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HCT

TEST REPORT

FCC Test for PSR-9536-B Certification

APPLICANT
TJ innovation Co., Ltd.

REPORT NO.
HCT-RF-2002-FC003-R1

DATE OF ISSUE
February 20, 2020

HCT Co., Ltd.
74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383 KOREA
Tel. +82 31 634 6300 F ax. +82 31 645 6401

HCT Co., Ltd.
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REPORT NO.
HCT-RF-2002-FC003-R1

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Additional Model
VISION78

Applicant	**TJ innovation Co., Ltd.** 2018, Sambo Techno-tower 122, Jomaru-ro 385beon-gil, Bucheon-si, Gyeonggi-do, Korea
Eut Type Model Name	Public Safety Repeater (PSR-9536) PSR-9536-B
FCC ID	2AVNP-PSR-9536-B
Output Power	Uplink : 30 dBm / Downlink : 33 dBm
Date of Test	January 13, 2020 ~ February 10, 2020
FCC Rule Parts:	Part 2, Part 90

This test results were applied only to the test methods required by the standard.

Tested by
Kyung Soo Kang (signature)

Technical Manager
Jong Seok Lee (signature)

HCT CO., LTD.
Soo Chan Lee
SooChan Lee / CEO

REVISION HISTORY

The revision history for this test report is shown in table.

Revision No.	Date of Issue	Description
0	February 12, 2020	Initial Release
1	February 20, 2020	Revised antenna peak gain on page 5.

The result shown in this test report refer only to the sample(s) tested unless otherwise stated.

The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC Rules under normal use and maintenance.

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1. GENERAL INFORMATION

1.1. APPLICANT INFORMATION

Company Name	TJ innovation Co., Ltd.
Company Address	2018, Sambo Techno-tower 122, Jomaru-ro 385beon-gil, Bucheon-si, Gyeonggi-do, Korea

1.2. PRODUCT INFORMATION

EUT Type	Public Safety Repeater (PSR-9536)
EUT Serial Number	PSR-9536-B-2002-0001
Power Supply	Input : (110 ~ 240) Vac or DC +30.3V, +6.2V Output(Voltage, Current) : 30.3V/3.9A, 10A DC rating: 177W
Frequency Range	FirstNet: 758 MHz ~ 768 MHz(Uplink), 788 MHz ~ 798 MHz(Downlink) PS700: 769 MHz ~ 775 MHz(Uplink), 799 MHz ~ 805 MHz(Downlink) PS800: 851 MHz ~ 861 MHz(Uplink), 806 MHz ~ 816 MHz(Downlink)
Tx Output Power	Uplink : 30 dBm / Downlink : 33 dBm
Antenna Peak Gain	Downlink (service side) : Omni antenna, Gain: 2.9dBi Uplink (donor side) : Panel antenna, Gain: 5.9dBi

1.3. TEST INFORMATION

FCC Rule Parts	Part 2, Part 90
Measurement Standards	KDB 935210 D05 v01r03, ANSI C63.26-2015
Test Location	HCT CO., LTD. 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA

2. TEST STANDARDS

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with FCC Part 2, 90.

Description	Reference
AGC threshold	KDB 935210 D05 v01r03 3.2 KDB 935210 D05 v01r03 4.2
Out-of-band rejection	KDB 935210 D05 v01r03 3.3 KDB 935210 D05 v01r03 4.3
Occupied Bandwidth	§ 2.1049 § 90.219(e)(4)(ii)
Input-versus-output signal comparison	§ 90.210, § 90.219(e)(4)(iii)
Input/output power and amplifier/booster gain	§ 2.1046, § 90.219, § 90.541, § 90.542, § 90.635
Noise figure	§ 90.219(e)(2)
Emission masks Out-of-band/out-of-block emissions and spurious emissions	§ 2.1051, § 90.219(e)(3), § 90.543
Spurious emissions radiated	§ 2.1053

3. TEST SPECIFICATIONS

3.1. ADDITIONAL DESCRIPTIONS ABOUT TEST

Except for the following cases, EUT was tested under normal operating conditions.

: Out-of-band rejection test requires maximum gain condition without AGC

: Noise figure test requires any AGC circuitry be disabled over the duration of the measurement.

This EUT is supported power supply both of AC and DC. Test results are only attached worst cases.

The test was generally based on the method of KDB 935210 D05 v01r03 and only followed ANSI C63.26-2015 if there was no test method in KDB standard.

EUT was tested with following modulated signals provide by applicant.

Band Name	Link	Frequency	Tested signals
FirstNet	Uplink	(758 ~ 768) MHz	LTE 5 MHz, LTE 10 MHz
	Downlink	(788 ~ 798) MHz	
PS700	Uplink	(769 ~ 775) MHz	P25 Phase 1, P25 Phase 2, TETRA
	Downlink	(799 ~ 805) MHz	
PS800	Uplink	(851 ~ 861) MHz	P25 Phase 1, P25 Phase 2, TETRA
	Downlink	(806 ~ 816) MHz	

Below channels greater than 25 kHz in EUT specification are not tested because it could consist of a combination of P25 Phase 1, P25 Phase 2 and TETRA signals.

Channelizing	P25 Phase 1 combinations	P25 Phase 2 combinations	TETRA combinations
100 kHz	n = 8	n = 16	n = 4
200 kHz	n = 16	n = 32	n = 8

The frequency stability measurement has been omitted in accordance with section 3.7 of KDB 935210 D05 v01r03.

: It can be confirmed through input-versus-output spectrum test that EUT does not alter the input signal.

The tests results included actual loss value for attenuator and cable combination as shown in the table below.

