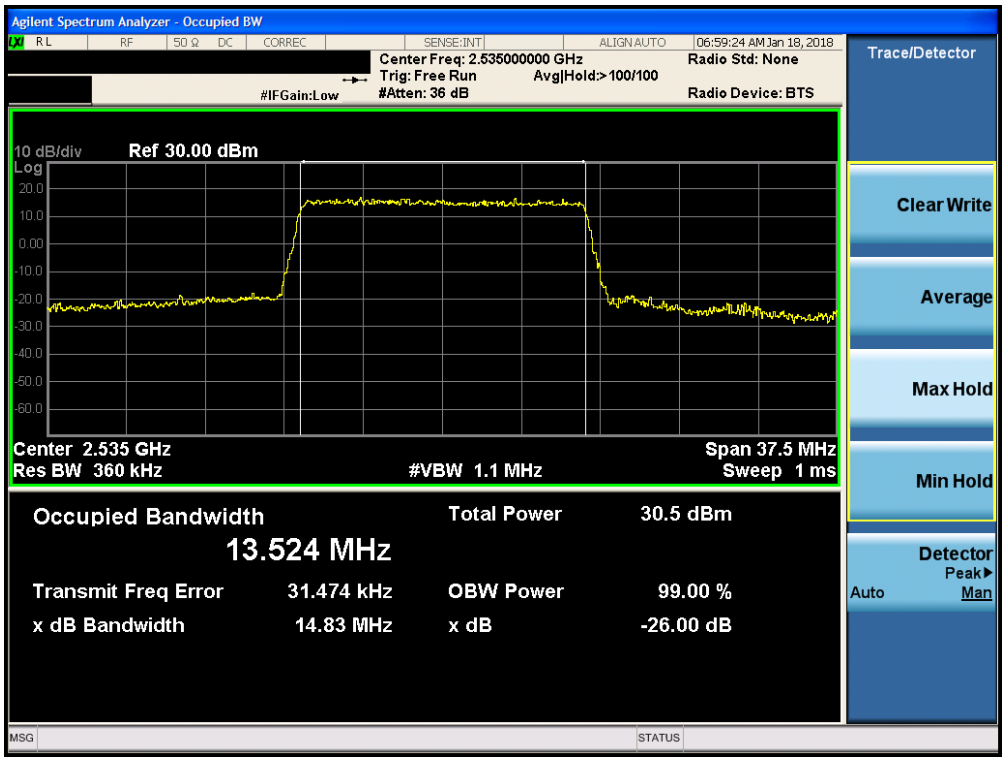
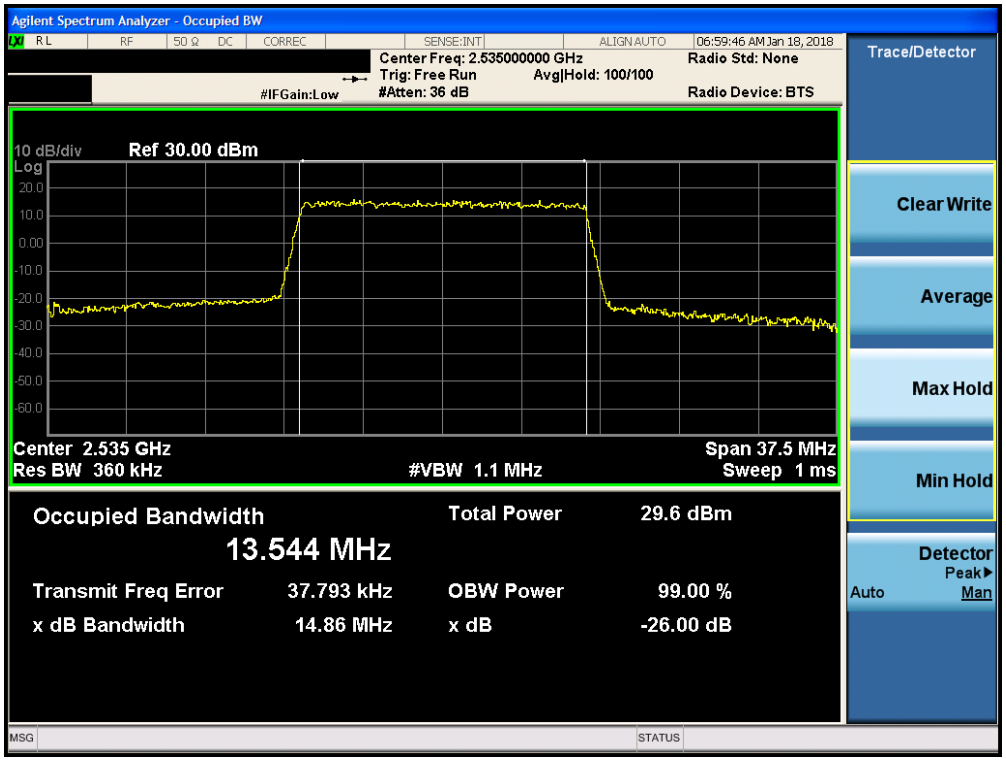


Plot 7-77. Occupied Bandwidth Plot (Band 7 - 15.0MHz QPSK - Full RB Configuration)



Plot 7-78. Occupied Bandwidth Plot (Band 7 - 15.0MHz 16-QAM - Full RB Configuration)

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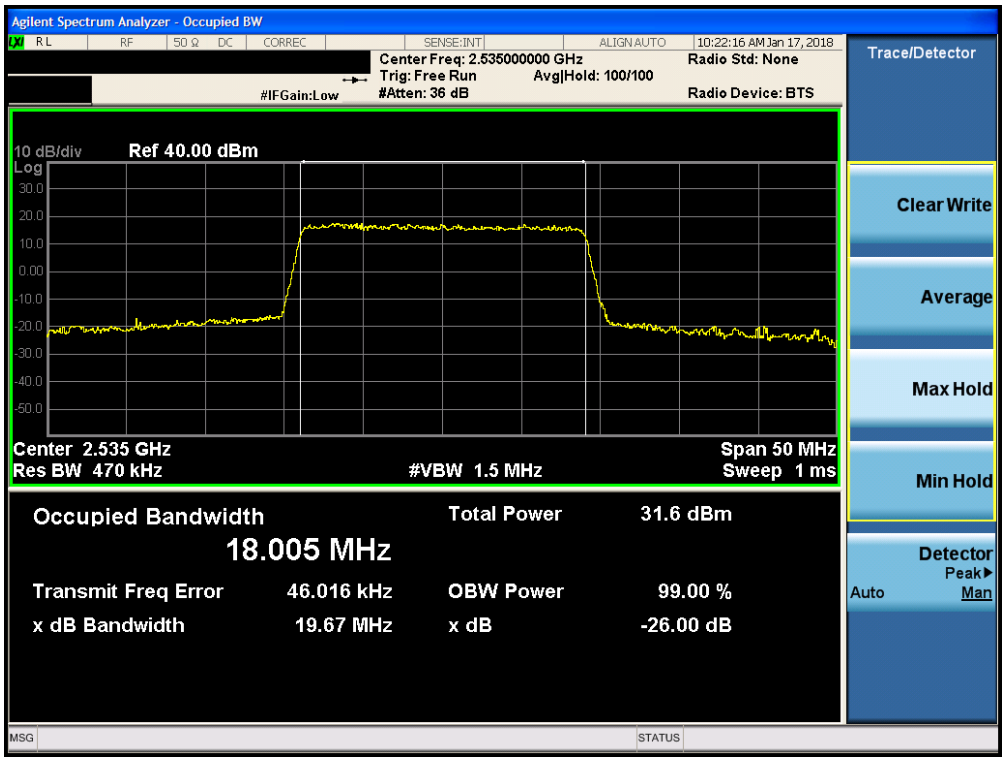
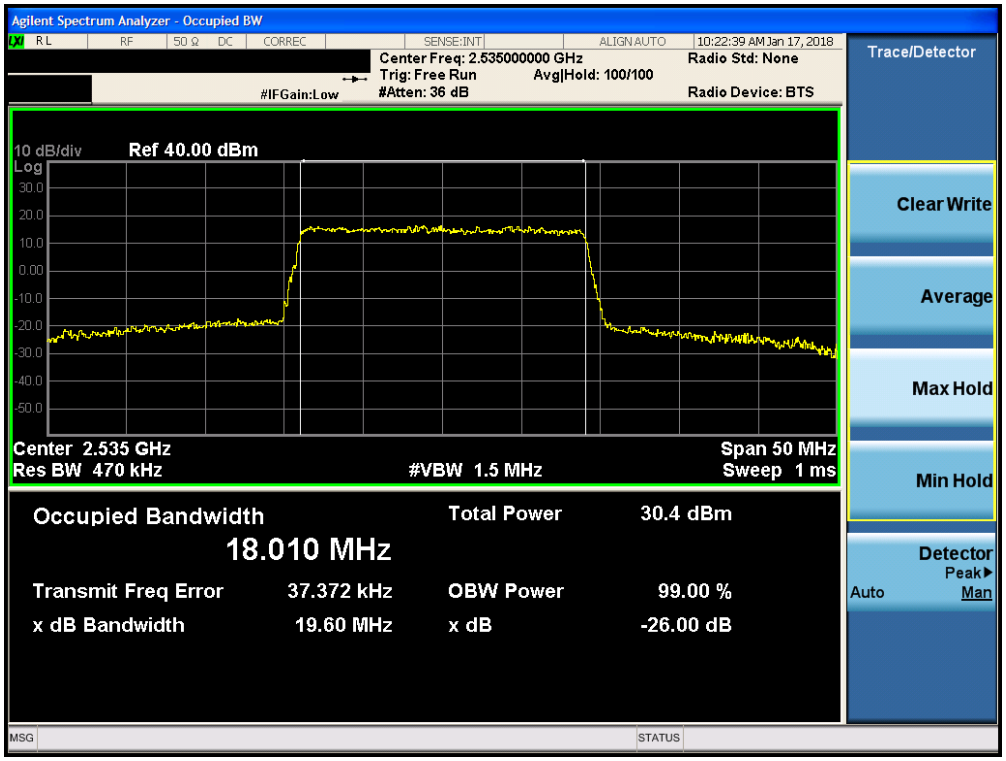


