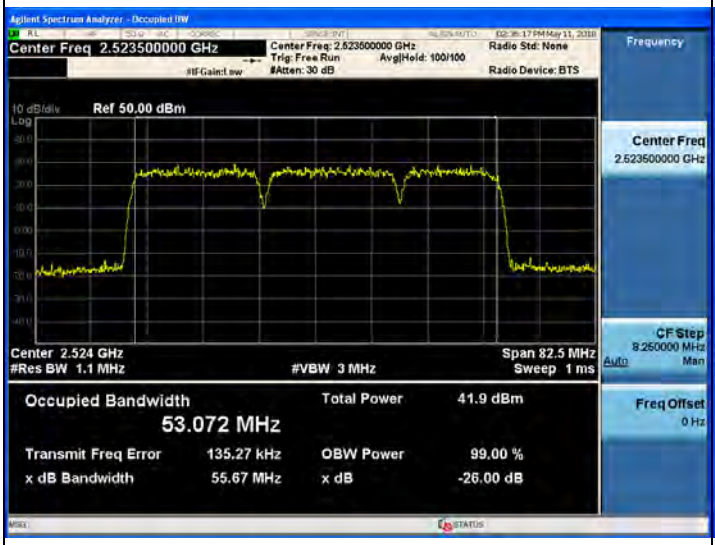
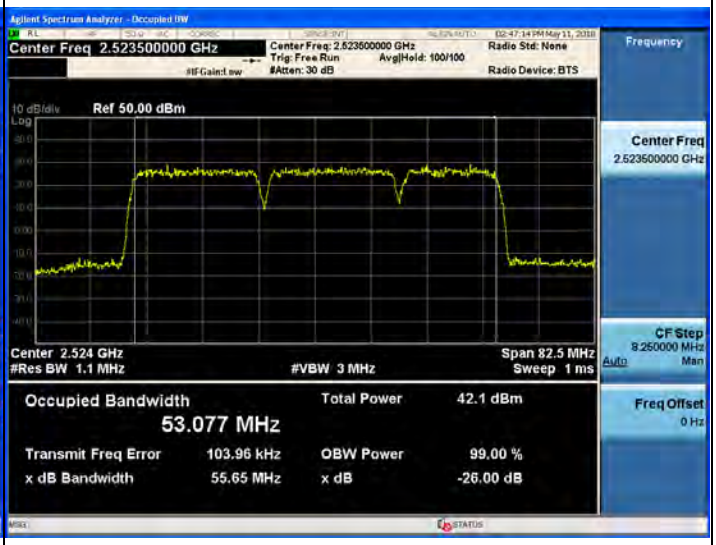
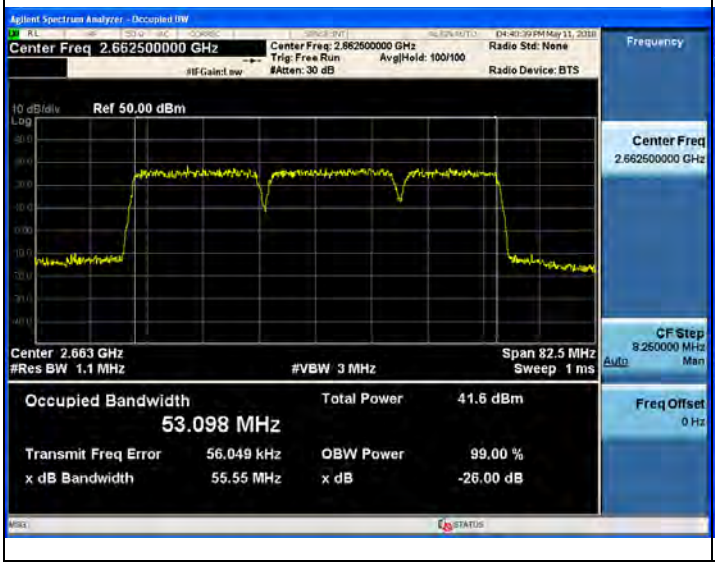
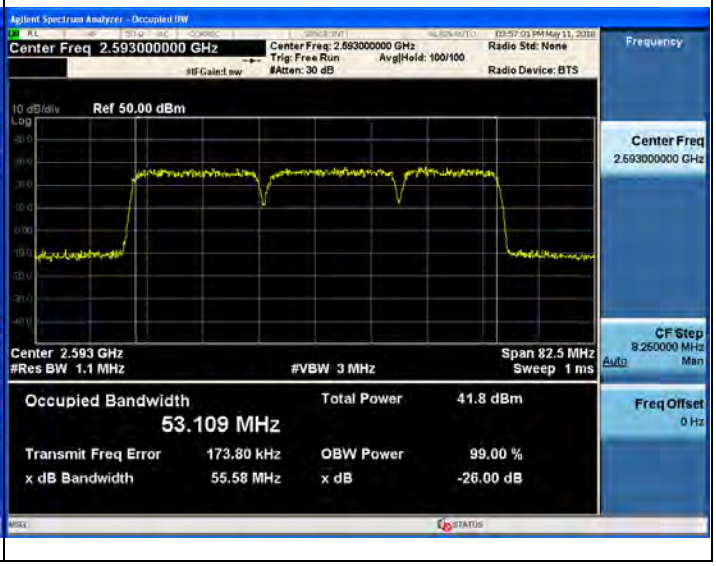
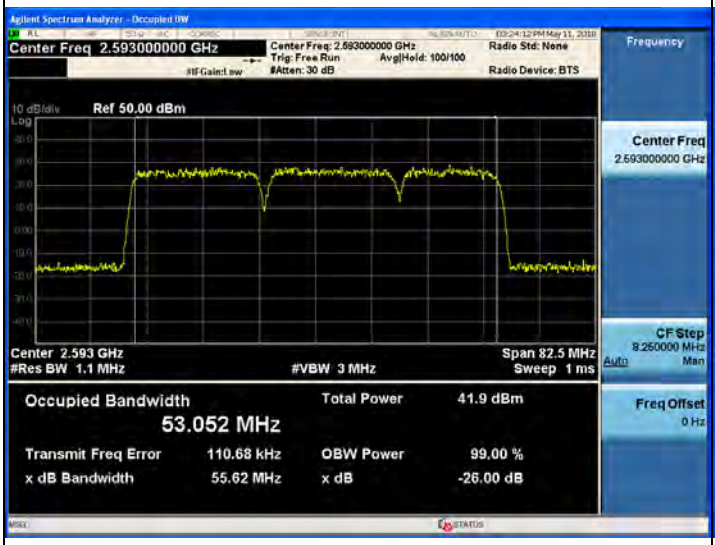
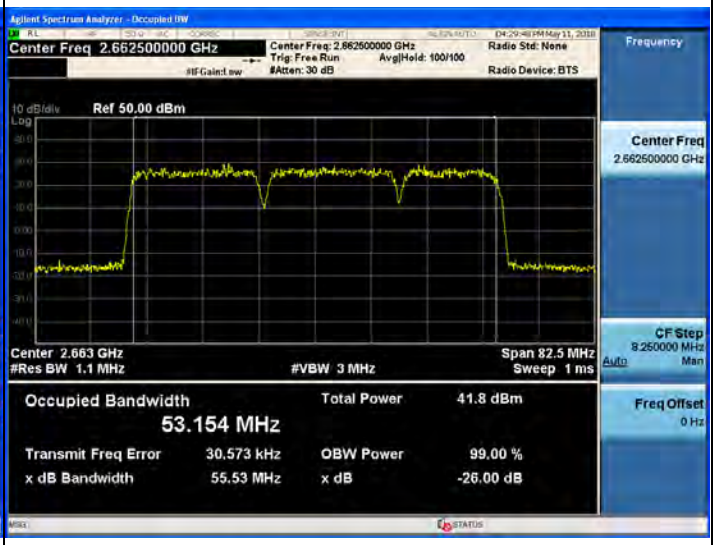
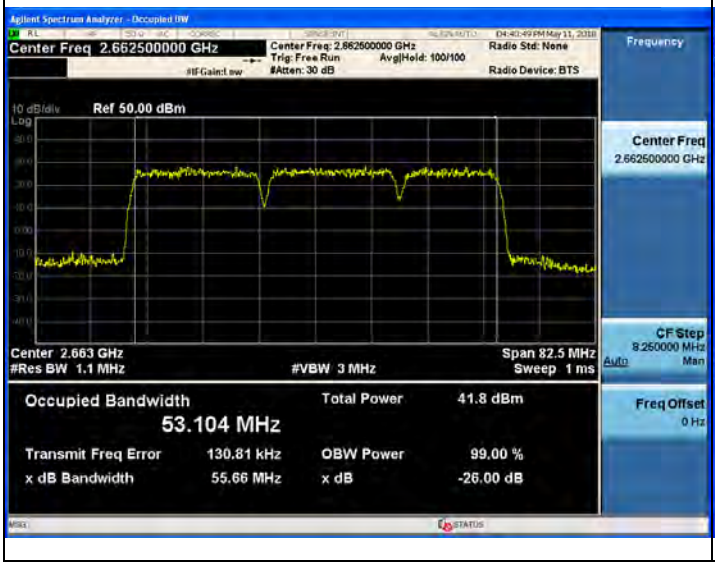
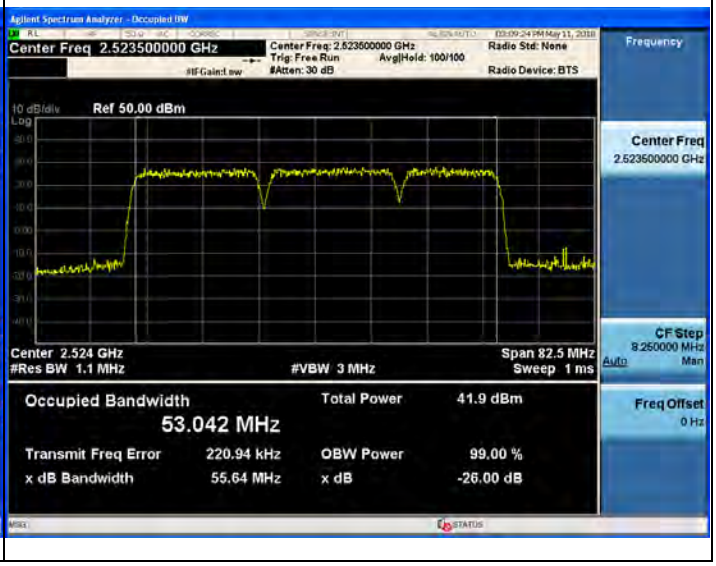
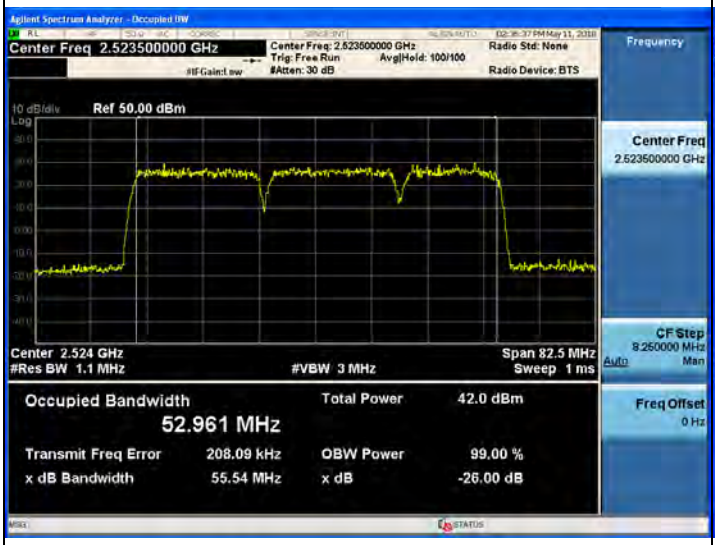
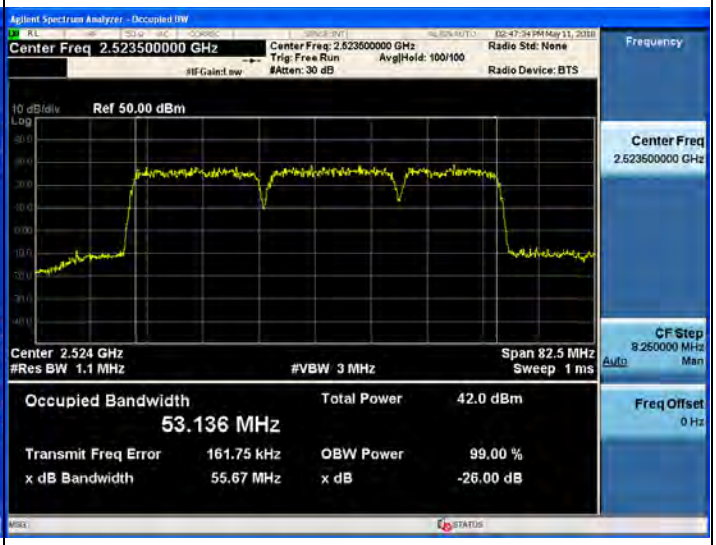
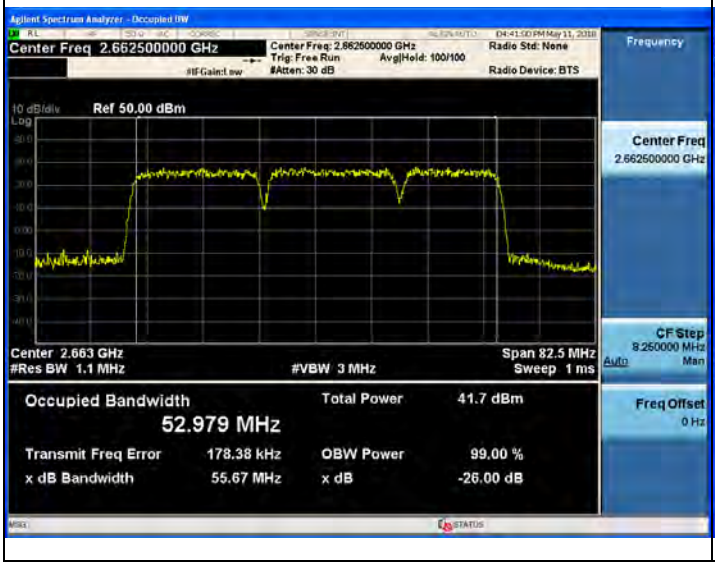
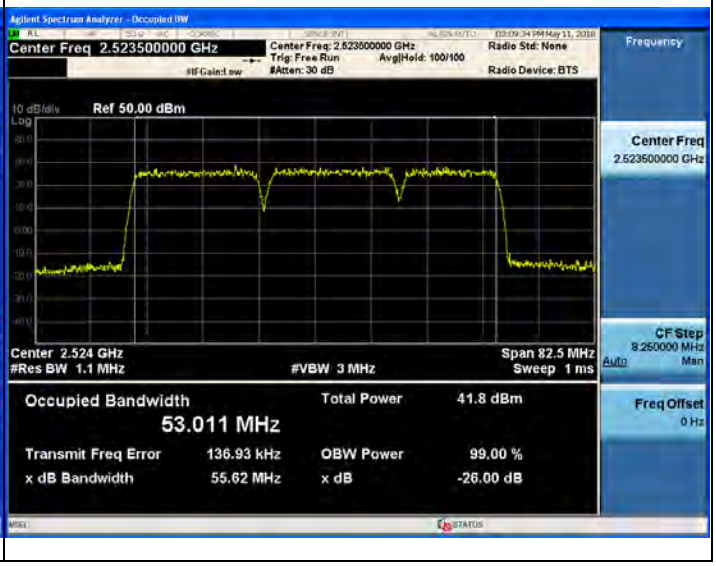
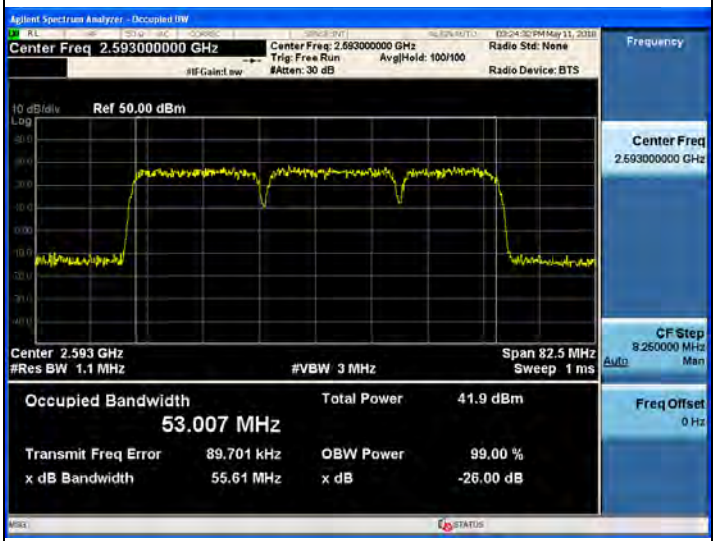