: Input Path

Correction factor table			
Frequency (MHz)	Factor (dB)	Frequency (MHz)	Factor (dB)
600	0.723	850	0.756
700	0.763	900	0.728
750	0.756	1 000	0.739
800	0.795	1 050	0.703

: Output Path

Correction factor table			
Frequency (MHz)	Factor (dB)	Frequency (MHz)	Factor (dB)
30	29.772	1500	31.413
50	29.780	2000	31.603
100	29.858	2500	31.931
150	29.939	3000	32.272
200	30.053	3500	32.387
250	30.195	4000	32.685
300	30.409	4500	32.517
350	30.491	5000	32.662
400	30.536	5500	33.296
450	30.532	6000	33.361
500	30.682	6500	34.388
550	30.602	7000	33.551
600	30.773	7500	33.924
650	30.819	8000	33.681
700	30.855	8500	33.775
750	30.842	9000	34.452
800	30.878		
850	30.890		
900	30.890		
950	30.947		
1000	30.920		

3.2. MEASUREMENTUNCERTAINTY

Description	Reference	Results
AGC threshold	-	±0.87 dB
Out-of-band rejection	-	±0.58 MHz
Occupied Bandwidth	OBW ≤ 25 kHz	±0.16 MHz
	OBW > 5 MHz	±0.58 MHz
Input-versus-output signal comparison	-	±0.87 dB
Input/output power and amplifier/booster gain	-	±0.87 dB
Out-of-band/out-of-block emissions and spurious emissions	-	±1.08 dB
Spurious emissions radiated	f ≤ 1 GHz	±4.80 dB
	f > 1 GHz	±6.07 dB

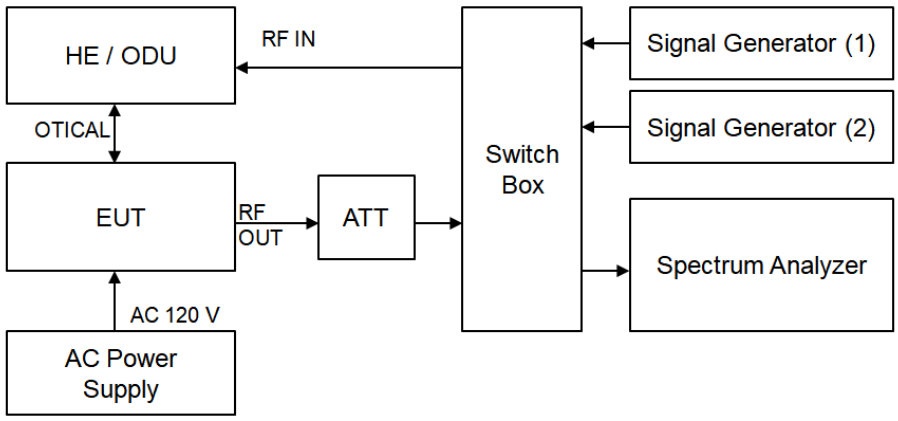
** Coverage factor k = 2, Confidence levels of 95 %*

3.3. STANDARDS ENVIRONMENTAL TEST CONDITIONS

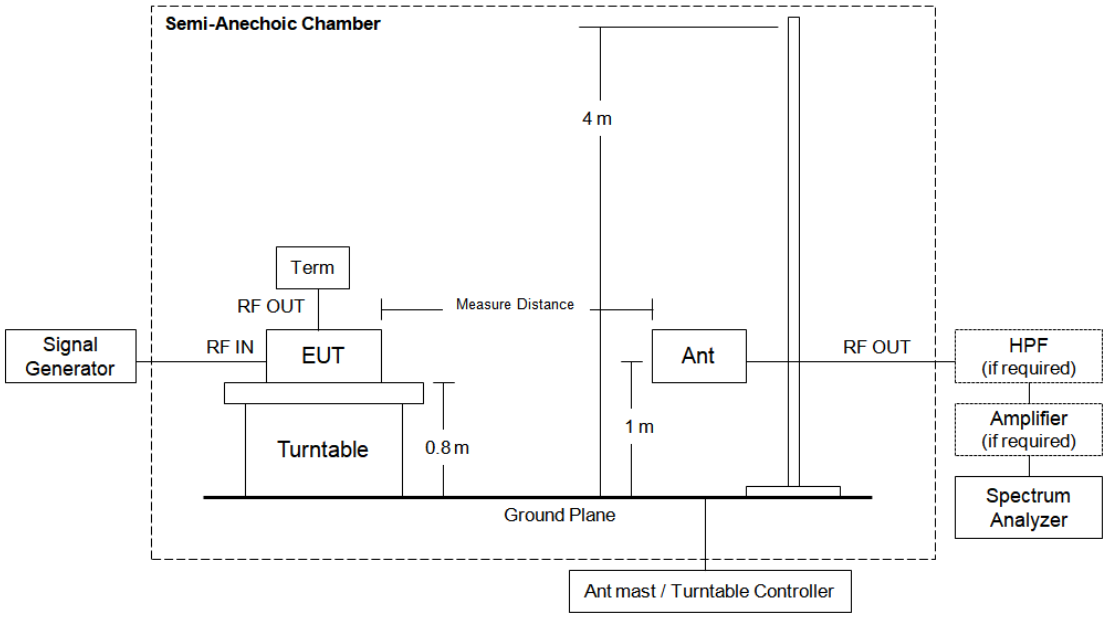
Temperature	+15 °C to +35 °C
Relative humidity	30 % to 60 %
Air pressure	860 mbar to 1 060 mbar

3.4. TEST DIAGRAMS

Conducted Test



Radiated Test



※ EUT position is adopted by placement of floor-standing refer to section 5.5.2.3.2 of ANSI C63.26-2015