Plot 7-79. Occupied Bandwidth Plot (Band 7 - 20.0MHz QPSK - Full RB Configuration)



Plot 7-80. Occupied Bandwidth Plot (Band 7 - 20.0MHz 16-QAM - Full RB Configuration)

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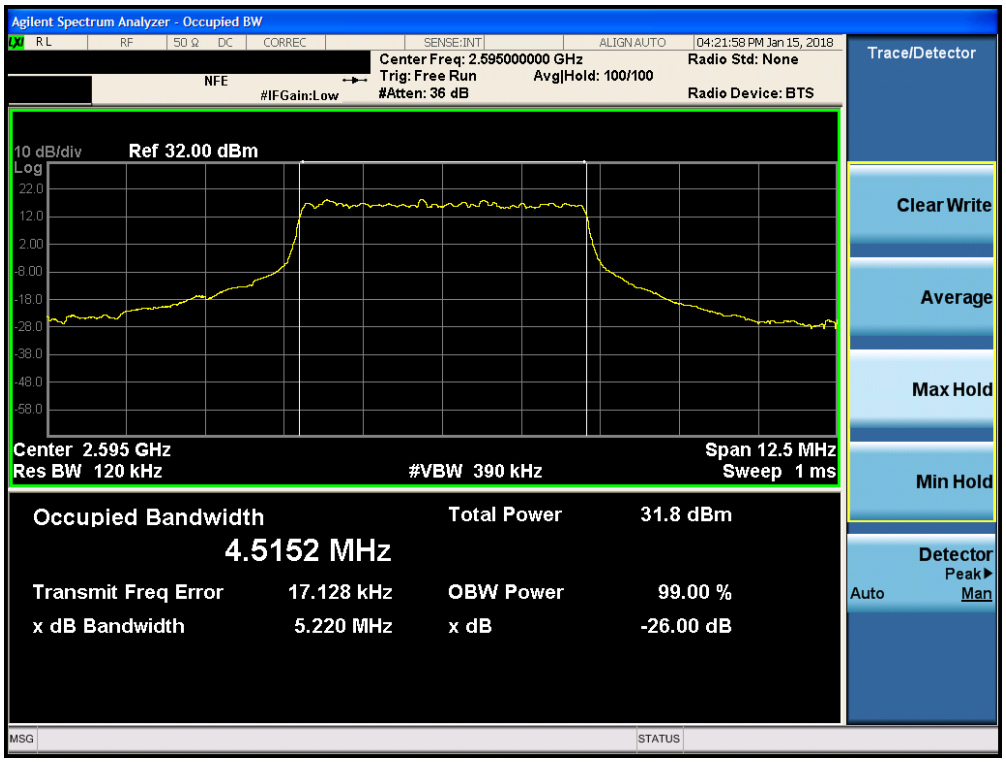
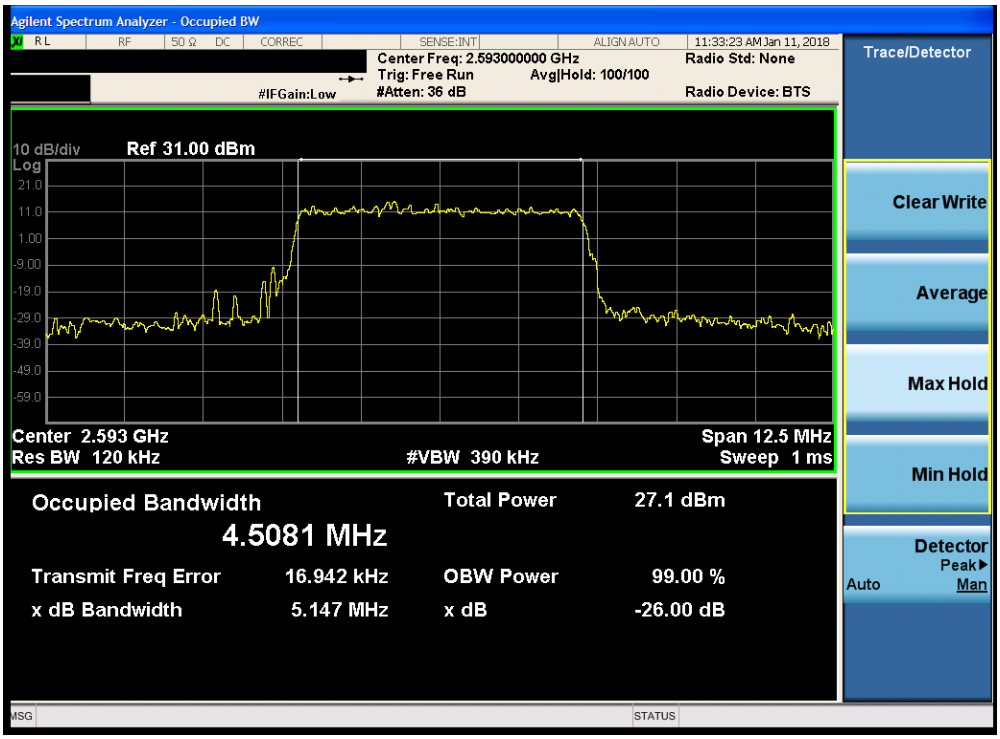
Band 41



Plot 7-81. Occupied Bandwidth Plot (Band 41 - 5.0MHz QPSK - Full RB Configuration)



Plot 7-82. Occupied Bandwidth Plot (Band 41 - 5.0MHz 16-QAM - Full RB Configuration)