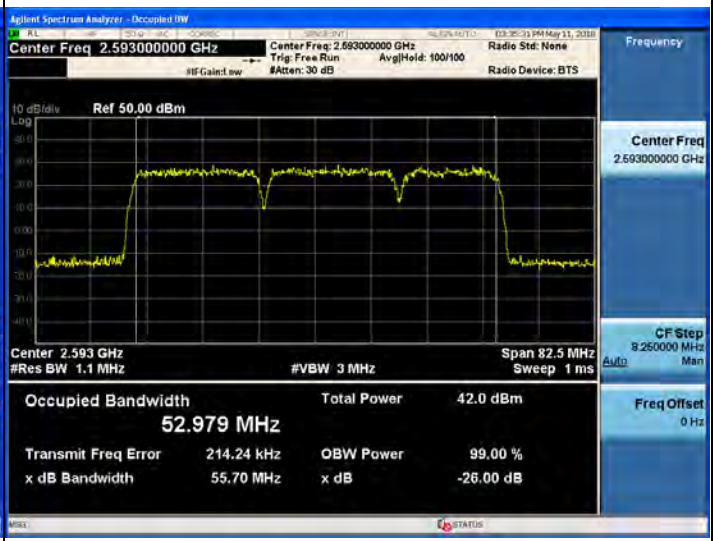
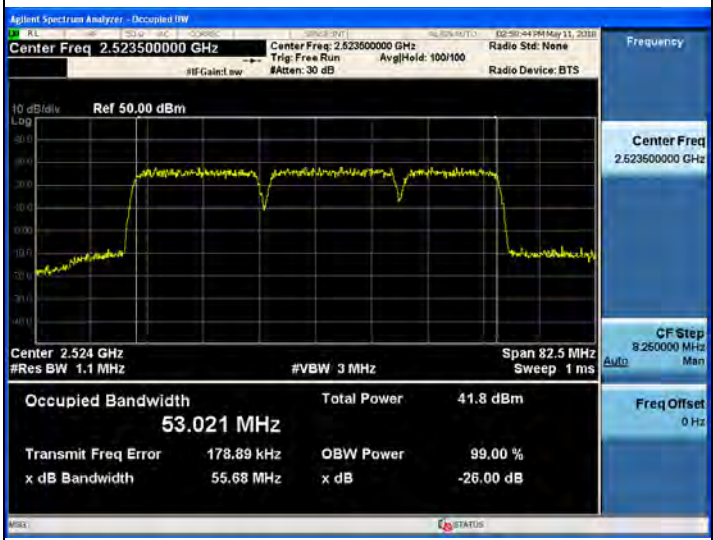
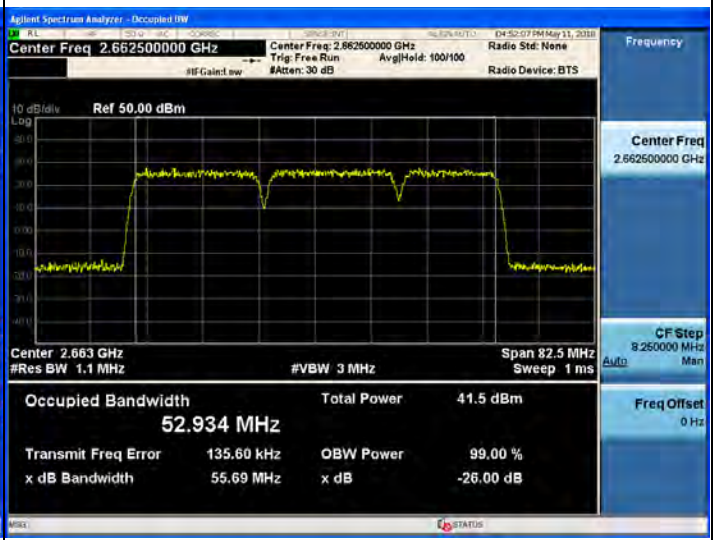
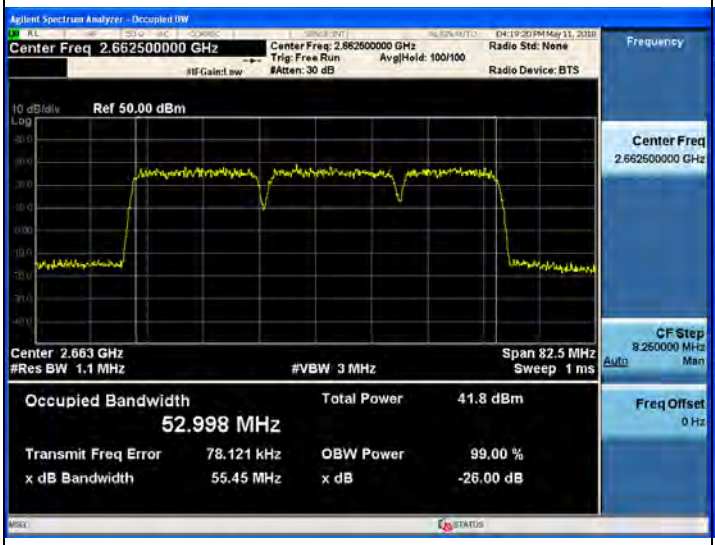
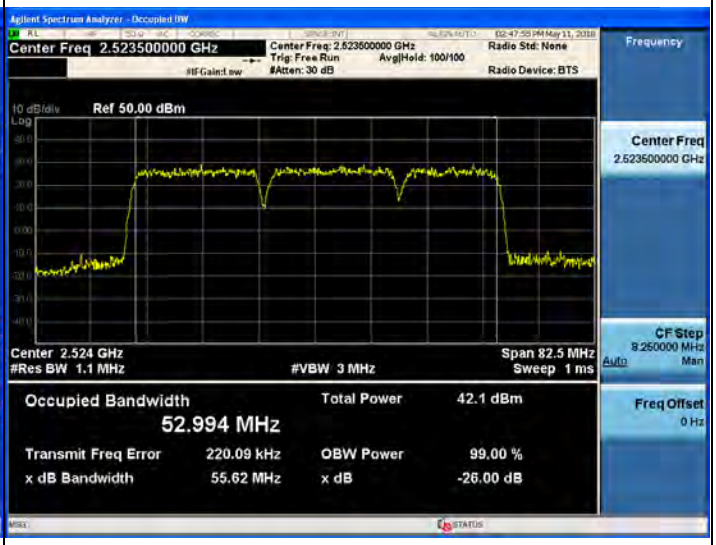
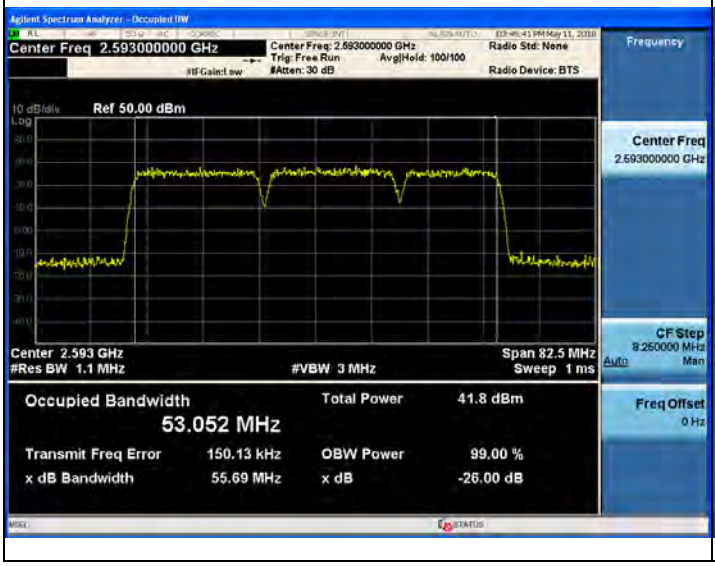
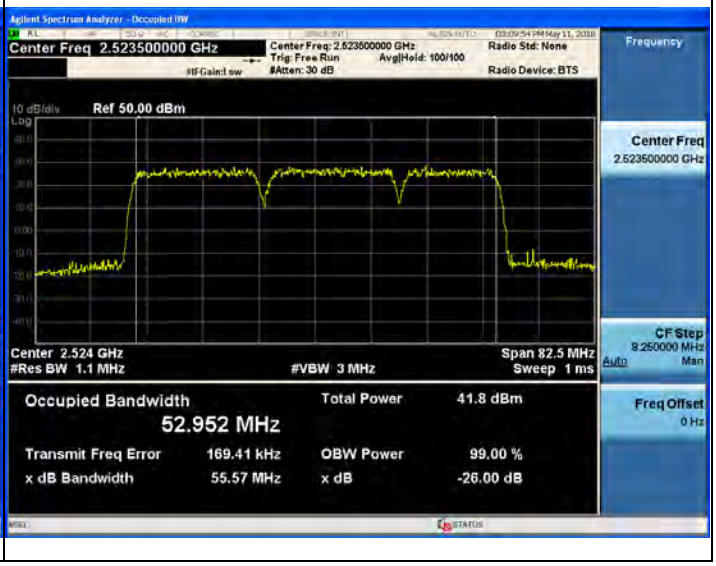
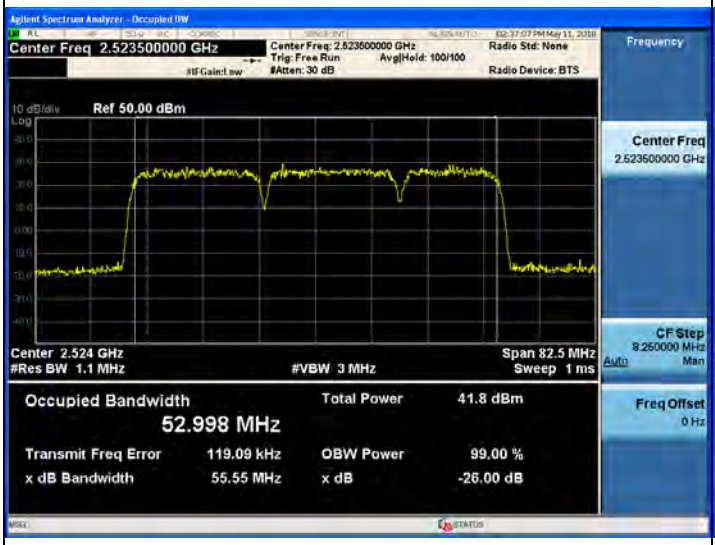
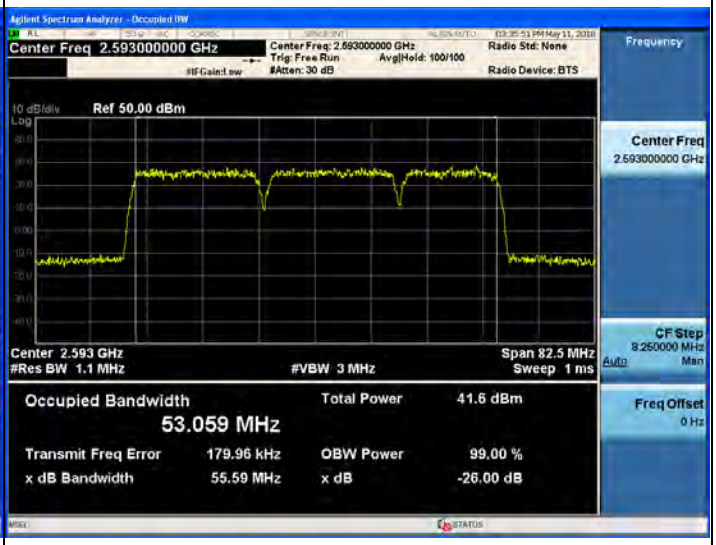
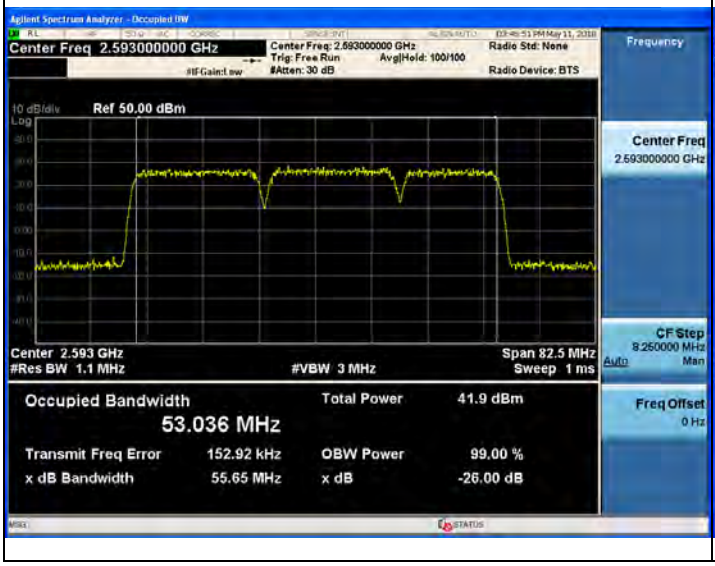
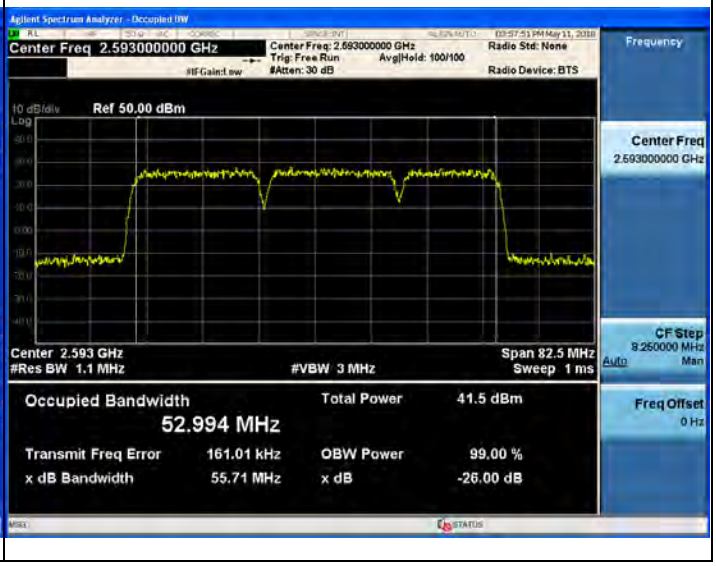
Port 49			
Modulation:	**QPSK**	**Modulation:**	**16QAM**
Channel:	**Low**	**Channel:**	**Low**
			