4. TEST EQUIPMENTS

Manufacturer	Model / Equipment	Calibration Date	Calibration Interval	Serial No.
Agilent	N9020A / MXA Signal Analyzer	05/08/2019	Annual	MY51110063
Agilent	N5182A / MXG Vector Signal Generator	12/23/2019	Annual	MY46240523
Agilent	N5182A / MXG Vector Signal Generator	01/17/2020	Annual	MY47070406
Agilent	8498A / 30 dB Attenuator	02/18/2019	Annual	51161
KEITHLEY	S46 / Switch	N/A	N/A	1088024
Deayoung ENT	DFSS60 / AC Power Supply	04/04/2019	Annual	1003030-1
Innco system	CO3000 / Controller(Antenna mast)	N/A	N/A	CO3000-4p
Innco system	MA4640/800-XP-EP / Antenna Position Tower	N/A	N/A	N/A
Audix	EM1000 / Controller	N/A	N/A	060520
Audix	- / Turn Table	N/A	N/A	N/A
Rohde&Schwarz	- / Loop Antenna	04/26/2019	Biennial	1513-175
Schwarzbeck	VULB 9168 / Hybrid Antenna	03/22/2019	Biennial	760
Schwarzbeck	BBHA 9120D / Horn Antenna	04/29/2019	Biennial	9120D-937
Rohde & Schwarz	FSP(9 kHz ~ 30 GHz) / Spectrum Analyzer	05/09/2019	Annual	100854
Wainwright Instruments	WHKX10-900-1000-15000-40SS	07/15/2019	Annual	5
CERNEX	CBLU1183540 / Power Amplifier	07/01/2019	Annual	22964
CERNEX	CBL06185030 / Power Amplifier	07/01/2019	Annual	22965

5. TEST RESULT

5.1. AGC THRESHOLD

Test Requirement:

KDB 935210 D05 v01r03

Testing at and above the AGC threshold is required.

Test Procedures:

Measurements were in accordance with the test methods section 3.2 of KDB 935210 D05 v01r03.

In the case of fiber-optic distribution systems, the RF input port of the equipment under test (EUT) refers to the RF input of the supporting equipment RF to optical convertor; see also descriptions and diagrams for typical DAS booster systems in KDB Publication 935210 D02

Devices intended to be directly connected to an RF source (donor port) only need to be evaluated for any over-the-air transmit paths.

a) Connect a signal generator to the input of the EUT.
b) Connect a spectrum analyzer or power meter to the output of the EUT using appropriate attenuation as necessary.
c) The signal generator should initially be configured to produce either of the required test signals.
d) Set the signal generator frequency to the center frequency of the EUT operating band.
e) While monitoring the output power of the EUT, measured using the methods of ANSI C63.26-2015 subclause 5.2.4.4.1, increase the input level until a 1 dB increase in the input signal power no longer causes a 1 dB increase in the output signal power.
f) Record this level as the AGC threshold level.
g) Repeat the procedure with the remaining test signal.

Measurements were in accordance with the test methods section 4.2 of KDB 935210 D05 v01r03.

Testing at and above the AGC threshold will be required. The AGC threshold shall be determined by applying the procedure of 3.2, but with the signal generator configured to produce a test signal defined in Table 1, a CW input signal, or a digitally modulated signal, consistent with the discussion about signal types in 4.1.

Output power measurement in subclause 5.2.4.4.1 of ANSI C63.26

a) Set span to 2 × to 3 × the OBW.
b) Set RBW = 1% to 5% of the OBW.
c) Set VBW ≥ 3 × RBW.
d) Set number of measurement points in sweep ≥ 2 × span / RBW.
e) Sweep time: auto-couple

f) Detector = power averaging (rms).

g) If the EUT can be configured to transmit continuously, then set the trigger to free run.

h) Omit

i) Trace average at least 100 traces in power averaging (rms) mode if sweep is set to auto-couple. To accurately determine the average power over multiple symbols, it can be necessary to increase the number of traces to be averaged above 100 or, if using a manually configured sweep time, increase the sweep time.

j) Compute the power by integrating the spectrum across the OBW of the signal using the instrument's band or channel power measurement function, with the band/channel limits set equal to the OBW band edges. If the instrument does not have a band or channel power function, then sum the spectrum levels (in linear power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.

Test Results:

Test Band	Link	Tested signals	Measured Frequency (MHz)	AGC Threshold Level (dBm)	Output Level (dBm)
FirstNet	Uplink	LTE 5 MHz	793.00	-65	29.59
		LTE 10 MHz	793.00	-65	29.44
	Downlink	LTE 5 MHz	763.00	-62	33.16
		LTE 10 MHz	763.00	-62	33.09
PS700	Uplink	P25 Phase 1	802.00	-65	29.94
		P25 Phase 2	802.00	-65	30.05
		TETRA	802.00	-65	30.05
	Downlink	P25 Phase 1	772.00	-62	32.98
		P25 Phase 2	772.00	-61	32.84
		TETRA	772.00	-62	32.99
PS800	Uplink	P25 Phase 1	811.00	-65	30.62
		P25 Phase 2	811.00	-65	30.15
		TETRA	811.00	-65	30.03
	Downlink	P25 Phase 1	856.00	-62	32.67
		P25 Phase 2	856.00	-62	32.71
		TETRA	856.00	-62	32.70

5.2. OUT-OF-BAND REJECTION

Test Requirement:

KDB 935210 D05 v01r03

Out-of-band rejection required.

Test Procedures:

Measurements were in accordance with the test methods section 3.3 of KDB 935210 D05 v01r03.