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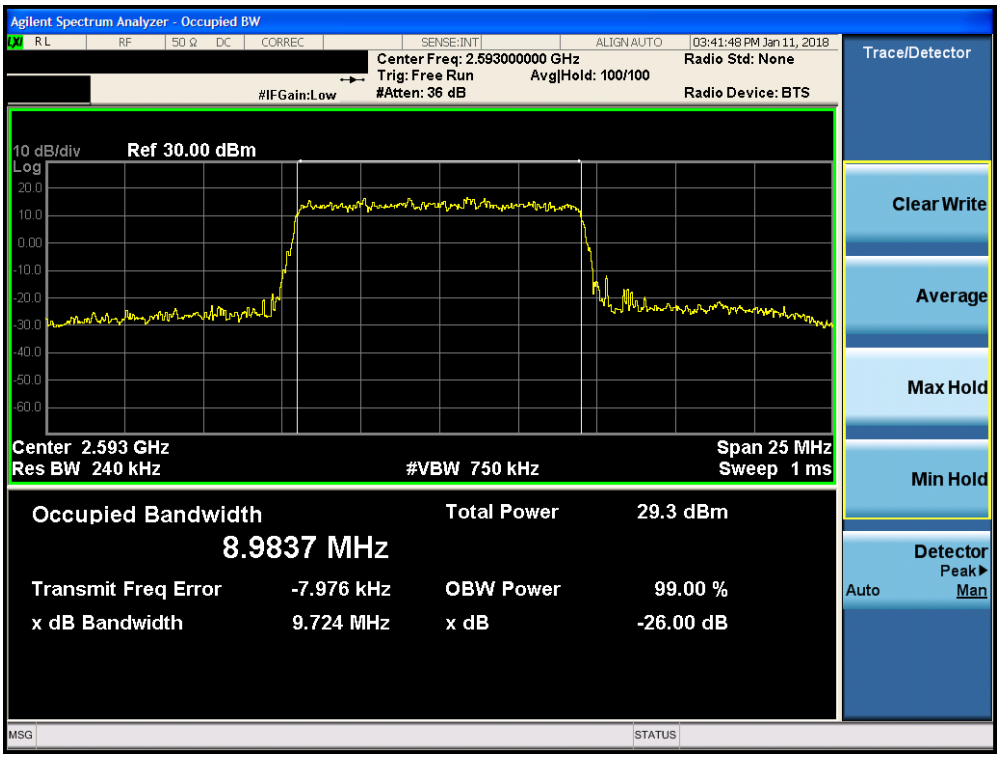
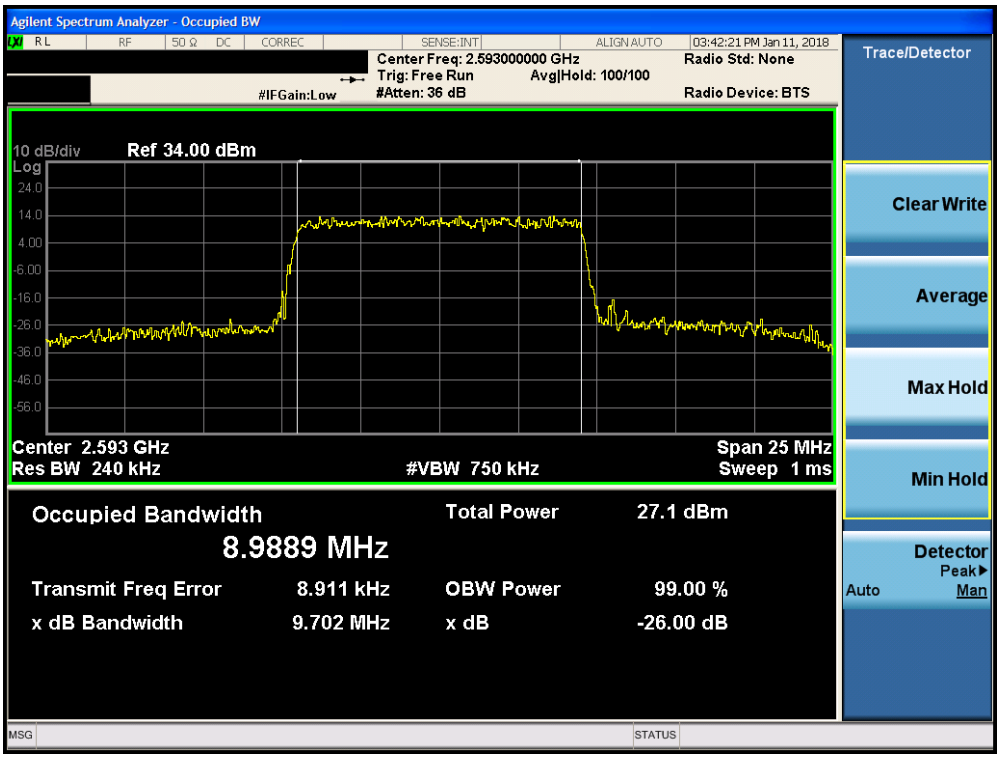


Plot 7-83. Occupied Bandwidth Plot (Band 41 - 10.0MHz QPSK - Full RB Configuration)



Plot 7-84. Occupied Bandwidth Plot (Band 41 - 10.0MHz 16-QAM - Full RB Configuration)

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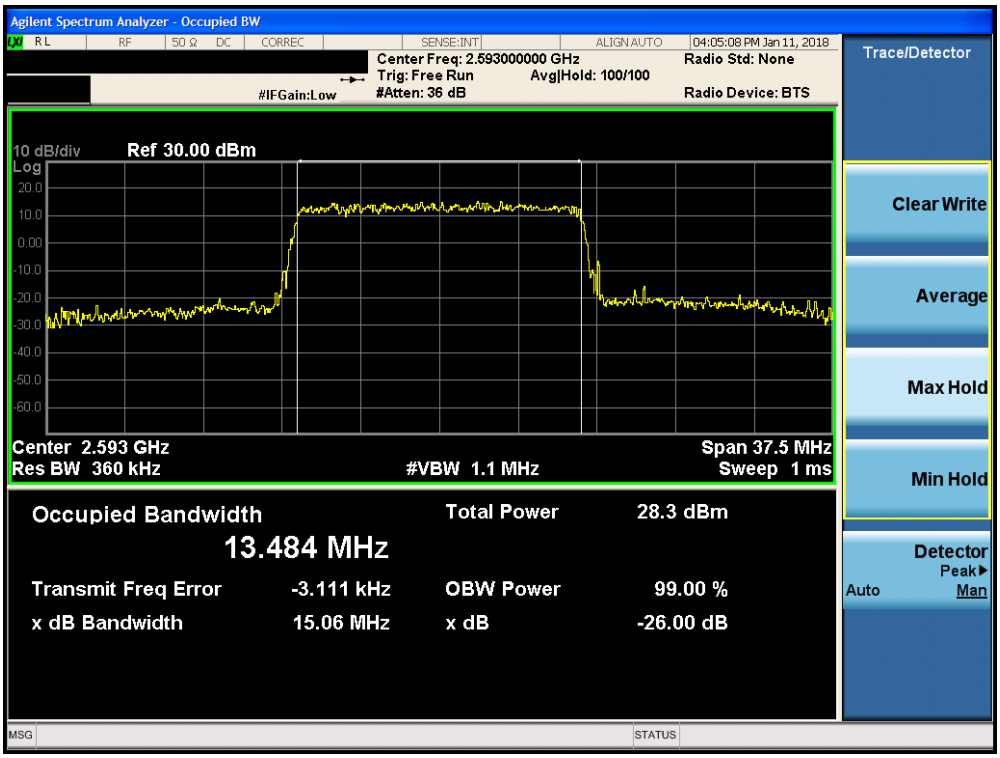
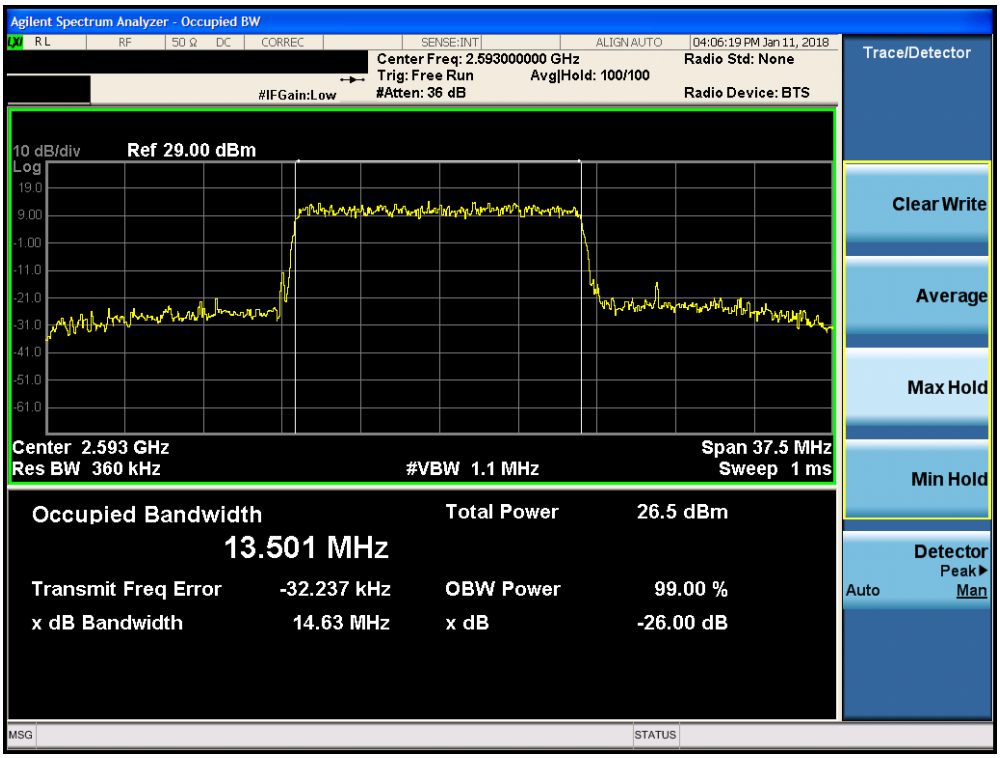