Modulation:	**64QAM**	**Modulation:**	**256QAM**
Channel:	**High**	**Channel:**	**Middle**
			

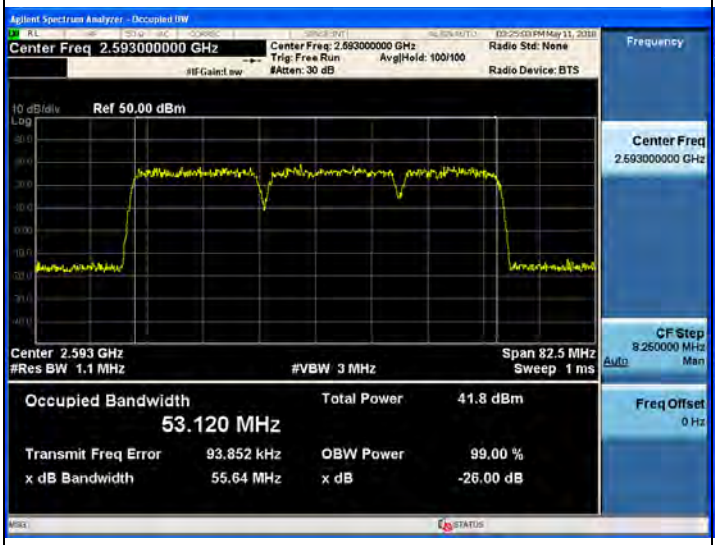
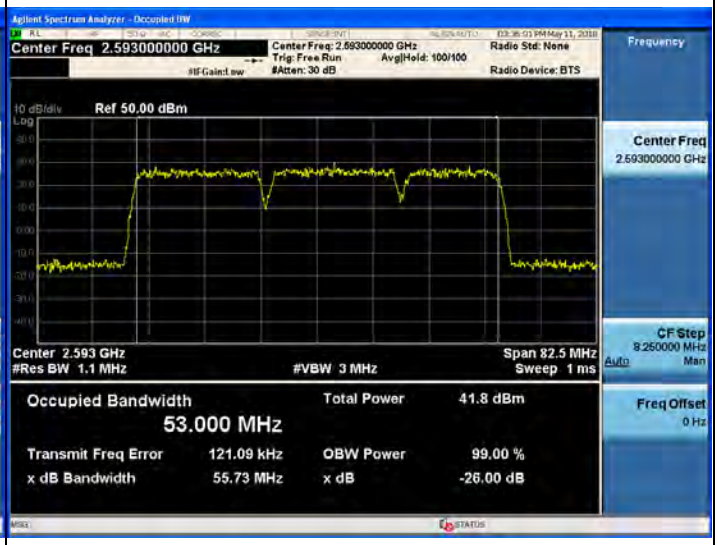
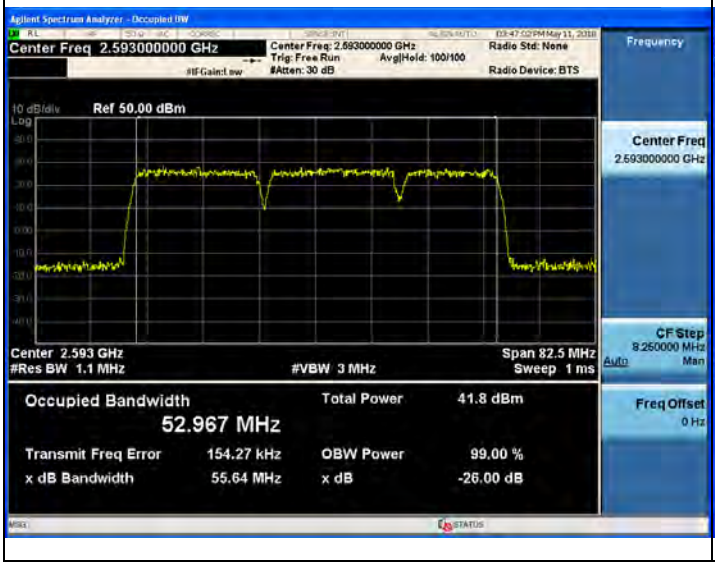
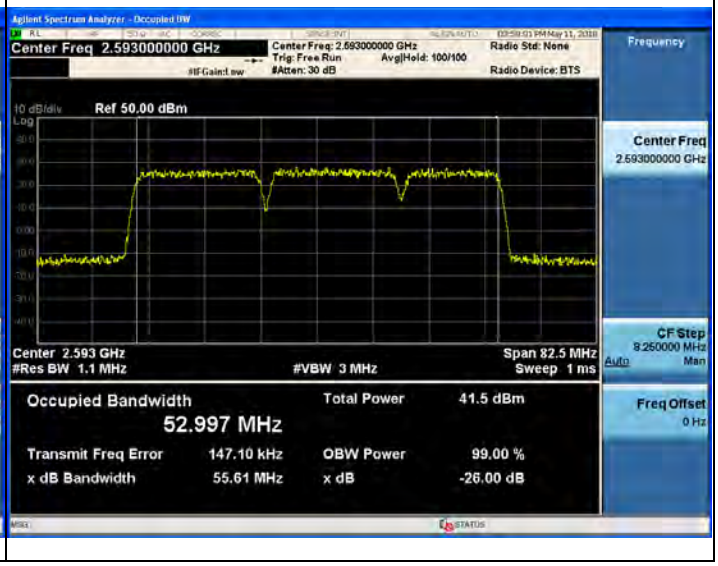
Port 50			
Modulation:	**QPSK**	**Modulation:**	**16QAM**
Channel:	**Middle**	**Channel:**	**High**
			
Modulation:	**64QAM**	**Modulation:**	**256QAM**
Channel:	**High**	**Channel:**	**Low**
			

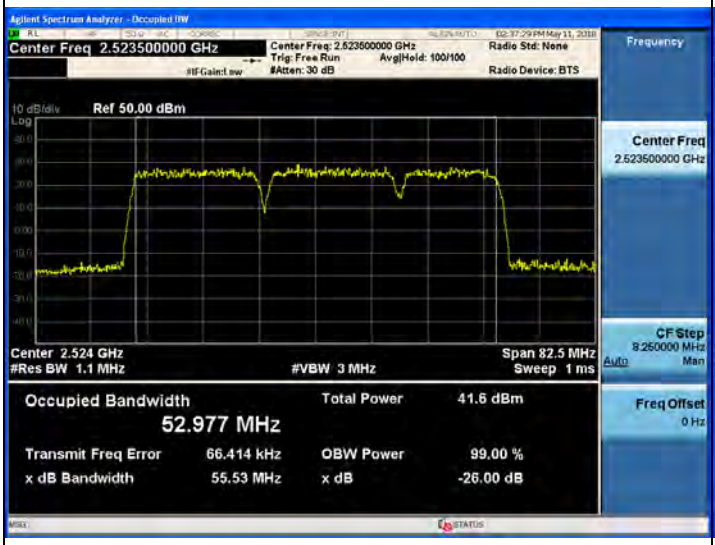
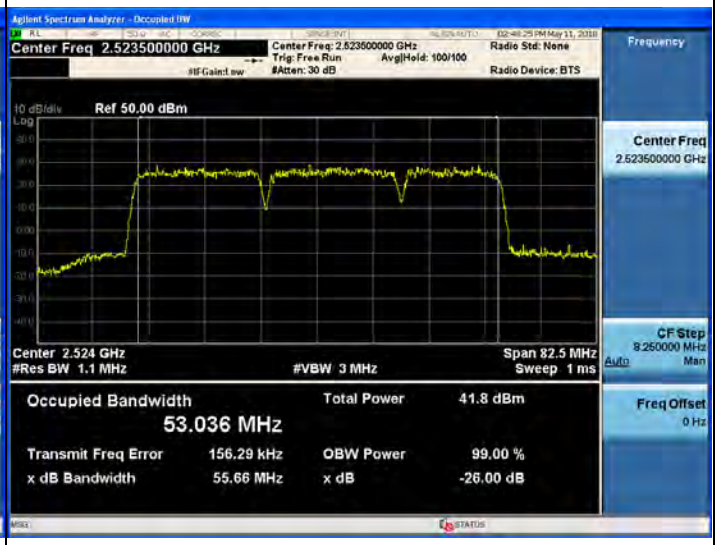
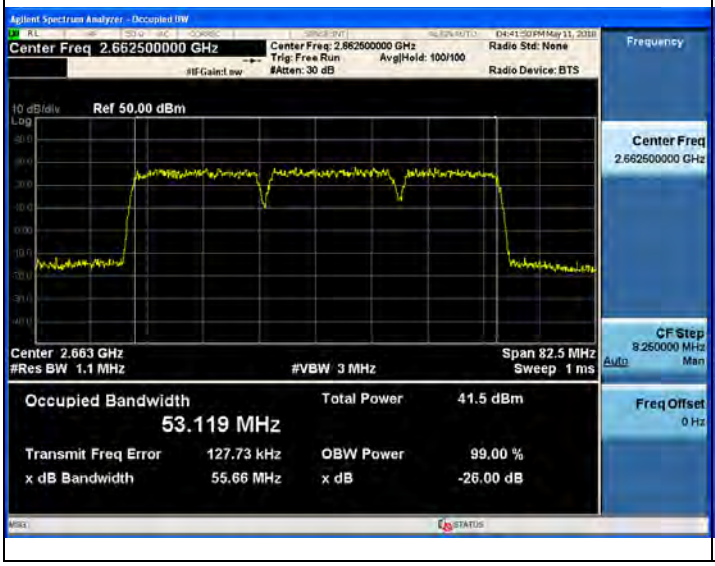
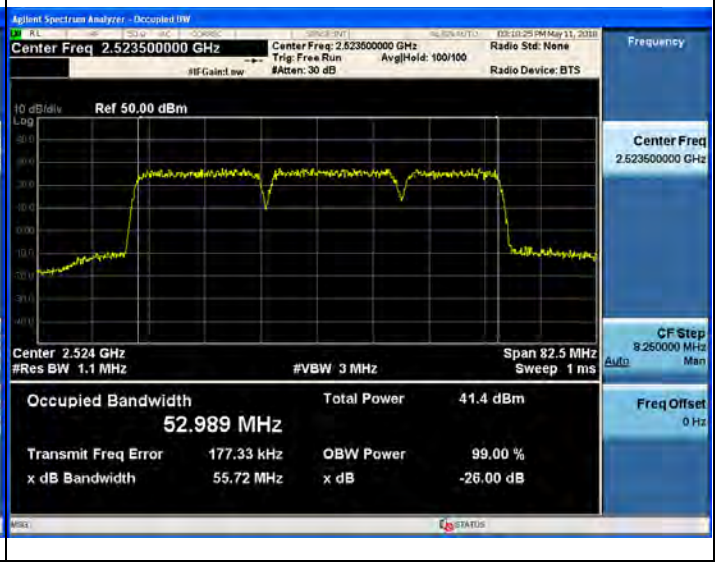
Port 51			
Modulation:	**QPSK**	**Modulation:**	**16QAM**
Channel:	**Low**	**Channel:**	**Low**
			