Adjust the internal gain control of the EUT to the maximum gain for which equipment certification is sought.

a) Connect a signal generator to the input of the EUT.
b) Configure a swept CW signal with the following parameters:
   1) Frequency range = ±250 % of the passband, for each applicable CMRS band.
   2) Level = a sufficient level to affirm that the out-of-band rejection is > 20 dB above the noise floor and will not engage the AGC during the entire sweep.
   3) Dwell time = approximately 10 ms.
   4) Number of points = SPAN/(RBW/2).
c) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation.
d) Set the span of the spectrum analyzer to the same as the frequency range of the signal generator.
e) Set the resolution bandwidth (RBW) of the spectrum analyzer to be 1 % to 5 % of the EUT passband, and the video bandwidth (VBW) shall be set to ≥ 3 × RBW.
f) Set the detector to Peak Max-Hold and wait for the spectrum analyzer's spectral display to fill.
g) Place a marker to the peak of the frequency response and record this frequency as f_0.
h) Place two markers, one at the lowest and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the −20 dB down amplitude, to determine the 20 dB bandwidth.
i) Capture the frequency response of the EUT.
j) Repeat for all frequency bands applicable for use by the EUT.

Measurements were in accordance with the test methods section 4.3 of KDB 935210 D05 v01r03.

Adjust the internal gain control of the EUT to the maximum gain for which equipment certification is sought.

a) Connect a signal generator to the input of the EUT.
b) Configure a swept CW signal with the following parameters:
   1) Frequency range = ± 250 % of the manufacturer's specified pass band.
   2) The CW amplitude shall be 3 dB below the AGC threshold (see 4.2), and shall not activate the AGC threshold throughout the test.
   3) Dwell time = approximately 10 ms.

4) Frequency step = 50 kHz.

c) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation.

d) Set the RBW of the spectrum analyzer to between 1 % and 5 % of the manufacturer's rated passband, and VBW = 3 × RBW.

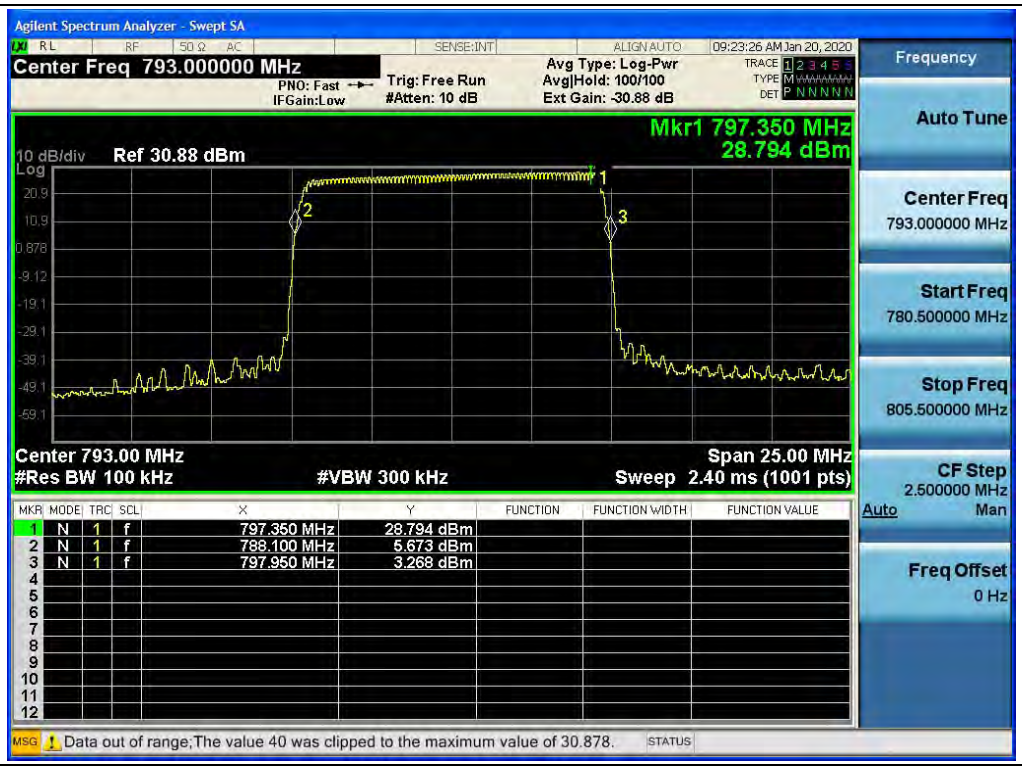
e) Set the detector to Peak and the trace to Max-Hold.

f) After the trace is completely filled, place a marker at the peak amplitude, which is designated as f0, and with two additional markers (use the marker-delta method) at the 20 dB bandwidth (i.e., at the points where the level has fallen by 20 dB).

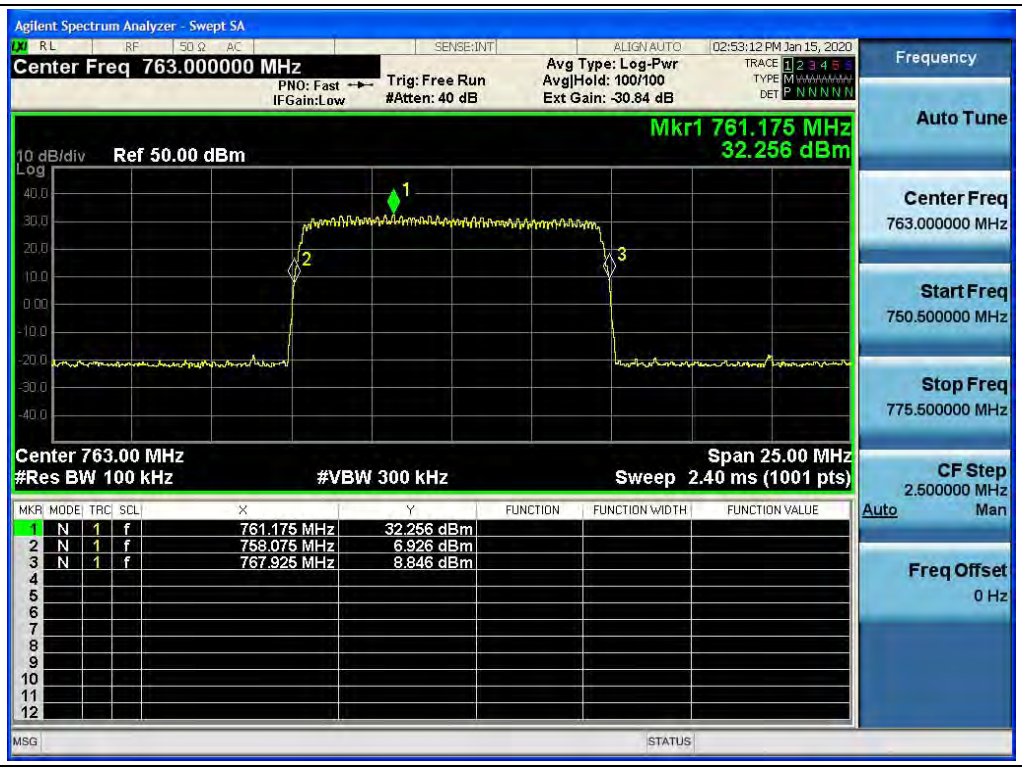
g) Capture the frequency response plot for inclusion in the test report.