Plot 7-85. Occupied Bandwidth Plot (Band 41 - 15.0MHz QPSK - Full RB Configuration)



Plot 7-86. Occupied Bandwidth Plot (Band 41 - 15.0MHz 16-QAM - Full RB Configuration)

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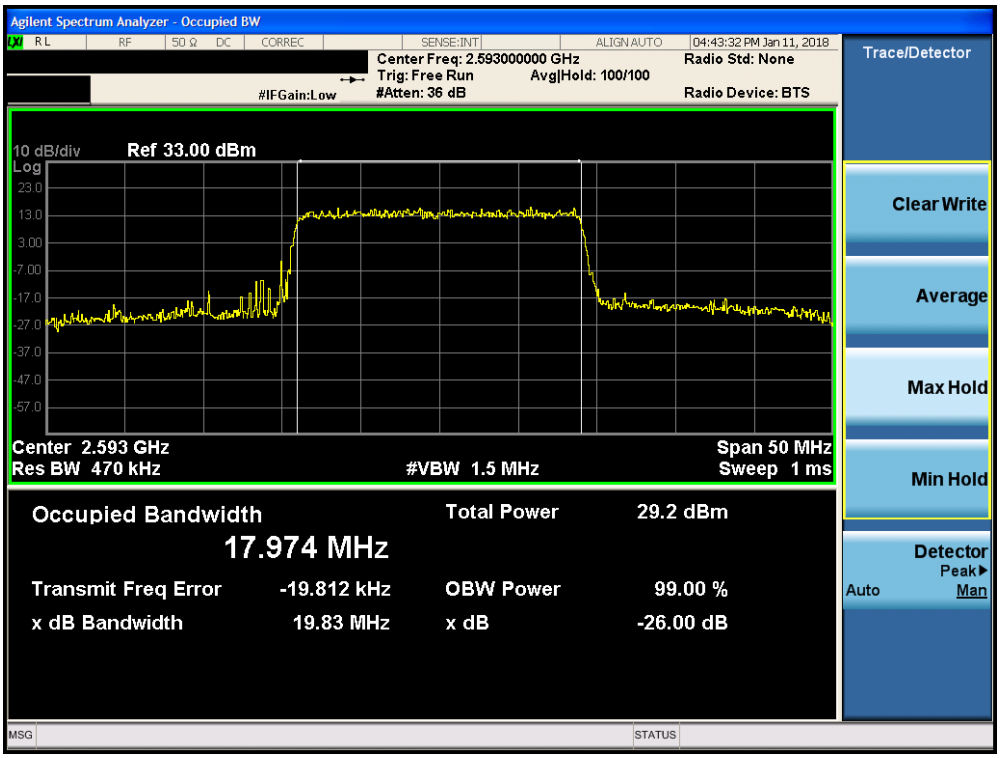
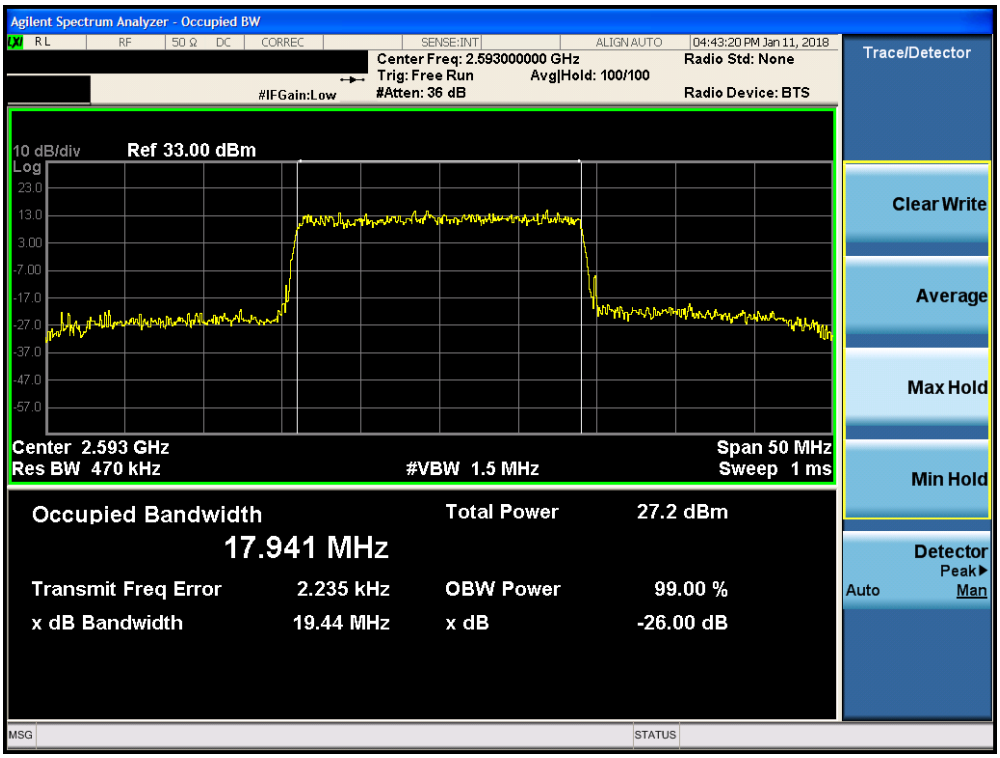


Plot 7-87. Occupied Bandwidth Plot (Band 41 – 20.0MHz QPSK - Full RB Configuration)



Plot 7-88. Occupied Bandwidth Plot (Band 41 - 20.0MHz 16-QAM - Full RB Configuration)

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7.3 Spurious and Harmonic Emissions at Antenna Terminal

§2.1051 §22.917(a) §24.238(a) §27.53(c)(2) §27.53(g) §27.53(h) §27.53(m) §27.53(a)(4)

Test Overview

The level of the carrier and the various conducted spurious and harmonic frequencies is measured by means of a calibrated spectrum analyzer. The spectrum is scanned from the lowest frequency generated in the equipment up to a frequency including its 10th harmonic. All out of band emissions are measured with a spectrum analyzer connected to the antenna terminal of the EUT while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates were investigated to determine the worst case configuration. All modes of operation were investigated and the worst case configuration results are reported in this section.

The minimum permissible attenuation level of any spurious emission is 43 + $\log_{10}(P_{[Watts]})$, where P is the transmitter power in Watts.

For Band 30, the minimum permissible attenuation level of any spurious emission <2288MHz and >2365MHz is 70 + $\log_{10}(P_{[Watts]})$.

For Band 7 and 41, the minimum permissible attenuation level of any spurious emission is 55 + $\log_{10}(P_{[Watts]})$.

Test Procedure Used

KDB 971168 D01 v03 – Section 6.0

Test Settings

1. Start frequency was set to 30MHz and stop frequency was set to at least 10 * the fundamental frequency (separated into at least two plots per channel)
2. Detector = RMS
3. Trace mode = trace average for continuous emissions, max hold for pulse emissions
4. Sweep time = auto couple
5. The trace was allowed to stabilize
6. Please see test notes below for RBW and VBW settings

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

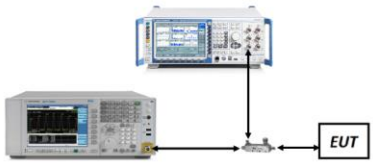

Figure 7-2. Test Instrument & Measurement Setup

Test Notes

Compliance with the applicable limits is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater for frequencies less than 1 GHz and 1 MHz or greater for frequencies greater than 1 GHz. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emission are attenuated at least 26 dB below the transmitter power.