Modulation:	**64QAM**	**Modulation:**	**256QAM**
Channel:	**High**	**Channel:**	**Low**
			

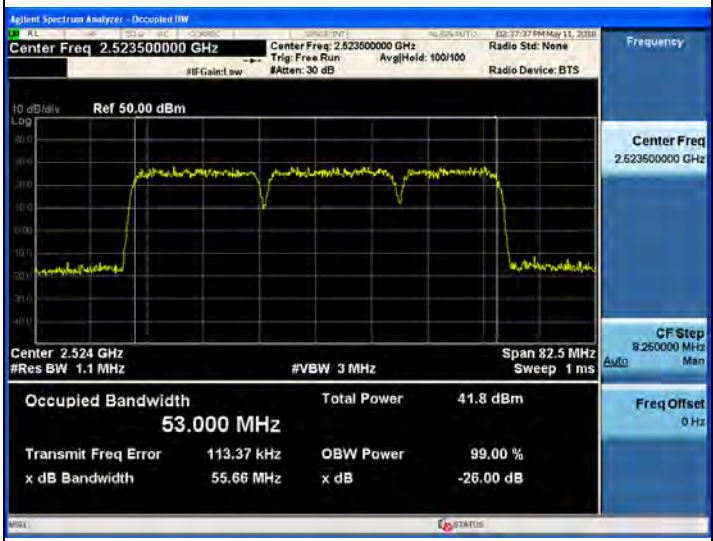
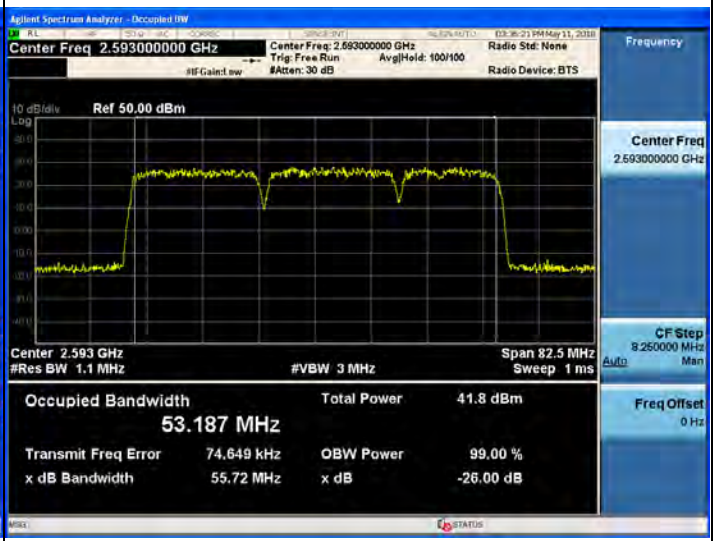
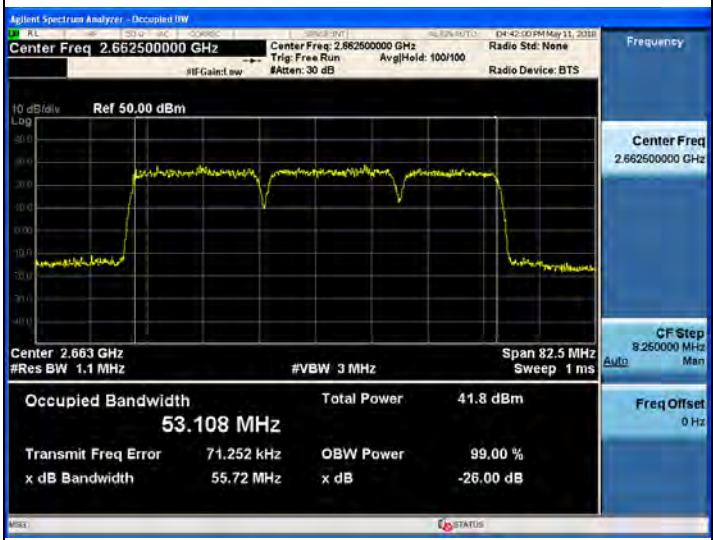
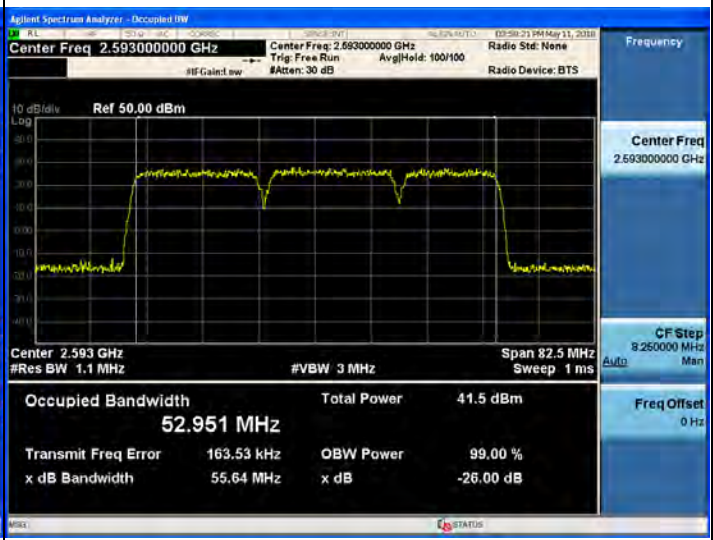
Port 52			
Modulation:	**QPSK**	**Modulation:**	**16QAM**
Channel:	**Middle**	**Channel:**	**Middle**
			
Modulation:	**64QAM**	**Modulation:**	**256QAM**
Channel:	**Low**	**Channel:**	**High**
			

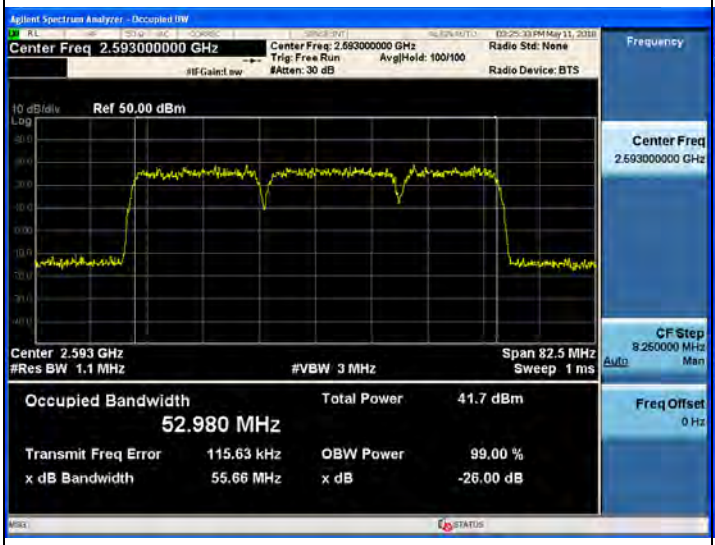
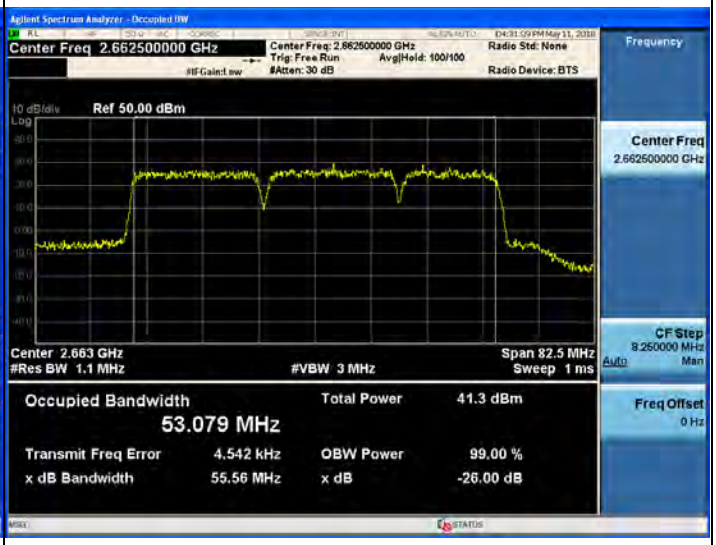
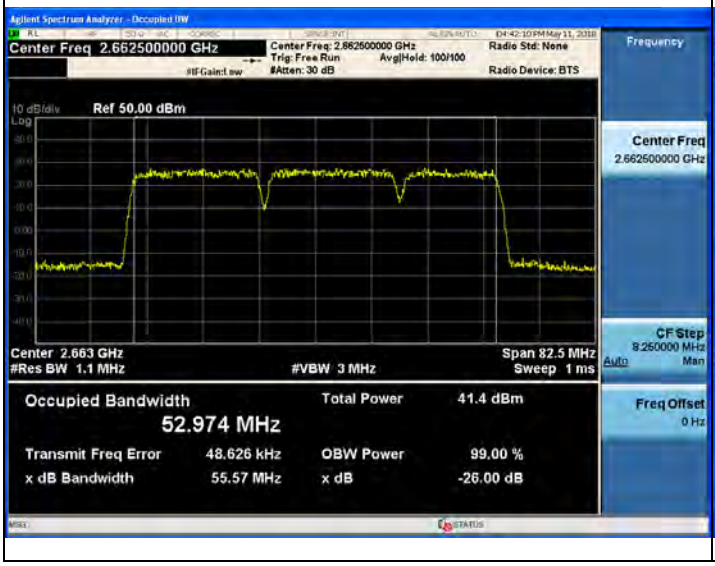
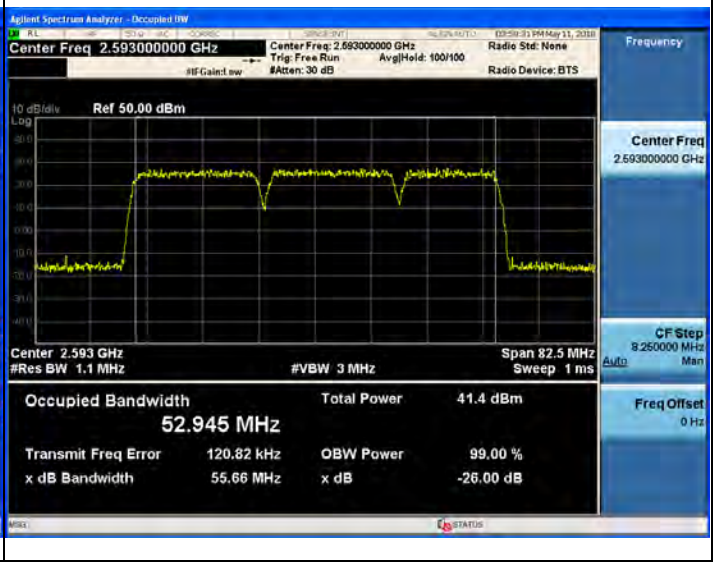
Port 53			
Modulation:	**QPSK**	**Modulation:**	**16QAM**
Channel:	**High**	**Channel:**	**Low**
			
Modulation:	**64QAM**	**Modulation:**	**256QAM**
Channel:	**Middle**	**Channel:**	**Low**
			