Test Results:

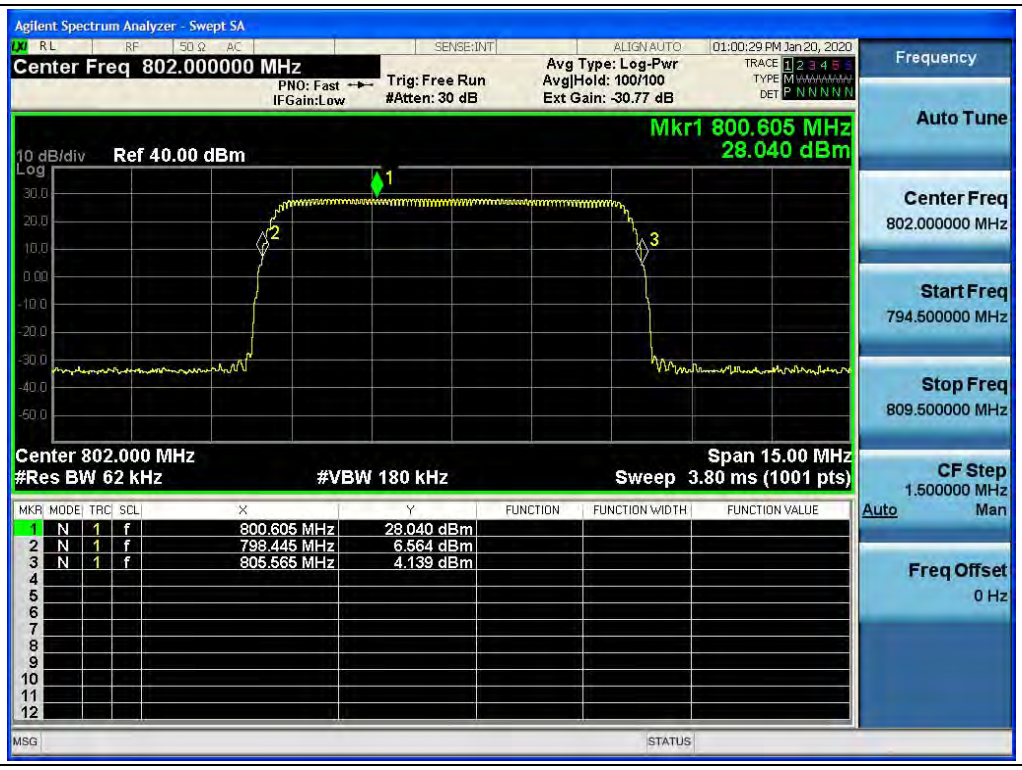
FirstNet / Uplink



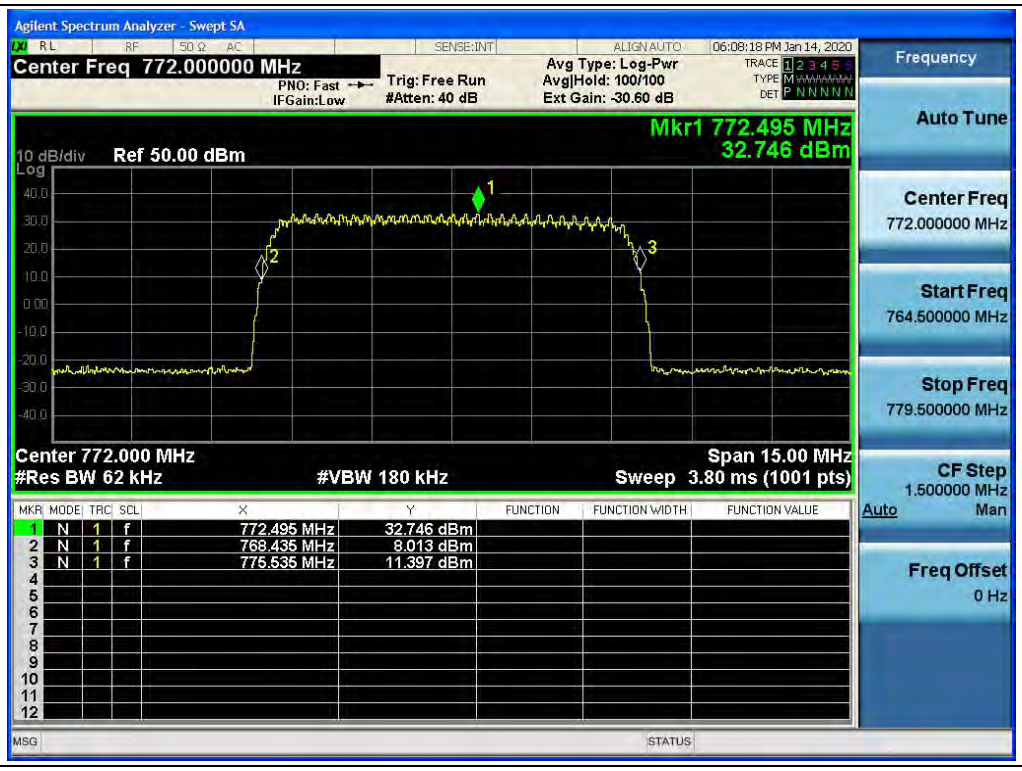
FirstNet / Downlink



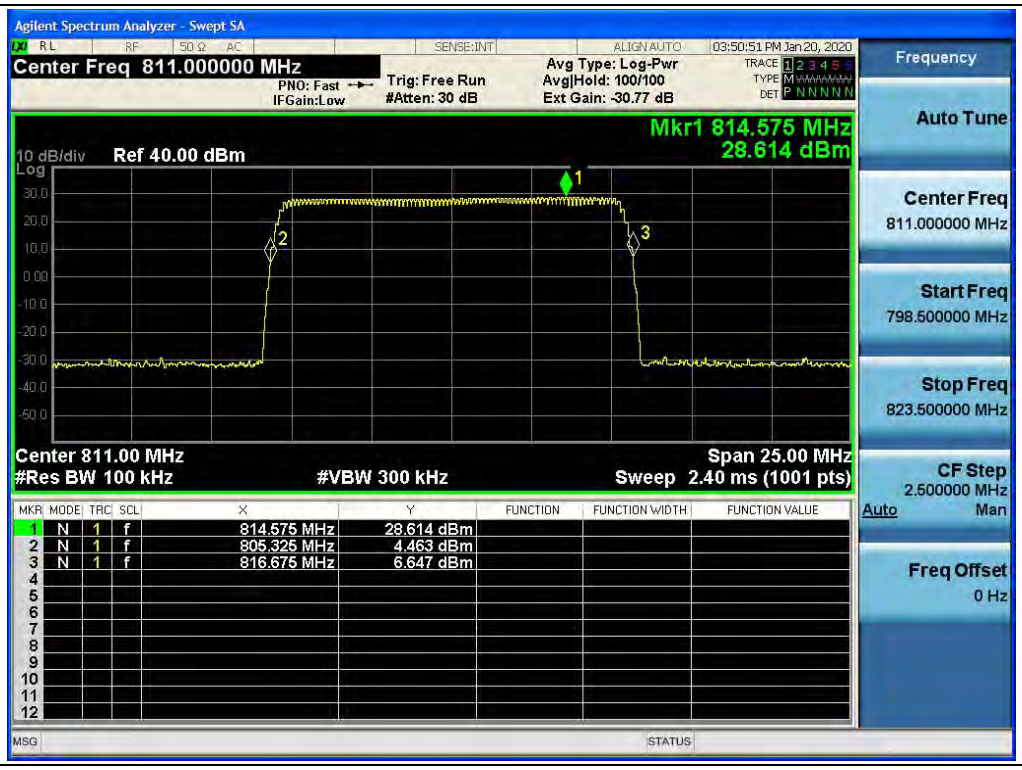
PS700 / Uplink