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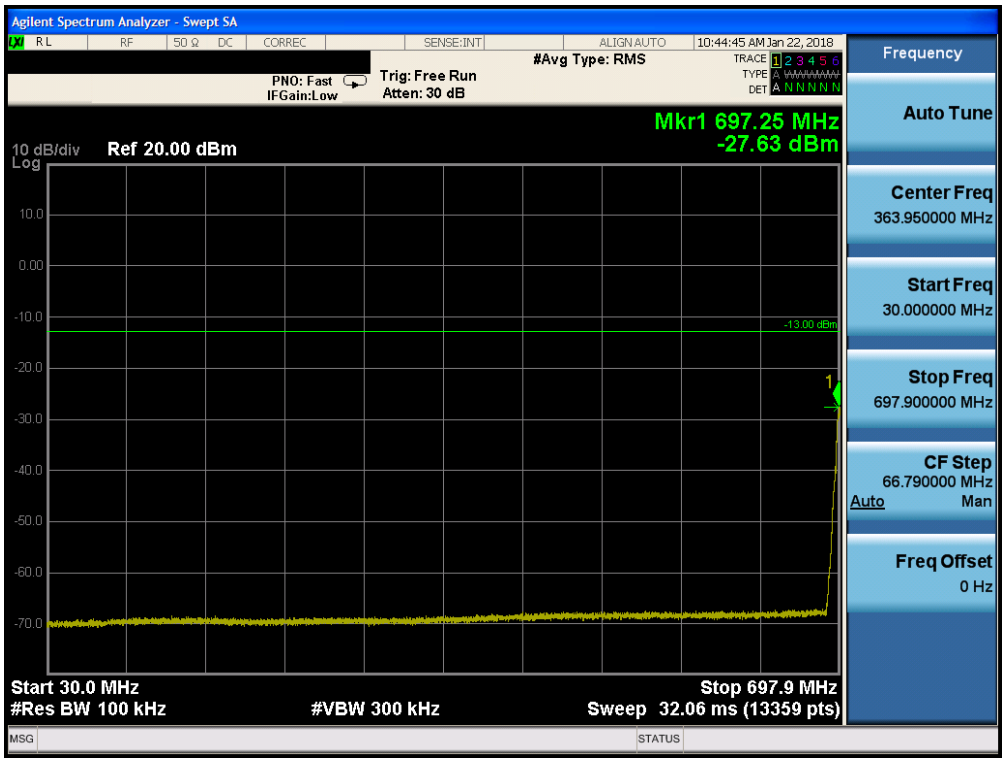
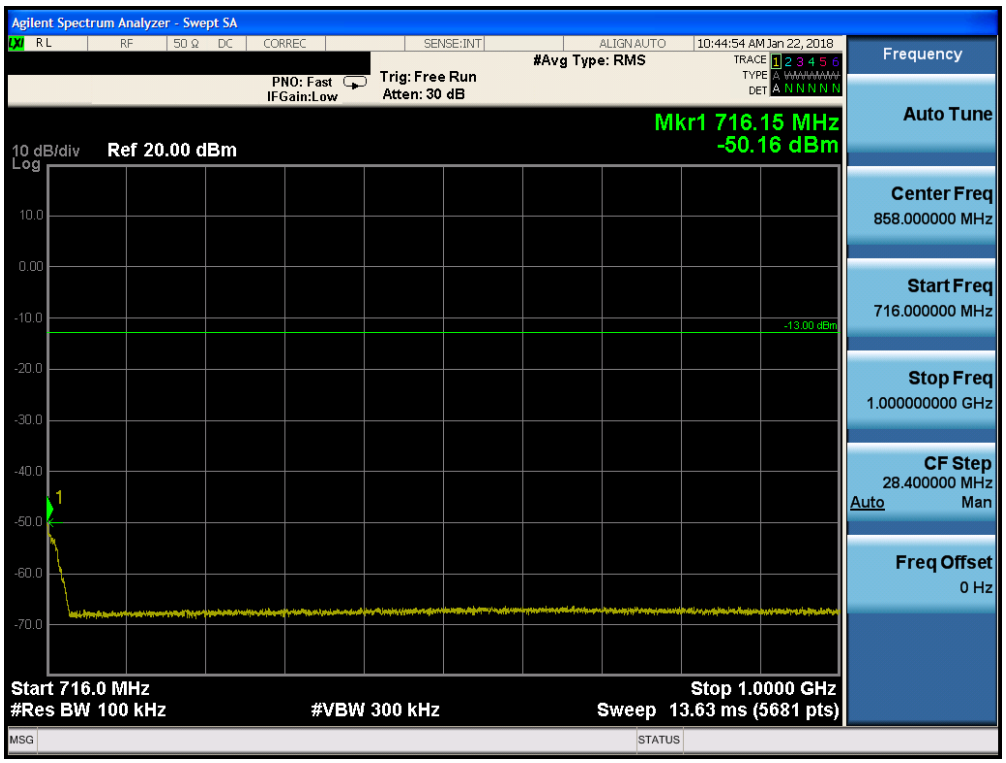
Band 12



Plot 7-89. Conducted Spurious Plot (Band 12 - 5.0MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)



Plot 7-90. Conducted Spurious Plot (Band 12 - 5.0MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)

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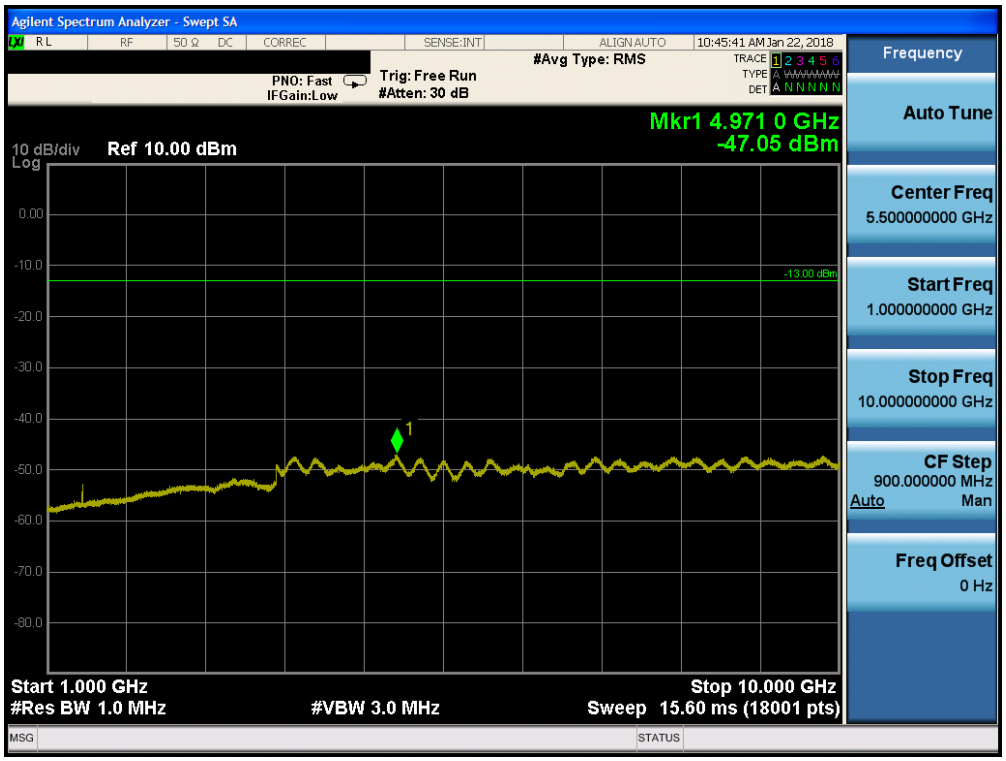
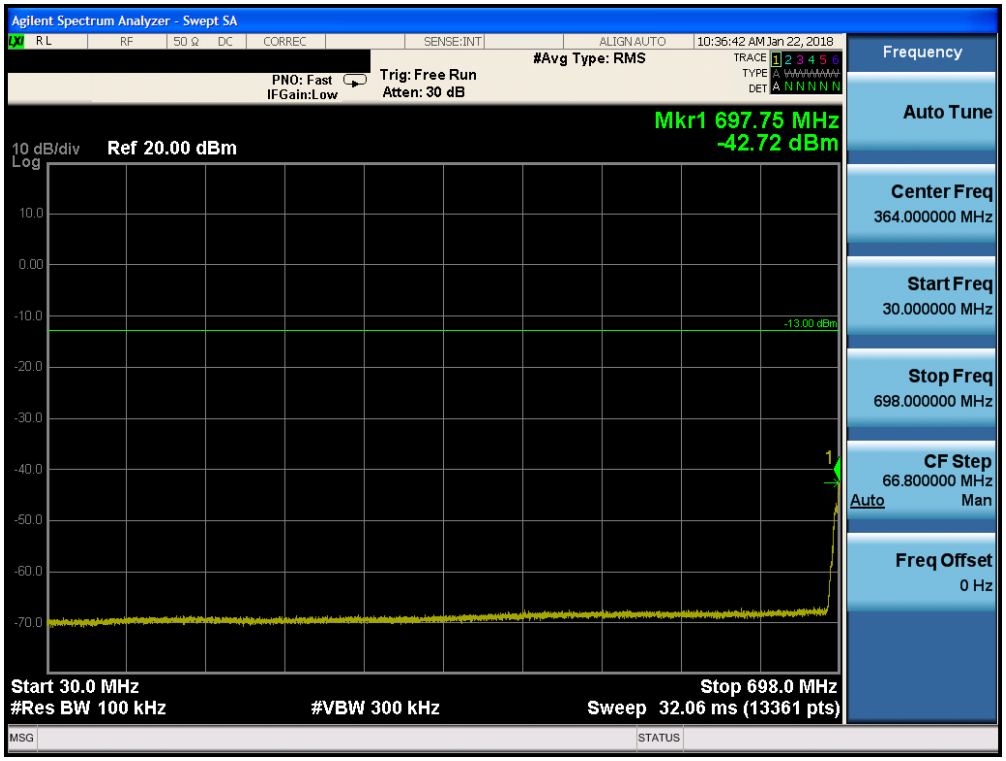