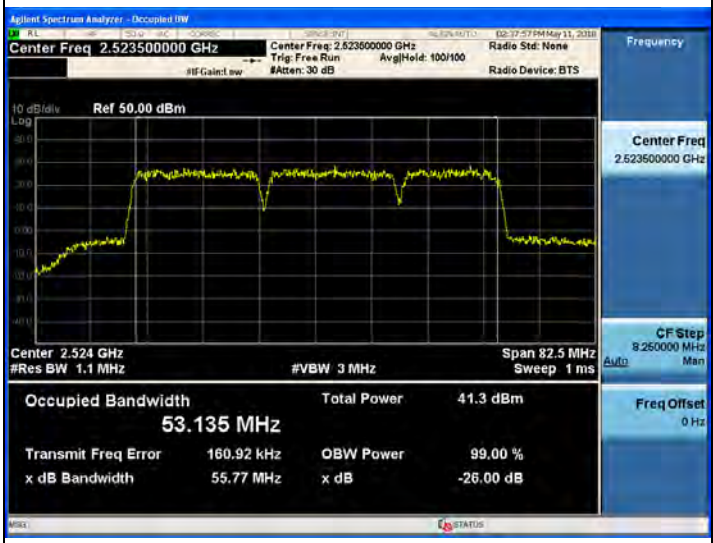
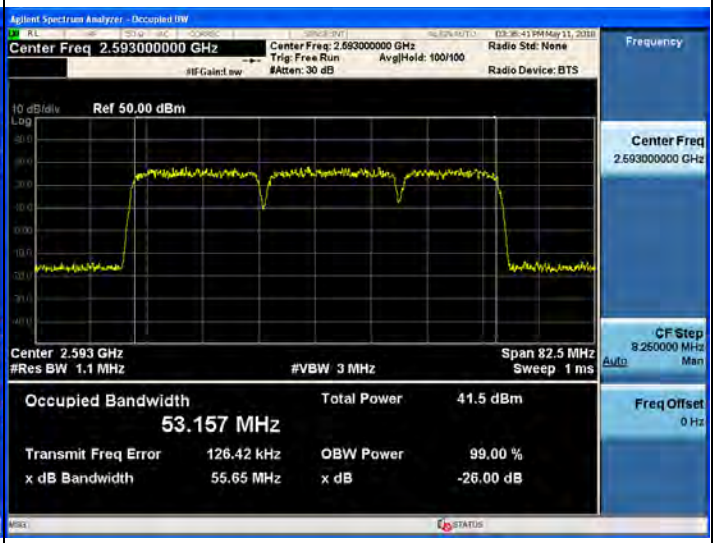
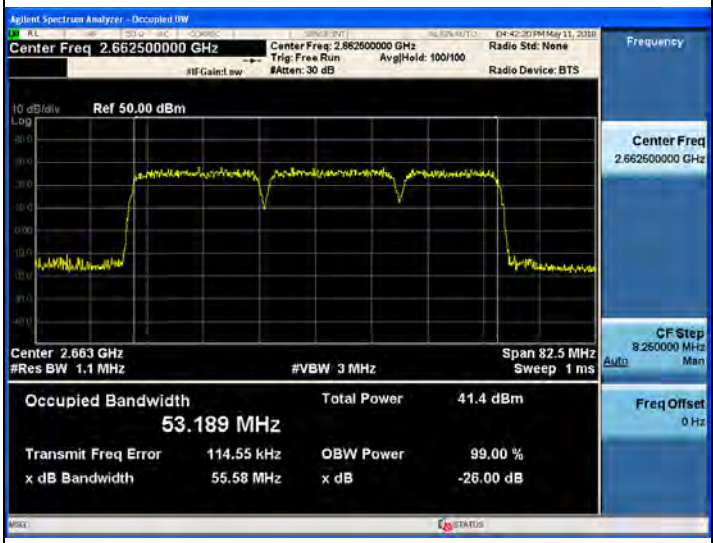
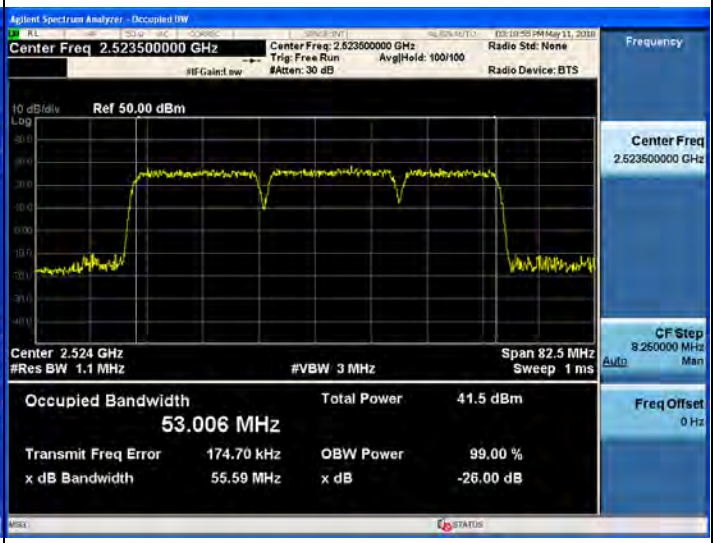
Port 54			
Modulation:	**QPSK**	**Modulation:**	**16QAM**
Channel:	**Low**	**Channel:**	**Middle**
			
Modulation:	**64QAM**	**Modulation:**	**256QAM**
Channel:	**Middle**	**Channel:**	**Middle**
			

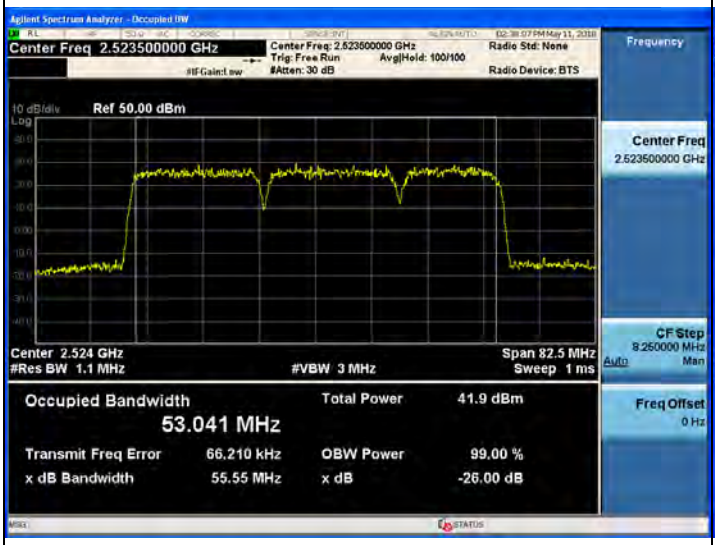
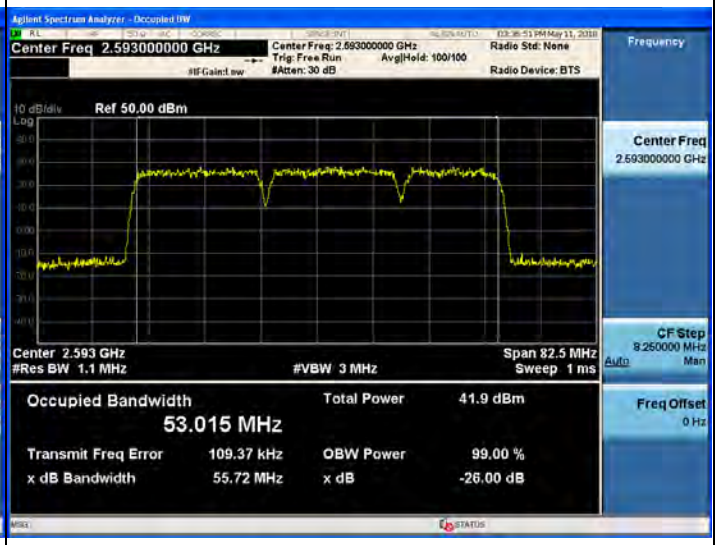
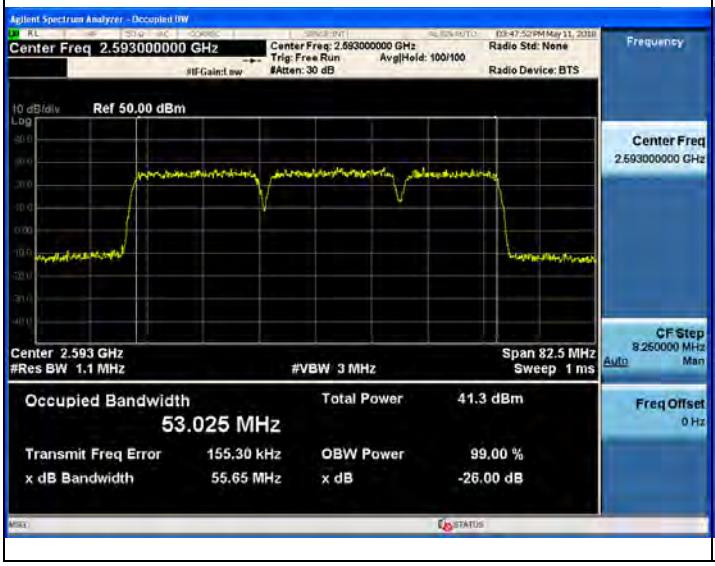
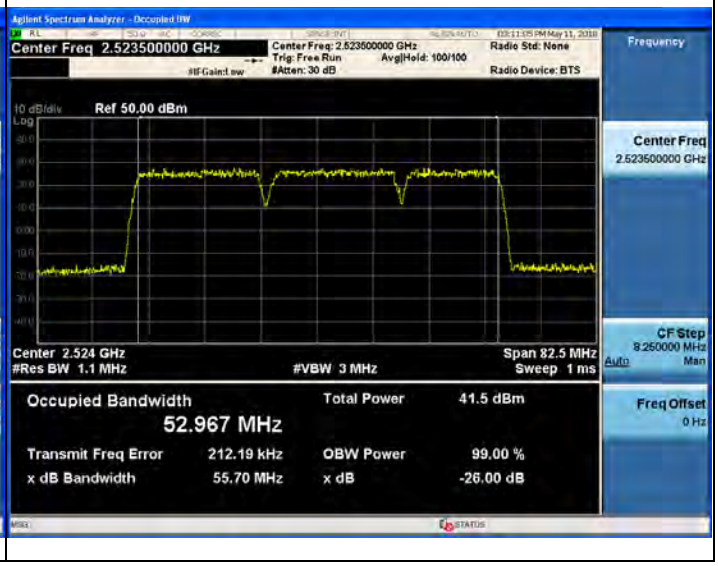
Port 55			
Modulation:	**QPSK**	**Modulation:**	**16QAM**
Channel:	**Middle**	**Channel:**	**Middle**
			
Modulation:	**64QAM**	**Modulation:**	**256QAM**
Channel:	**Middle**	**Channel:**	**Middle**
			

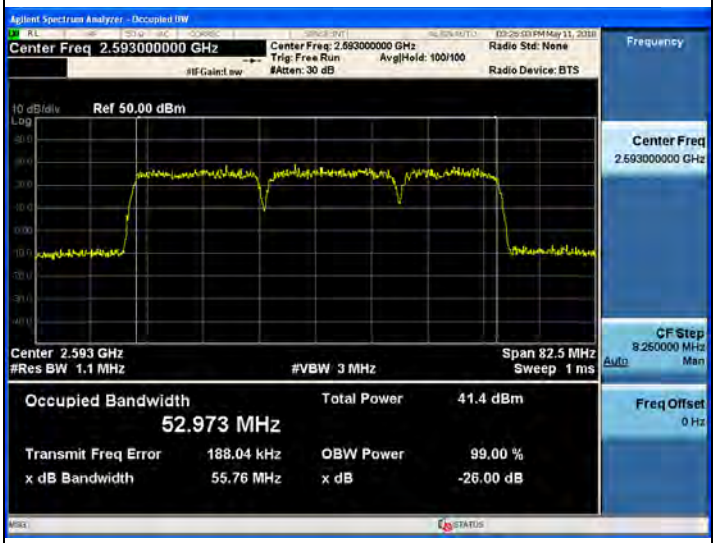
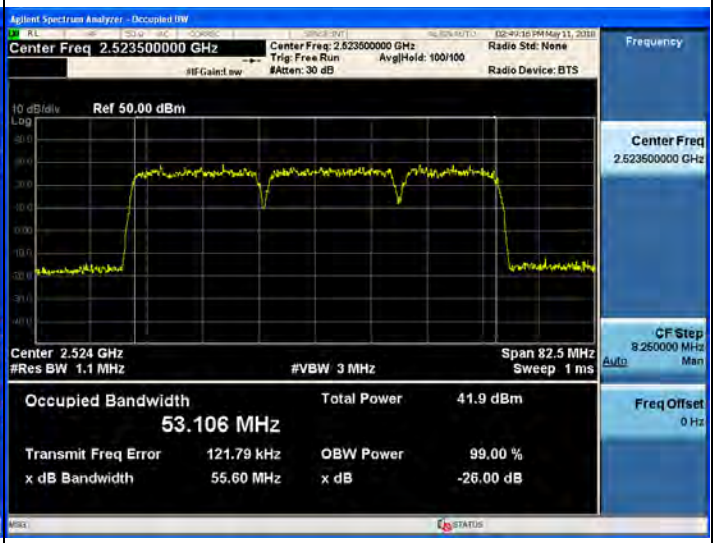
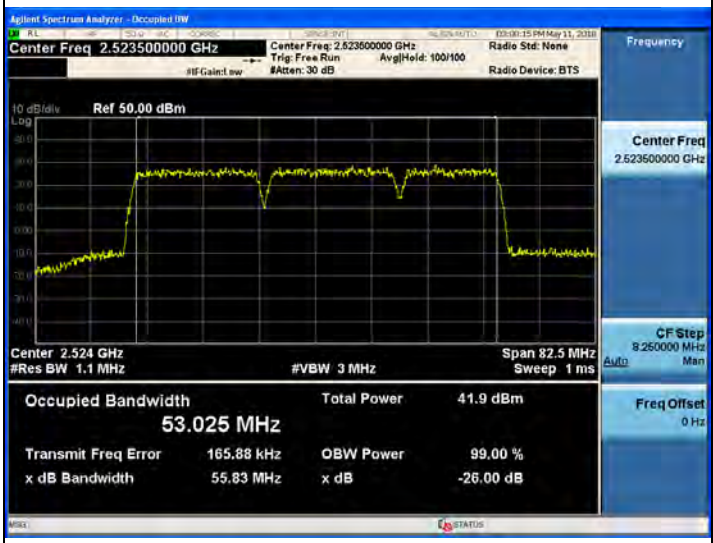
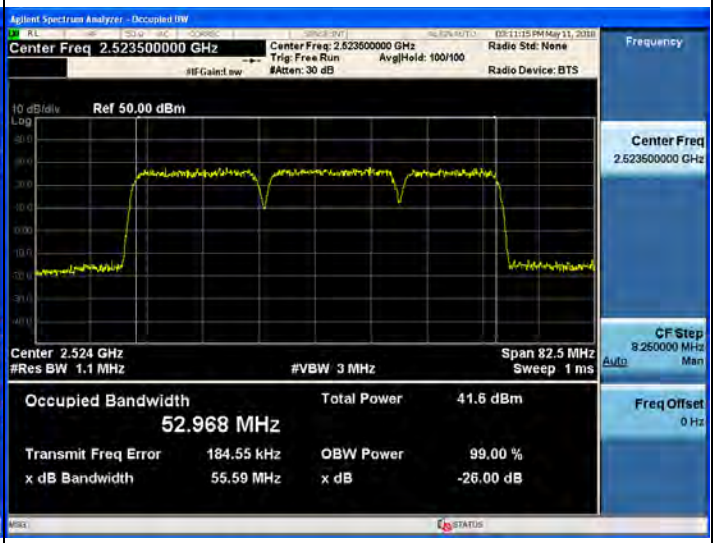
Port 56			
Modulation:	**QPSK**	**Modulation:**	**16QAM**
Channel:	**Low**	**Channel:**	**Low**
			