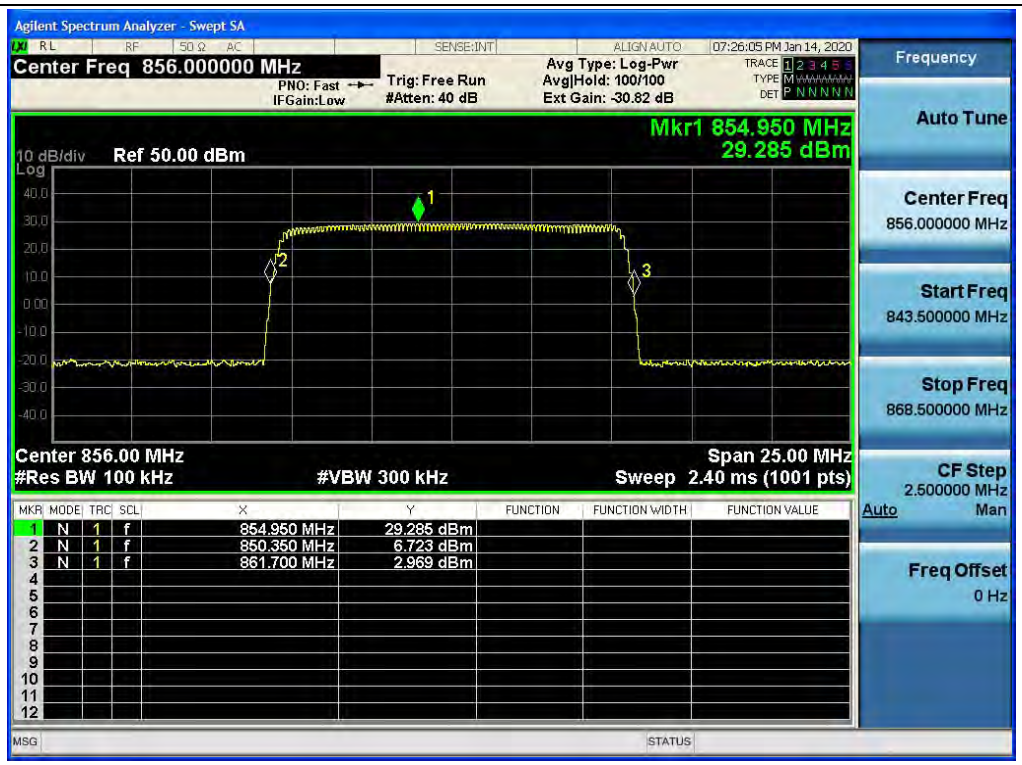
PS700 / Downlink



PS800 / Uplink



PS800 / Downlink



5.3. OCCUPIED BANDWIDTH

Test Requirement:

§ 2.1049 Measurements required: Occupied bandwidth.