Plot 7-91. Conducted Spurious Plot (Band 12 - 5.0MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)



Plot 7-92. Conducted Spurious Plot (Band 12 - 5.0MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)

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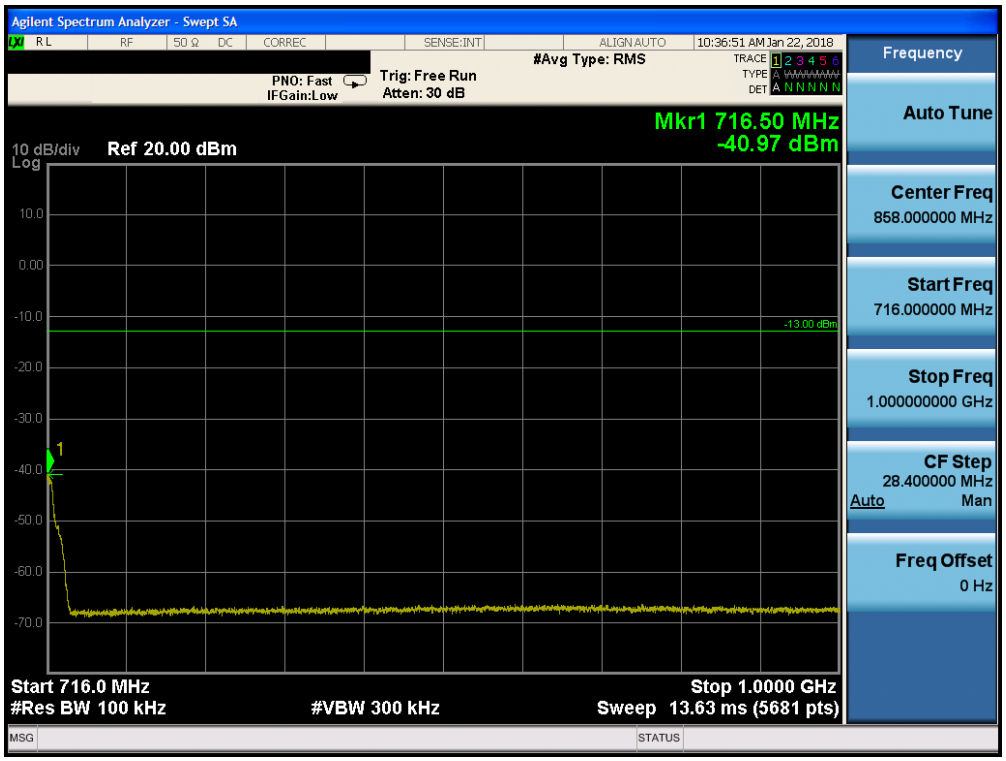
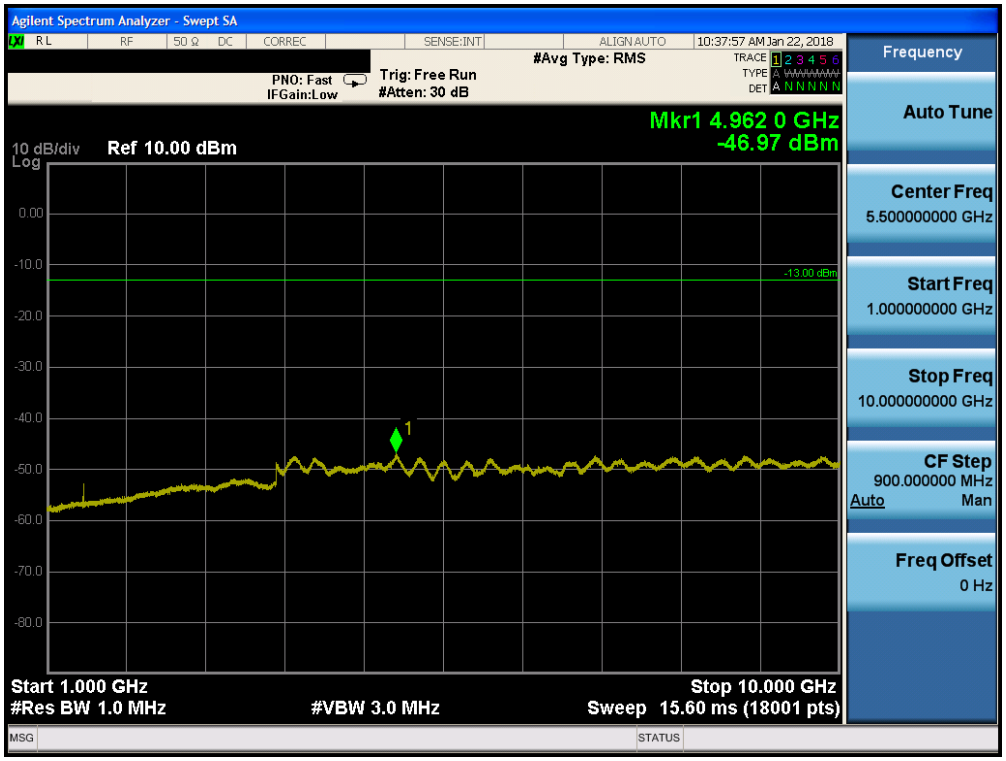


Plot 7-93. Conducted Spurious Plot (Band 12 - 5.0MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)



Plot 7-94. Conducted Spurious Plot (Band 12 - 5.0MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)