Modulation:	**64QAM**	**Modulation:**	**256QAM**
Channel:	**High**	**Channel:**	**Low**
			

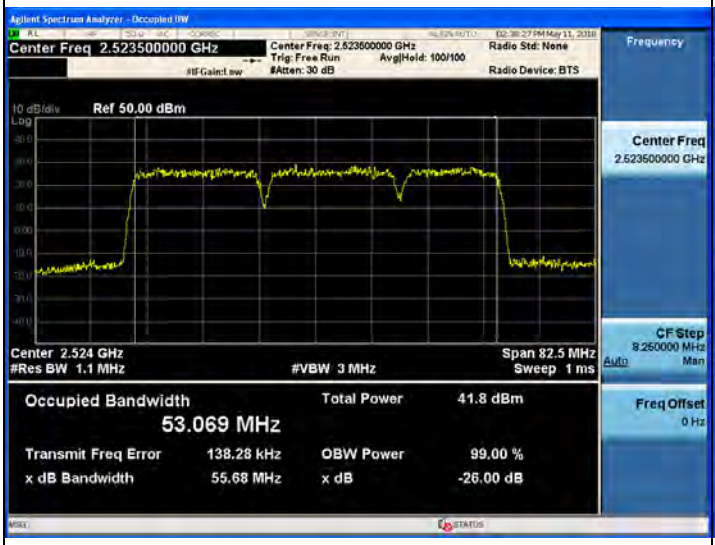
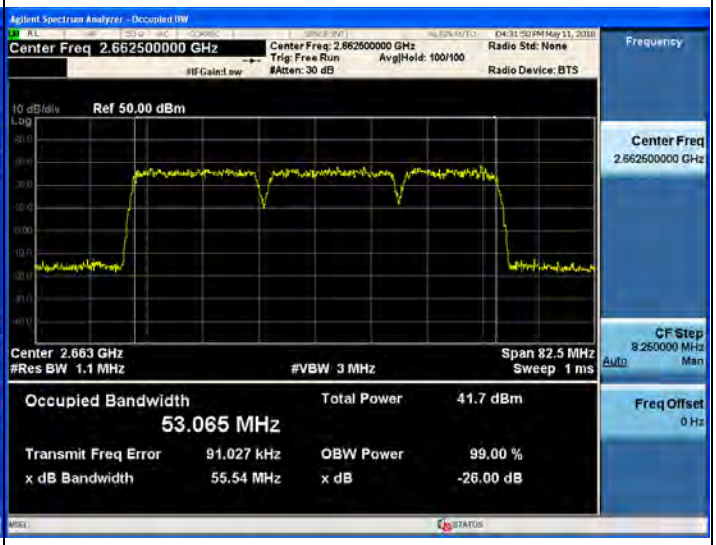
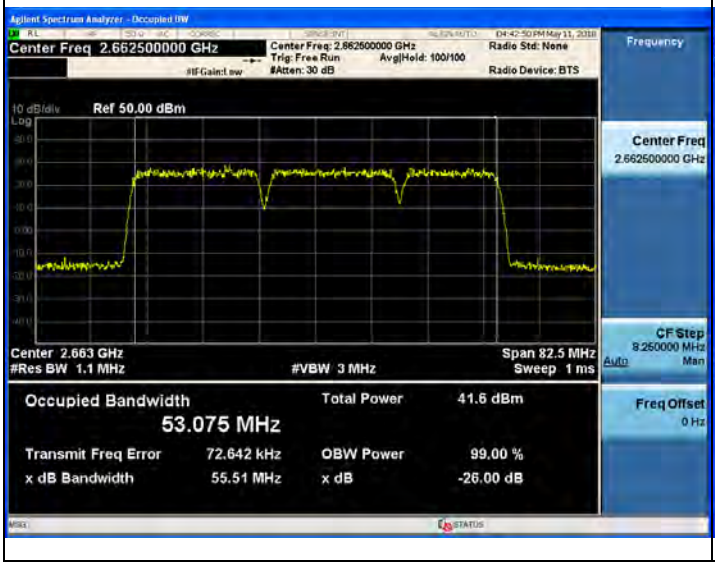
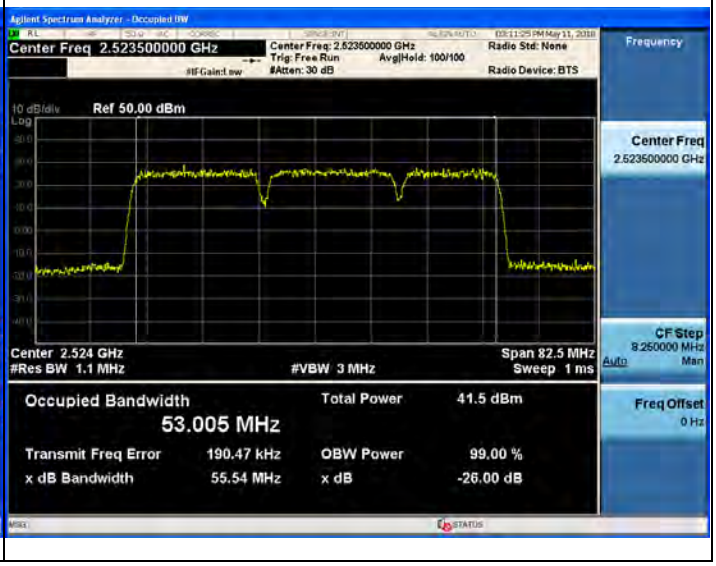
Port 57			
Modulation:	**QPSK**	**Modulation:**	**16QAM**
Channel:	**Low**	**Channel:**	**Middle**
			
Modulation:	**64QAM**	**Modulation:**	**256QAM**
Channel:	**High**	**Channel:**	**Middle**
			

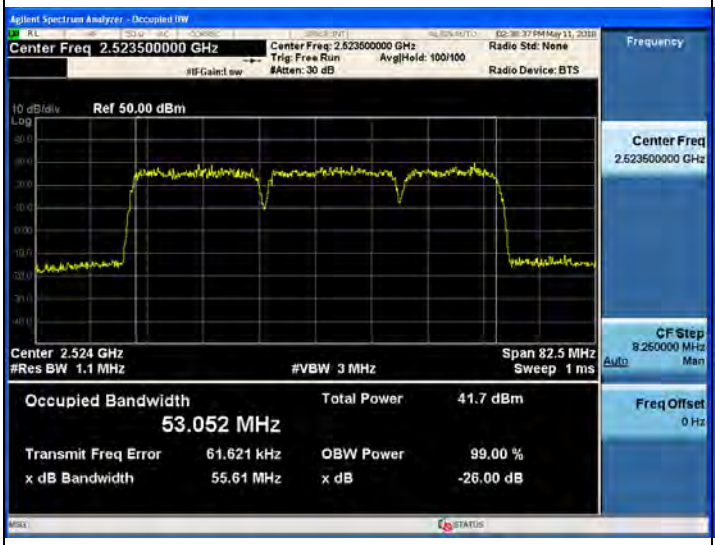
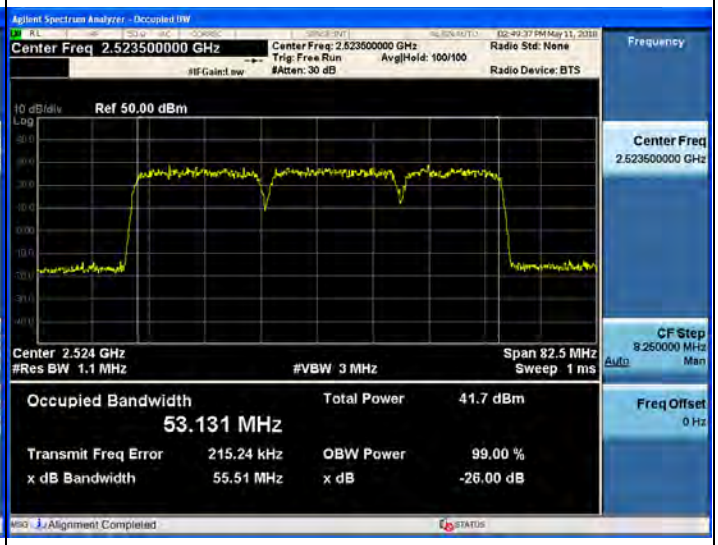
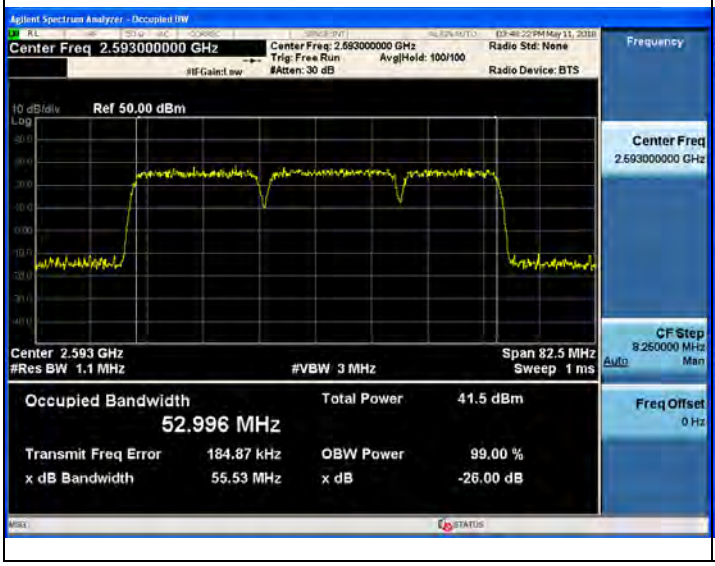
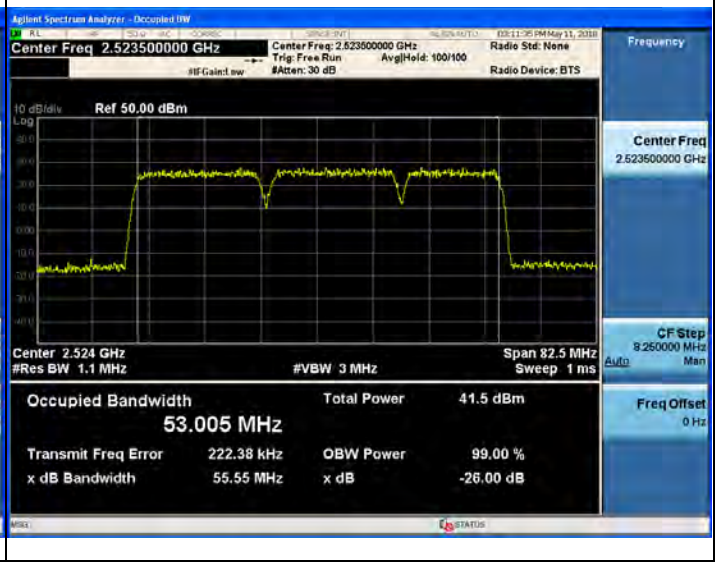
Port 58			
Modulation:	**QPSK**	**Modulation:**	**16QAM**
Channel:	**Middle**	**Channel:**	**High**
			
Modulation:	**64QAM**	**Modulation:**	**256QAM**
Channel:	**High**	**Channel:**	**Middle**
			

Port 59			
Modulation:	**QPSK**	**Modulation:**	**16QAM**
Channel:	**Low**	**Channel:**	**Middle**
			
Modulation:	**64QAM**	**Modulation:**	**256QAM**
Channel:	**High**	**Channel:**	**Low**
			

Port 60			
Modulation:	**QPSK**	**Modulation:**	**16QAM**
Channel:	**Low**	**Channel:**	**Middle**
			
Modulation:	**64QAM**	**Modulation:**	**256QAM**
Channel:	**Middle**	**Channel:**	**Low**
			

Port 61			
Modulation:	**QPSK**	**Modulation:**	**16QAM**
Channel:	**Middle**	**Channel:**	**Low**
			
Modulation:	**64QAM**	**Modulation:**	**256QAM**
Channel:	**Low**	**Channel:**	**Low**
			

Port 62			
Modulation:	**QPSK**	**Modulation:**	**16QAM**
Channel:	**Low**	**Channel:**	**High**
			
Modulation:	**64QAM**	**Modulation:**	**256QAM**
Channel:	**High**	**Channel:**	**Low**
			

Port 63			
Modulation:	**QPSK**	**Modulation:**	**16QAM**
Channel:	**Low**	**Channel:**	**Low**
			
Modulation:	**64QAM**	**Modulation:**	**256QAM**
Channel:	**Middle**	**Channel:**	**Low**
			

7. UNWANTED CONDUCTED EMISSIONS

FCC Rules

Test Requirements:

§ 2.1051 Measurements required: Spurious emissions at antenna terminals.