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 under the specified conditions of § 2.1049 (a) through (i) as applicable.

§ 90.219 Use of signal boosters.

(e) Device Specifications. In addition to the general rules for equipment certification in § 90.203(a)(2) and part 2, subpart J of this chapter, a signal booster must also meet the rules in this paragraph.

(4) A signal booster must be designed such that all signals that it retransmits meet the following requirements:

(ii) There is no change in the occupied bandwidth of the retransmitted signals.

Test Procedures:

Measurements were in accordance with the test methods section 3.4 of KDB 935210 D05 v01r03.

a) Connect a signal generator to the input of the EUT.

b) Configure the signal generator to transmit the AWGN signal.

c) Configure the signal amplitude to be just below the AGC threshold level (see 3.2), but not more than 0.5 dB below.

d) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation.

e) Set the spectrum analyzer center frequency to the center frequency of the operational band under test. The span range of the spectrum analyzer shall be between 2 times to 5 times the emission bandwidth (EBW) or alternatively, the OBW.

f) The nominal RBW shall be in the range of 1 % to 5 % of the anticipated OBW, and the VBW shall be ≥ 3 × RBW.

g) Set the reference level of the instrument as required to preclude the signal from exceeding the maximum spectrum analyzer input mixer level for linear operation. In general, the peak of the spectral envelope must be more than [10 log (OBW / RBW)] below the reference level.

h) Steps f) and g) may require iteration to enable adjustments within the specified tolerances.

i) The noise floor of the spectrum analyzer at the selected RBW shall be at least 36 dB below the reference level.

j) Set spectrum analyzer detection function to positive peak.

k) Set the trace mode to max hold.

l) Determine the reference value: Allow the trace to stabilize. Set the spectrum analyzer marker to the highest amplitude level of the displayed trace (this is the reference value) and record the associated frequency.

m) Place two markers, one at the lowest and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the −26 dB down amplitude. The 26 dB EBW (alternatively OBW) is the positive frequency difference between the two markers. If the spectral envelope crosses the −26 dB down amplitude at multiple points, the lowest or highest frequency shall be selected as the frequencies that

are the furthest removed from the center frequency at which the spectral envelope crosses the −26 dB down amplitude point.

n) Repeat steps e) to l) with the input signal connected directly to the spectrum analyzer (i.e., input signal measurement).

o) Compare the spectral plot of the input signal (determined from step m) to the output signal (determined from step l) to affirm that they are similar (in passband and rolloff characteristic features and relative spectral locations), and include plot(s) and descriptions in test report.

A. Repeat the procedure [steps e) to n)] with the input signal amplitude set to 3 dB above the AGC threshold.

p) Repeat steps e) to o) with the signal generator set to the narrowband signal.

q) Repeat steps e) to p) for all frequency bands authorized for use by the EUT.

Measurements were in accordance with the test methods section 5.4.4 of ANSI C63.26-2015.

a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be set wide enough to capture all modulation products including the emission skirts (typically a span of 1.5 × OBW is sufficient).

b) The nominal IF filter 3 dB bandwidth (RBW) shall be in the range of 1% to 5% of the anticipated OBW, and the VBW shall be set ≥ 3 × RBW.

c) Set the reference level of the instrument as required to prevent the signal amplitude from exceeding the maximum spectrum analyzer input mixer level for linear operation. See guidance provided in 4.2.3.

NOTE—Step a), step b), and step c) may require iteration to adjust within the specified tolerances.

d) Set the detection mode to peak, and the trace mode to max-hold.

e) Omit

f) The OBW shall be reported and plot(s) of the measuring instrument display shall be provided with the test report. The frequency and amplitude axis and scale shall be clearly labeled. Tabular data can be reported in addition to the plot(s).

Test Results:

Tabular data of Output Occupied Bandwidth

Test Band	Link	Tested signals	Measured Frequency (MHz)	99 % OBW (MHz)	26 dB OBW (MHz)
FirstNet	Uplink	LTE 5 MHz	793.00	4.5142	4.986
		LTE 10 MHz	793.00	8.9197	9.577
	Downlink	LTE 5 MHz	763.00	4.5122	5.053
		LTE 10 MHz	763.00	8.9445	9.482
Test Band	Link	Tested signals	Measured Frequency (MHz)	99 % OBW (kHz)	26 dB OBW (MHz)
PS700	Uplink	P25 Phase 1	802.000	8.241	11.00
		P25 Phase 2	802.000	4.830	5.458
		TETRA	802.000	21.071	23.86
	Downlink	P25 Phase 1	772.000	8.325	11.79
		P25 Phase 2	772.000	4.876	5.446
		TETRA	772.000	20.998	23.83
PS800	Uplink	P25 Phase 1	811.000	8.310	11.48
		P25 Phase 2	811.000	4.855	5.465
		TETRA	811.000	21.025	23.77
	Downlink	P25 Phase 1	856.000	8.148	10.52
		P25 Phase 2	856.000	4.860	5.452
		TETRA	856.000	21.068	23.79