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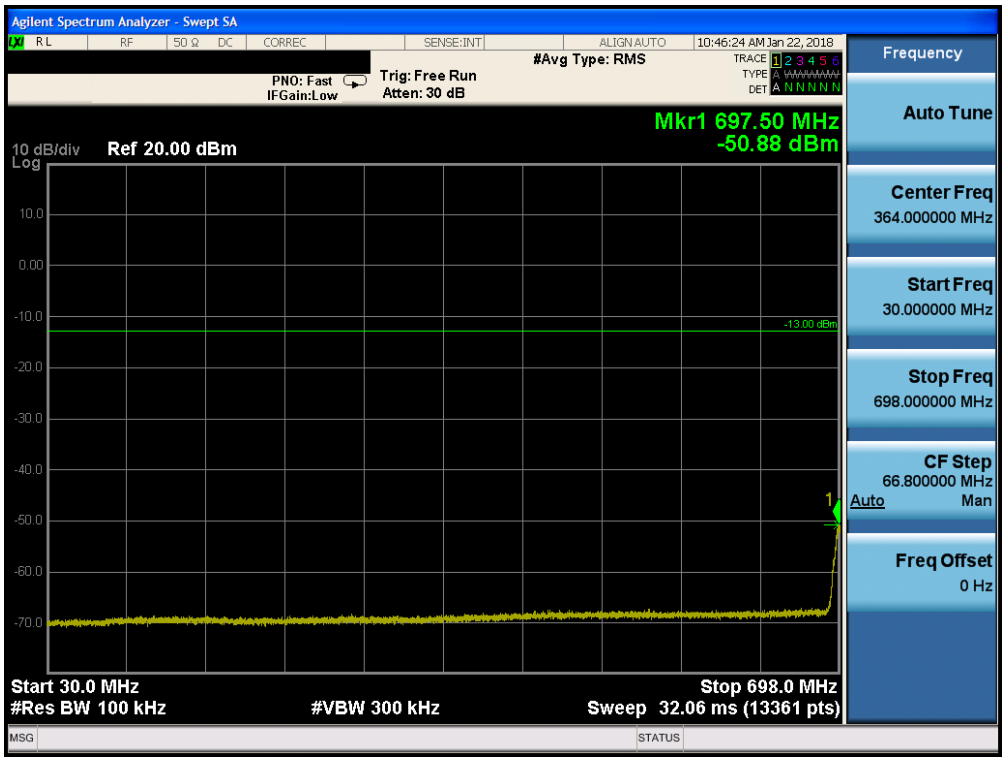
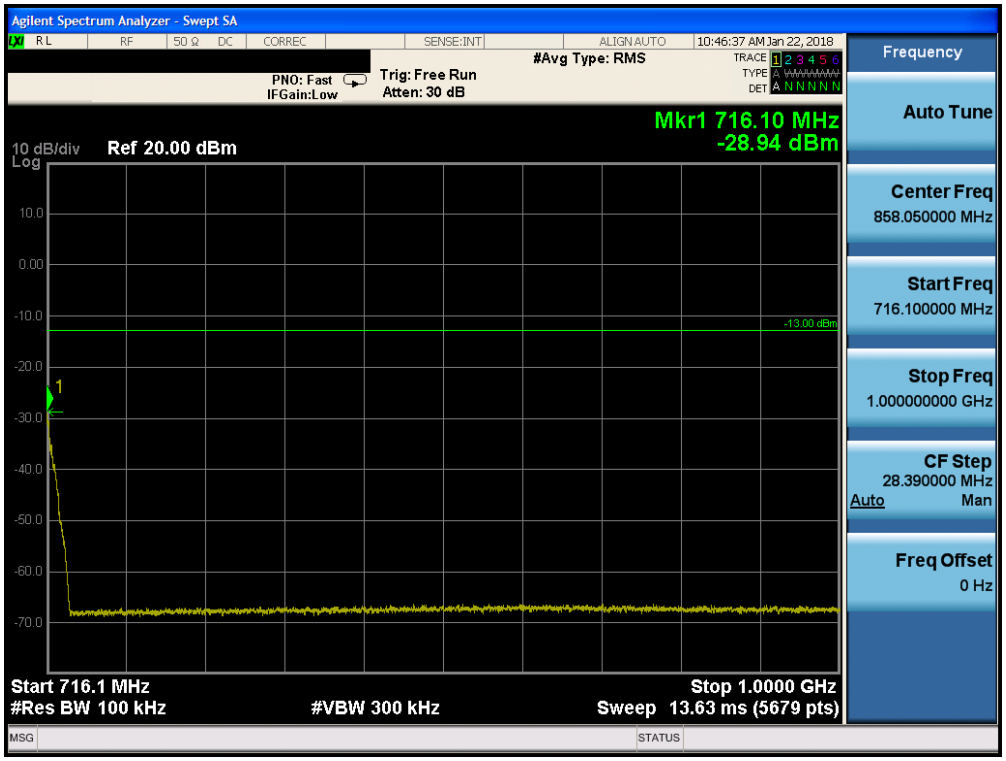


Plot 7-95. Conducted Spurious Plot (Band 12 - 5.0MHz QPSK - RB Size 1, RB Offset 0 - High Channel)



Plot 7-96. Conducted Spurious Plot (Band 12 - 5.0MHz QPSK - RB Size 1, RB Offset 0 - High Channel)

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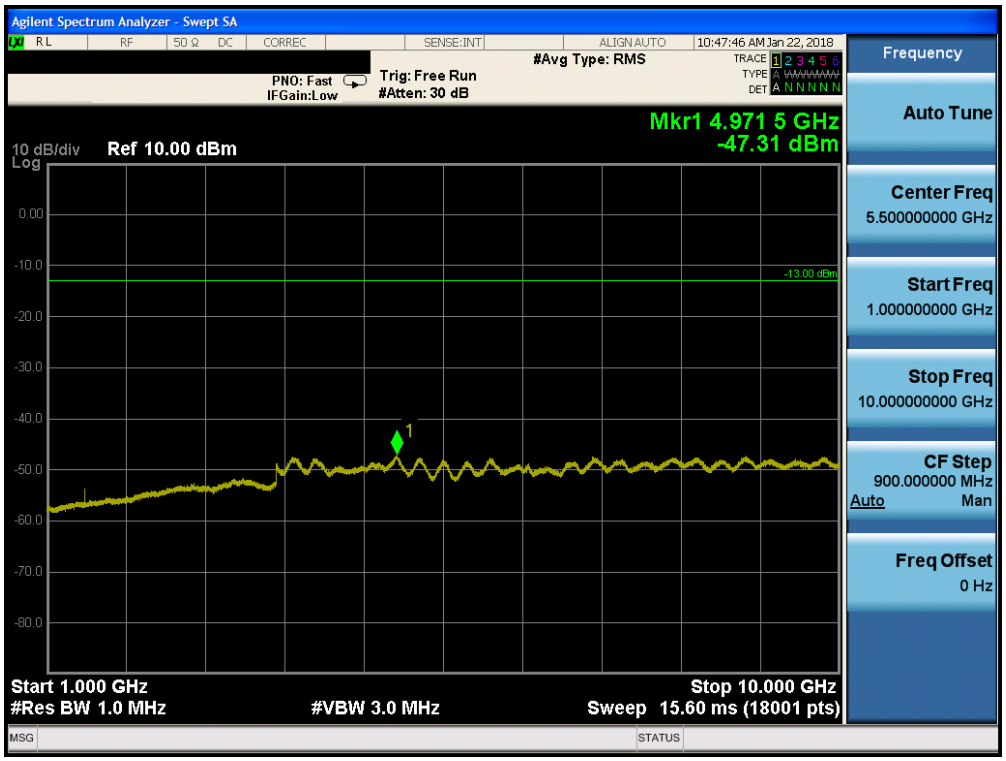

Plot 7-97. Conducted Spurious Plot (Band 12 - 5.0MHz QPSK - RB Size 1, RB Offset 0 - High Channel)