The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in §2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

§ 27.53 Emission limits.

(m) For BRS and EBS stations, the power of any emissions outside the licensee's frequency bands of operation shall be attenuated below the transmitter power (P) measured in watts in accordance with the standards below. If a licensee has multiple contiguous channels, out-of-band emissions shall be measured from the upper and lower edges of the contiguous channels.

(2) For digital base stations, the attenuation shall be not less than 43 + 10 log (P) dB, unless a documented interference complaint is received from an adjacent channel licensee with an overlapping Geographic Service Area. Mobile Satellite Service licensees operating on frequencies below 2495 MHz may also submit a documented interference complaint against BRS licensees operating on channel BRS No. 1 on the same terms and conditions as adjacent channel BRS or EBS licensees. Provided that a documented interference complaint cannot be mutually resolved between the parties prior to the applicable deadline, then the following additional attenuation requirements shall apply:

Test Procedures:

The measurement is performed in accordance with Section 5.7.3 and 5.7.4 of ANSI C63.26.

5.7.3 Out-of-band unwanted emissions measurements

a) Set the spectrum analyzer center frequency to the block, band, or channel edge frequency.

b) Set the span wide enough to capture the fundamental emission closest to the authorized block or band edge, and to include all modulation products that spill into the immediately adjacent frequency band. In some cases, it may be possible to set the center frequency and span so as to encompass the fundamental emission and the unwanted out-of-band (band-edge) emissions on either side of the authorized block, band, or channel. This can be accomplished with a single (slow) sweep, if adequate overload protection and sufficient dynamic range can be maintained.

c) Set the number of points in sweep ≥ 2 × span / RBW.

d) Sweep time should be auto for peak detection. For rms detection the sweep time should be

set as follows:

1) Omitted

2) Omitted

3) If the device cannot be configured to transmit continuously (duty cycle < 98%) and a freerunning sweep must be used, set the sweep time so that the averaging is performed over multiple on/off cycles by setting the sweep time > (number of points in sweep) × (transmitter period) (i.e., the transmit on-time + the off-time). The spectrum analyzer readings shall subsequently be corrected by [10 log (1/duty cycle)]. This assumes that the transmission period and duty cycle is relatively constant (duty cycle variation ≤ ±2%).

4) Omitted

e) The test report shall include the plots of the measuring instrument display and the measured data.

f) See Annex I for example emission mask plots.

5.7.4 Spurious unwanted emission measurements

a) Set the spectrum analyzer start frequency to the lowest frequency generated by the EUT, without going below 9 kHz, and the stop frequency to the lower frequency covered by the measurements previously performed in 5.7.3. As an alternative, the stop frequency can be set to the value specified in 5.1.1, depending on the EUT operating range, if the resulting plot can clearly demonstrate compliance for all frequencies not addressed by the out-of-band emissions measurements performed as per 5.7.3.

b) When using an average power (rms) detector, ensure that the number of points in the sweep ≥ 2 × (span / RBW). This may require that the measurement range defined by the start and stop frequencies be subdivided, depending on the spectrum analyzer capabilities. This requirement does not apply to peak-detected power measurements. When average power is specified by the applicable regulation, a peak-detector can be utilized for preliminary measurements to accommodate wider frequency spans. Any emissions found in the preliminary measurement to exceed the applicable limit(s) shall be further examined using a power averaging (rms) detector with the minimum number of measurement points as defined above.

c) The sweep time should be set to auto-couple for performing peak-detector measurements. For measurements that use a power averaging (rms) detector, the sweep time shall be set as described for out-of-band emissions measurements in item d) of 5.7.3.

d) Identify and measure the highest spurious emission levels in each frequency range. It is not necessary to re-measure the out-of-band emissions as a part of this test. Record the frequencies and amplitudes corresponding to the measured emissions and capture the data plots.

e) Repeat step b) through step d) for the upper spurious emission frequency range if not already captured by a wide span measurement performed as per the alternative provided in step a). The upper frequency for this measurement is defined in 5.1.1 as a function of the EUT operating

range.

f) Compare the results with the corresponding limit in the applicable regulation.

g) The test report shall include the data plots of the measuring instrument display and the measured data.

Note:

1) In 9 kHz to 30 MHz band, RBW narrower than reference bandwidth is used. So following correction factor is applied.

   - 10 log [(reference bandwidth)/(resolution bandwidth)]
   - 9 kHz to 150 kHz applied 1 kHz RBW, 10 log (1 kHz / 1MHz) = 30 dB
   - 150 kHz to 30 MHz applied 100 kHz RBW, 10 log (10 kHz / 1 MHz) = 20 dB
   - Because of test equipment's noise specification, we used N9030A signal analyzer for these bands.

2) Due to 64x64 MIMO operations, a correction has been added to the limit according to KDB 662911 D01 v02r01.

   - MIMO correction: 10 log(N_{ANT}) = 10 log(64) = 18.062 dB

3) Since the EUT cannot be configured to transmit continuously and a free-running sweep must be used, duty correction has been added in accordance with 5.7.3 d) 3) of ANSI C63.26-2015.

   - Duty Correction = 10 log (1/duty cycle) = 10 log (1/0.744) = 1.284 dB

4) For the same reason as above 3), Sweep time is calculated as follows.

   - Sweep time > number of point in sweep x transmit period = 1001 x 5 ms = 5005 ms

5) Because the emission limit is calculated by MIMO-Summing, only one output port that measured maximum output power is tested as the worst condition.

   - Port 31, 20 MHz + 20 MHz + 20 MHz / 3 Carriers, 64QAM

6) Only MIMO correction was applied to the result table limit.

   - Limit = -13 dB -18.062 dB = -31.062 dB

7) All corrections including RBW, MIMO, and Duty Cycle were applied to the plot limit.

   - Limit for 9 kHz to 150 kHz = -13 dB -18.062 dB - 1.284 dB - 30 dB = -62.346 dB
   - Limit for 150 kHz to 30 MHz = -13 dB -18.062 dB - 1.284 dB - 20 dB = -52.346 dB
   - Limit for other bands = -13 dB -18.062 dB - 1.284 dB = -32.346 dB

Test Results:

Band edge of 20 MHz + 20 MHz + 20 MHz Bandwidth / 3 Carriers

Port	Modulation	Point	Frequency (MHz)	Measured band edge (dBm)
Port 31	64QAM	Left	2496.00	-35.361
		Right	2690.00	-34.553

* Because the results corrected by duty cycle are recorded, they do not match the test plot.

Emission below 1 GHz of 20 MHz + 20 MHz + 20 MHz Bandwidth / 3 Carriers

Port	Modulation	Channel	Frequency (MHz)	Measured emission (dBm)		
				9 kHz ~ 150 kHz	150 kHz ~ 30 MHz	30 MHz ~ 1 GHz
Port 31	64QAM	Low	2 526.00	-53.140	-61.597	-45.935
		Middle	2 593.00	-53.539	-61.618	-45.912
		High	2 660.00	-53.688	-62.081	-45.939

* Because the results corrected by duty cycle and RBW are recorded, they do not match the test plot.

Emission above 1 GHz of 20 MHz + 20 MHz + 20 MHz Bandwidth / 3 Carriers

Port	Modulation	Channel	Frequency (MHz)	Measured emission (dBm)		
				1 GHz ~ 2.486 GHz	2.970 GHz ~ 12.75 GHz	12.75 GHz ~ 26.5 GHz
Port 31	64QAM	Low	2 526.00	-46.208	-46.654	-41.391
		Middle	2 593.00	-49.590	-46.911	-41.333
		High	2 660.00	-49.730	-44.702	-41.239

* Because the results corrected by duty cycle are recorded, they do not match the test plot.

Plots of Band edge - 20 MHz + 20 MHz + 20 MHz Bandwidth / 3 Carriers

Port 31			
Modulation:	**64QAM**	**Modulation:**	**64QAM**
Item:	**Left band edge**	**Item:**	**Right band edge**

Plots of Unwanted Conducted Emission - 20 MHz + 20 MHz + 20 MHz Bandwidth / 3 Carriers