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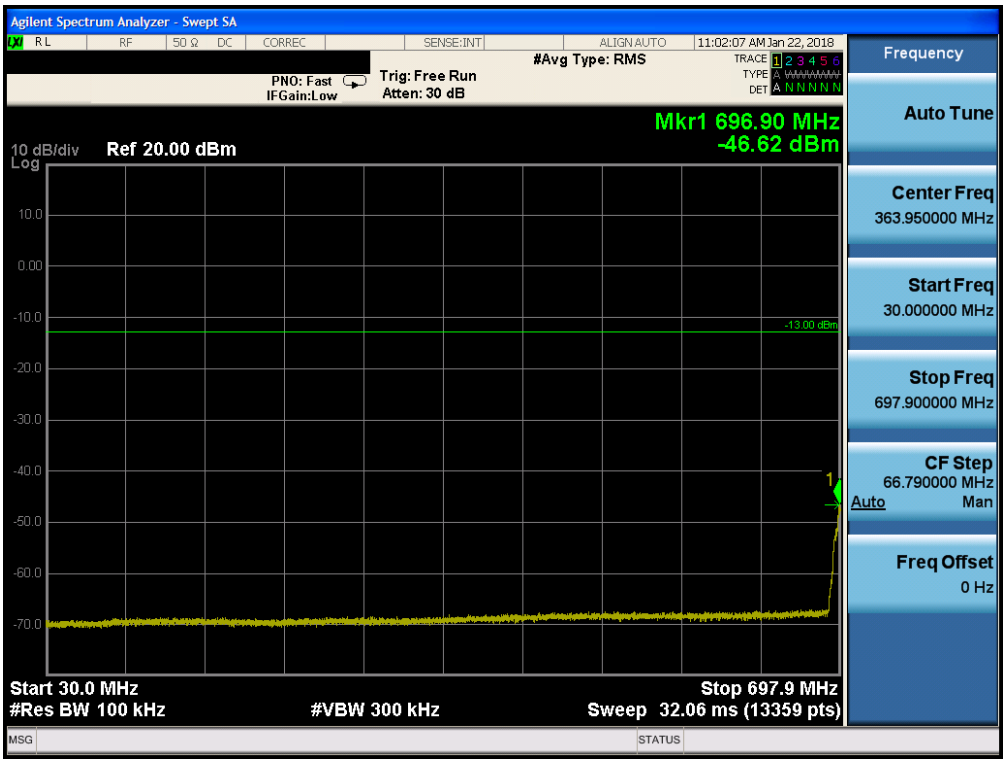
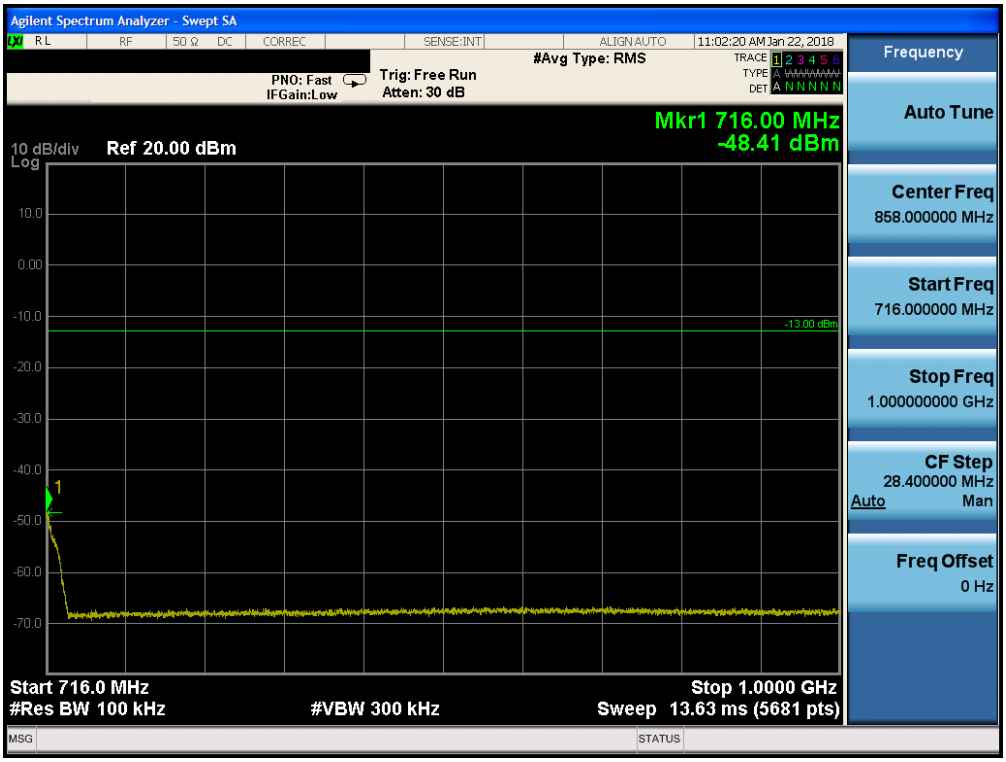
Band 17



Plot 7-98. Conducted Spurious Plot (Band 17 - 5.0MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)



Plot 7-99. Conducted Spurious Plot (Band 17 - 5.0MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)

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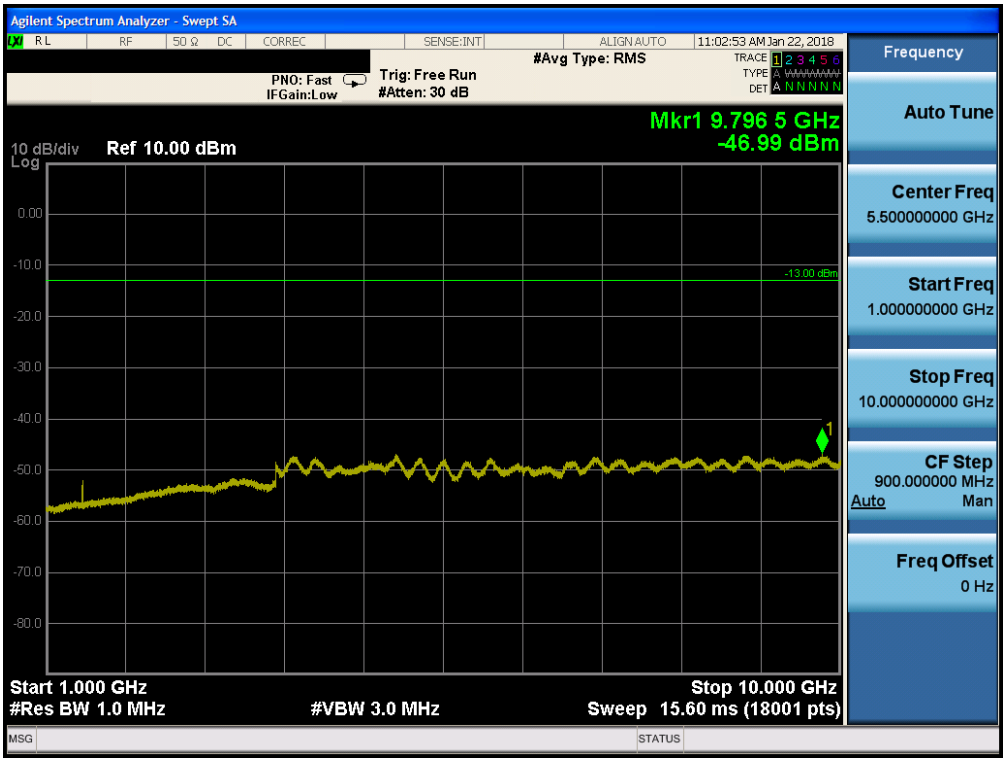
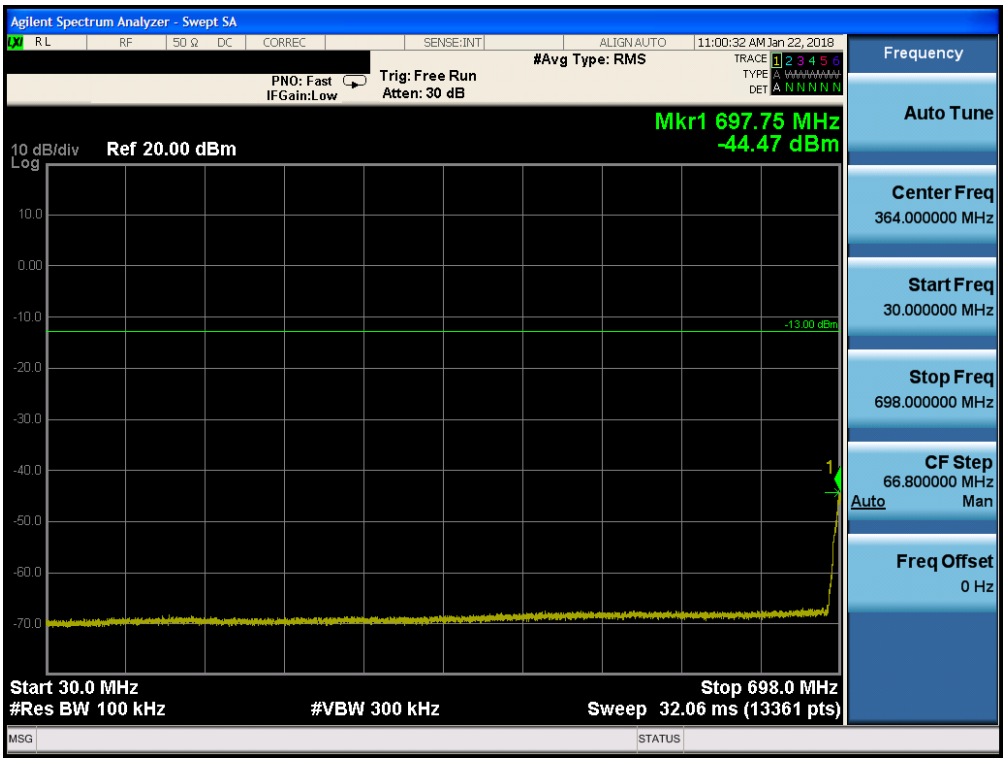


Plot 7-100. Conducted Spurious Plot (Band 17 - 5.0MHz QPSK - RB Size 1, RB Offset 0 - Low Channel)



Plot 7-101. Conducted Spurious Plot (Band 17 - 5.0MHz QPSK - RB Size 1, RB Offset 0 - Mid Channel)

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