Port 31, 64QAM, Low

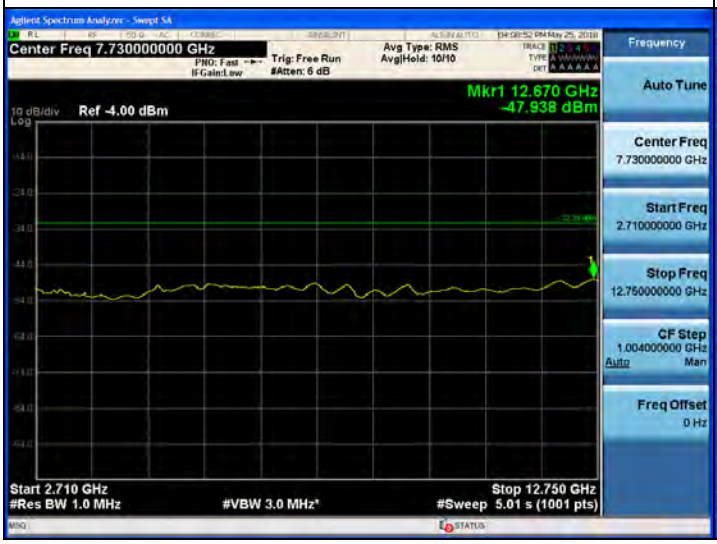
9 kHz ~ 150 kHz

150 kHz ~ 30 MHz

30 MHz ~ 1 GHz

1 GHz ~ 2.476 GHz

2.710 GHz ~ 12.75 GHz



12.75 GHz ~ 26.5 GHz

Port 31, 64QAM, Middle

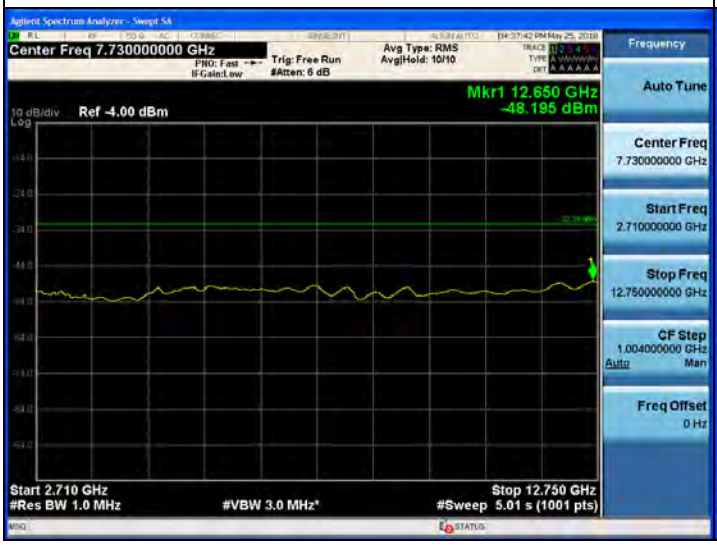
9 kHz ~ 150 kHz

150 kHz ~ 30 MHz

30 MHz ~ 1 GHz

1 GHz ~ 2.476 GHz

2.710 GHz ~ 12.75 GHz



12.75 GHz ~ 26.5 GHz

Port 31, 64QAM, High

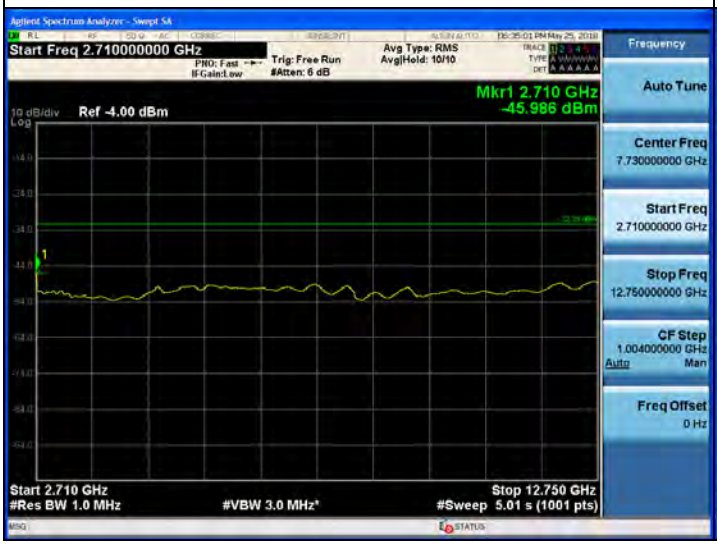
9 kHz ~ 150 kHz

150 kHz ~ 30 MHz

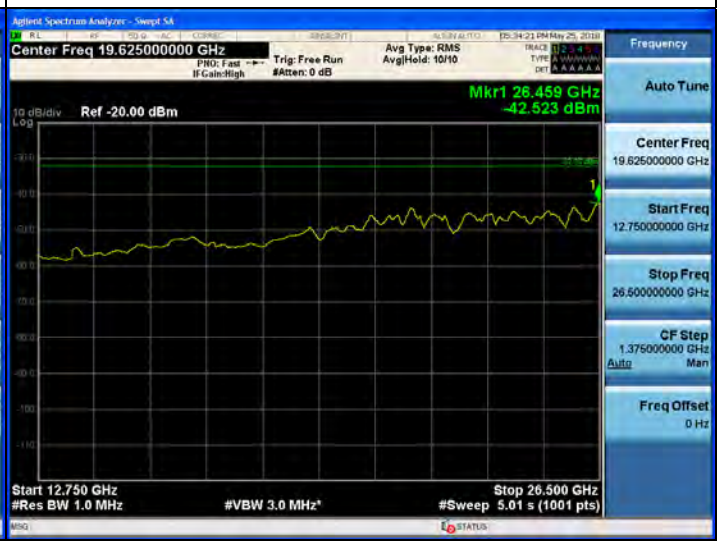
30 MHz ~ 1 GHz

1 GHz ~ 2.476 GHz

2.710 GHz ~ 12.75 GHz



12.75 GHz ~ 26.5 GHz



8. RADIATED EMISSIONS

FCC Rules

Test Requirements:

§ 2.1053 Measurements required: Field strength of spurious radiation.

(a) Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of §2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required, with the measuring instrument antenna located in the far-field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from halfwave dipole antennas.

(b) The measurements specified in paragraph (a) of this section shall be made for the following equipment:

(1) Those in which the spurious emissions are required to be 60 dB or more below the mean power of the transmitter.

(2) All equipment operating on frequencies higher than 25 MHz.

(3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.

(4) Other types of equipment as required, when deemed necessary by the Commission.

Test Procedures:

The measurement is performed in accordance with Section 5.5.4 and 5.5.3.2 of ANSI C63.26.

a) Place the EUT in the center of the turntable. The EUT shall be configured to transmit into the standard non-radiating load (for measuring radiated spurious emissions), connected with cables of minimal length unless specified otherwise. If the EUT uses an adjustable antenna, the antenna shall be positioned to the length that produces the worst case emission at the fundamental operating frequency.

b) Each emission under consideration shall be evaluated:

1) Raise and lower the measurement antenna in accordance 5.5.2, as necessary to enable

detection of the maximum emission amplitude relative to measurement antenna height.

2) Rotate the EUT through 360° to determine the maximum emission level relative to the axial position.

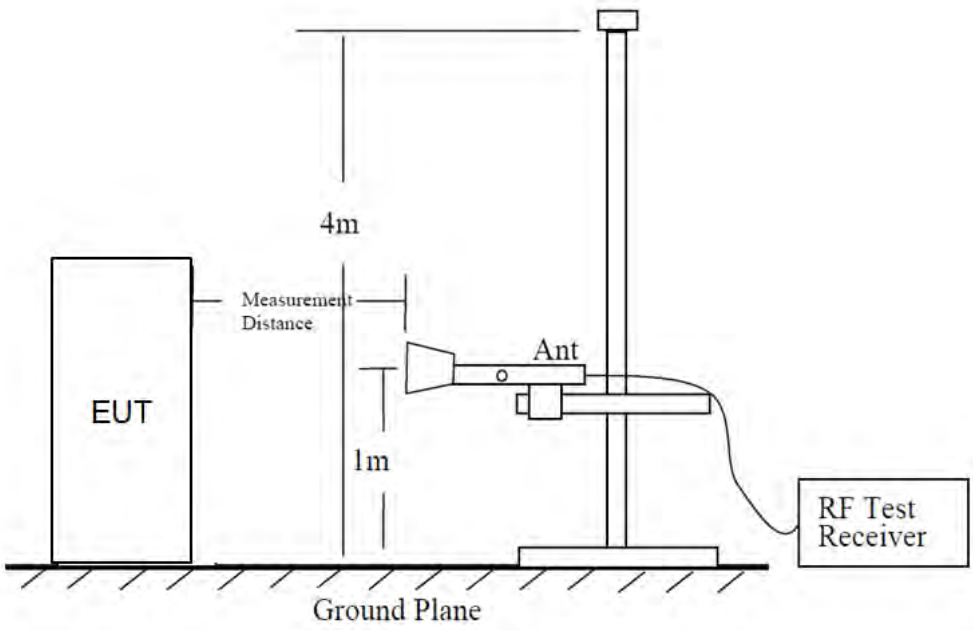
3) Return the turntable to the azimuth where the highest emission amplitude level was observed.

4) Vary the measurement antenna height again through 1 m to 4 m again to find the height associated with the maximum emission amplitude.

5) Record the measured emission amplitude level and frequency using the appropriate RBW.

c) Repeat step b) for each emission frequency with the measurement antenna oriented in both the horizontal and vertical polarizations to determine the orientation that gives the maximum emissions amplitude.

Test Setup:



Note:

1) According to SVSWR requirement in ANSI 63.4 (2014), we performed the radiated test at 3.75 m distance from center of turn table. So, we applied the distance factor (reference distance: 3 m).
2) Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
3) Position for testing is set according to floor-standing EUTs of ANSI C63.26 - 5.5.2.3.2

Test Result:

Ch.	Frequency (MHz)	Measured Level (dBuV/m)	Measured Power (dBm)	Ant. Factor (dB/m)	C.L (dB)	A.G. (dB)	D.F. (dB)	Pol.	Result (dBm)
No Critical Peaks Found									

* C.L.: Cable Loss / A.G.: Ant. Gain / D.F.: Distance Factor (3.75 m)

9. FREQUENCY STABILITY

FCC Rules

Test Requirements:

§ 2.1055 Measurements required: Frequency stability.

(a) The frequency stability shall be measured with variation of ambient temperature as follows:

(1) From −30° to + 50° centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.

§ 27.54 Frequency stability.

The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

Test Procedures:

The measurement is performed in accordance with Section 5.6.4 and 5.6.5 of ANSI C63.26.

5.6.4 Frequency stability over variations in temperature

a) Supply the EUT with a nominal 60 Hz ac voltage, dc voltage, or install a new or fully charged battery in the EUT.

b) If possible a dummy load should be connected to the EUT because an antenna near the metallic walls of an environmental test chamber could affect the output frequency of the EUT. If the EUT is equipped with a permanently attached, adjustable-length antenna, the EUT should be placed in the center of the chamber with the antenna adjusted to the shortest length possible.

c) Turn on the EUT, and tune it to the center frequency of the operating band.

d) Couple the transmitter output to the measuring instrument through a suitable attenuator and coaxial cable. If connection to the EUT output is not possible, make the measurement by connecting an antenna to the measuring instrument with a suitable length of coaxial cable and placing the measuring antenna near the EUT (e.g., 15 cm away).

NOTE—An instrument that has an adequate level of accuracy as specified by the procuring or regulatory authority is the recommended measuring instrument.

e) Adjust the location of the measurement antenna and the controls on the measurement instrument to obtain a suitable signal level (i.e., a level that will not overload the measurement instrument, but is strong enough to allow measurement of the operating or fundamental frequency of the EUT). Adjust the detector bandwidth and span settings to achieve a resolution capable of accurate frequency measurements over the applicable frequency stability limits.

f) Turn the EUT off, and place it inside the environmental temperature chamber. For devices that have oscillator heaters, energize only the heater circuit.

g) Set the temperature control on the chamber to the highest temperature specified in the regulatory requirements for the type of device, and allow the oscillator heater and the chamber

temperature to stabilize. Unless otherwise instructed by the regulatory authority, this temperature should be 50 °C.

h) While maintaining a constant temperature inside the environmental chamber, turn on the EUT and allow sufficient time for the EUT temperature to stabilize.

i) Measure the frequency.

j) Switch off the EUT, but do not switch off the oscillator heater.

k) Lower the chamber temperature to the next level that is required by the standard and allow the temperature inside the chamber to stabilize. Unless otherwise instructed by the regulators, this temperature step should be 10 °C.

l) Repeat step h) through step k) down to the lowest specified temperature. Unless otherwise instructed by the regulators, this temperature should be −30 °C. When the frequency stability limit is stated as being sufficient such that the fundamental emissions stay within the authorized bands of operation, a reference point shall be established at the applicable unwanted emissions limit using a RBW equal to the RBW required by the unwanted emissions specification of the applicable regulatory standard. These reference points measured using the lowest and highest channel of operation shall be identified as f_L and f_H respectively. The worst-case frequency offset determined in the above methods shall be added or subtracted from the values of f_L and f_H and the resulting frequencies must remain within the band.

m) Omitted

5.6.5 Frequency stability when varying supply voltage

a) Couple the transmitter output to the measuring instrument through a suitable attenuator and coaxial cable. If connection to the EUT output is not possible make the measurement by connecting an antenna to the measuring instrument with a suitable length of coaxial cable and placing the measuring antenna near the EUT (e.g., 15 cm away)

b) Supply the EUT with nominal ac or dc voltage. The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

c) Turn on the EUT, and couple its output to a frequency counter or other frequency-measuring instrument.

d) Tune the EUT to the center frequency of the operating band. Adjust the location of the measurement antenna and the controls on the measurement instrument to obtain a suitable signal level (i.e., a level that will not overload the measurement instrument, but is strong enough to allow measurement of the operating or fundamental frequency of the EUT). Adjust the detector bandwidth and span settings to achieve a resolution capable of accurate frequency measurements over the applicable frequency stability limits.

NOTE—An instrument that has an adequate level of accuracy as specified by the procuring or regulatory authority is the recommended measuring instrument.

e) Measure the frequency.

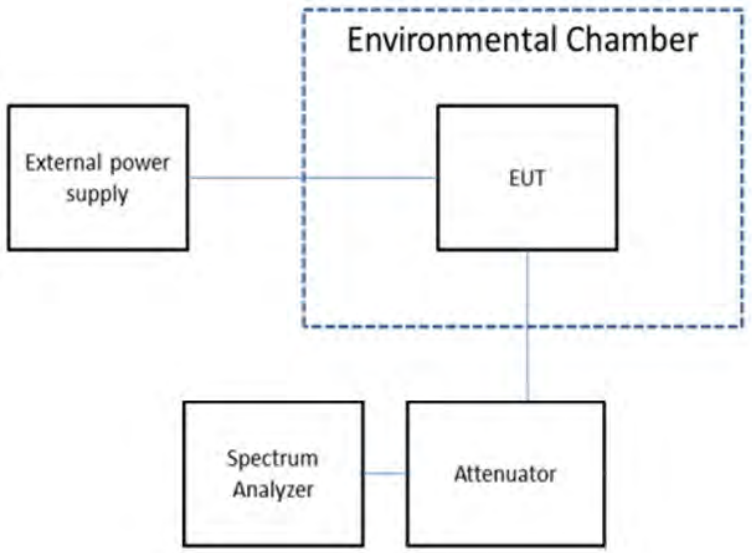
f) Unless otherwise specified, vary primary supply voltage from 85% to 115% of the nominal value for other than hand carried battery equipment.

g) For hand carried, battery powered equipment, reduce the primary ac or dc supply voltage to the battery operating end point, which shall be specified by the manufacturer.

h) Repeat the frequency measurement.

NOTE—For band-edge compliance, it can be required to make these measurements at the low and high channel of the operating band.

Test Setup:



Note:

1) The results of the frequency stability test shown above the frequency deviation measured values are very small and similar trend for each port, so we are attached only the worst case data.

Test Results:

Reference: Voltage = DC -48 V at 20°C, Frequency = 2 593.0 MHz

Voltage (%)	Temp.(℃)	Frequency (Hz)	Frequency Error (Hz)	Deviation (Hz)	ppm
100 %	+20(Ref)	2 593 000 119	118.900	0.000	0.00000
	-30	2 593 000 119	118.540	-0.360	-0.00014
	-20	2 593 000 118	118.110	-0.790	-0.00030
	-10	2 593 000 119	118.800	-0.100	-0.00004
	0	2 593 000 118	117.770	-1.130	-0.00044
	+10	2 593 000 119	119.050	0.150	0.00006
	+30	2 593 000 119	119.080	0.180	0.00007
	+40	2 593 000 119	118.940	0.040	0.00002
	+50	2 593 000 120	120.120	1.220	0.00047
115 %	+20	2 593 000 119	118.570	-0.330	-0.00013
85 %	+20	2 593 000 120	119.520	0.620	0.00024