Tabular data of Input Occupied Bandwidth

Test Band	Link	Tested signals	Measured Frequency (MHz)	99 % OBW (MHz)	26 dB OBW (MHz)
FirstNet	Uplink	LTE 5 MHz	793.00	4.5229	5.054
		LTE 10 MHz	793.00	9.0203	9.911
	Downlink	LTE 5 MHz	763.00	4.5178	5.029
		LTE 10 MHz	763.00	8.9889	9.972
Test Band	Link	Tested signals	Measured Frequency (MHz)	99 % OBW (kHz)	26 dB OBW (MHz)
PS700	Uplink	P25 Phase 1	802.000	8.270	11.09
		P25 Phase 2	802.000	4.871	5.450
		TETRA	802.000	20.932	23.86
	Downlink	P25 Phase 1	772.000	8.215	11.44
		P25 Phase 2	772.000	4.861	5.461
		TETRA	772.000	21.152	23.84
PS800	Uplink	P25 Phase 1	811.000	8.261	11.16
		P25 Phase 2	811.000	4.884	5.392
		TETRA	811.000	21.032	23.76
	Downlink	P25 Phase 1	856.000	8.355	11.68
		P25 Phase 2	856.000	4.856	5.445
		TETRA	856.000	21.091	23.82

Tabular data of 3 dB above the AGC threshold Output Occupied Bandwidth

Test Band	Link	Tested signals	Measured Frequency (MHz)	99 % OBW (MHz)	26 dB OBW (MHz)
FirstNet	Uplink	LTE 5 MHz	793.00	4.5029	4.960
		LTE 10 MHz	793.00	8.9479	9.541
	Downlink	LTE 5 MHz	763.00	4.5304	5.037
		LTE 10 MHz	763.00	8.9648	9.544
Test Band	Link	Tested signals	Measured Frequency (MHz)	99 % OBW (kHz)	26 dB OBW (MHz)
PS700	Uplink	P25 Phase 1	802.000	8.177	10.90
		P25 Phase 2	802.000	4.877	5.431
		TETRA	802.000	20.947	23.83
	Downlink	P25 Phase 1	772.000	8.247	10.75
		P25 Phase 2	772.000	4.865	5.455
		TETRA	772.000	21.205	23.79
PS800	Uplink	P25 Phase 1	811.000	8.333	11.83
		P25 Phase 2	811.000	4.846	5.465
		TETRA	811.000	21.076	23.89
	Downlink	P25 Phase 1	856.000	8.344	10.75
		P25 Phase 2	856.000	4.877	5.438
		TETRA	856.000	21.010	23.78

Measured Occupied Bandwidth Comparison

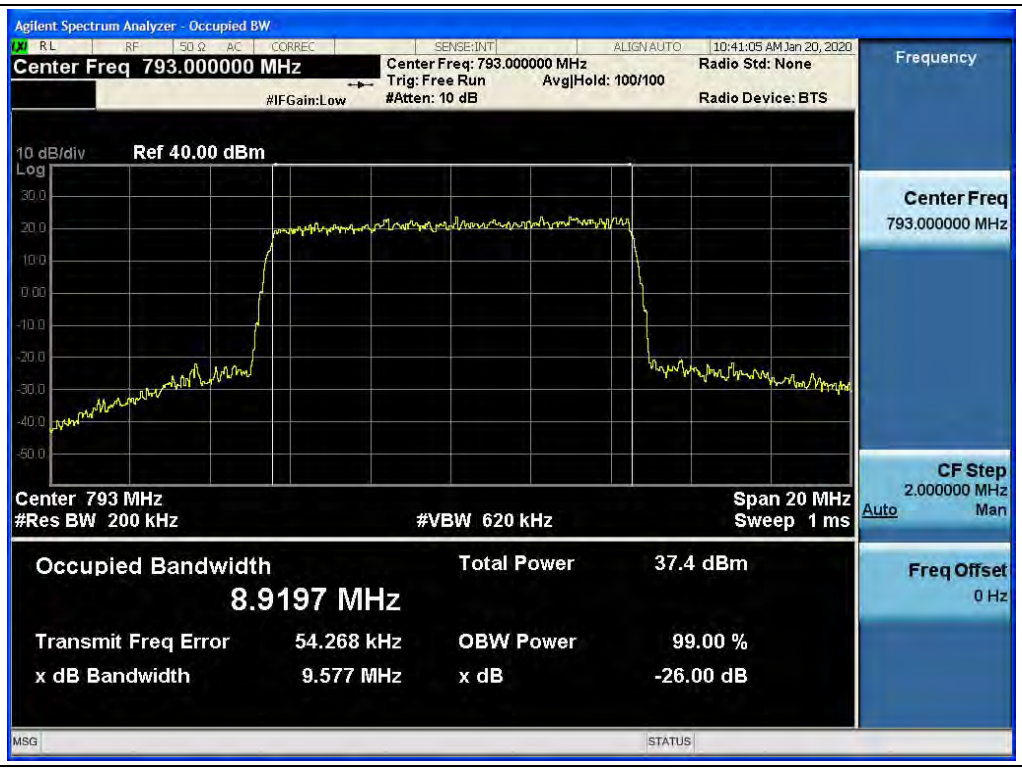
Test Band	Link	Tested signals	Variant of Input and output Occupied Bandwidth (%)	Variant of Input and 3 dB above the AGC threshold output Occupied Bandwidth (%)
FirstNet	Uplink	LTE 5 MHz	-1.345	-1.860
		LTE 10 MHz	-3.370	-3.733
	Downlink	LTE 5 MHz	0.477	0.159
		LTE 10 MHz	-4.914	-4.292
PS700	Uplink	P25 Phase 1	-0.345	-1.127
		P25 Phase 2	-0.848	0.118
		TETRA	0.664	0.072
	Downlink	P25 Phase 1	1.341	0.397
		P25 Phase 2	0.318	0.077
		TETRA	-0.728	0.251
PS800	Uplink	P25 Phase 1	0.597	0.868
		P25 Phase 2	-0.584	-0.768
		TETRA	-0.033	0.209
	Downlink	P25 Phase 1	-2.471	-0.126
		P25 Phase 2	0.071	0.438
		TETRA	-0.109	-0.384

** Change in input-output OBW is less than ±5 %.*

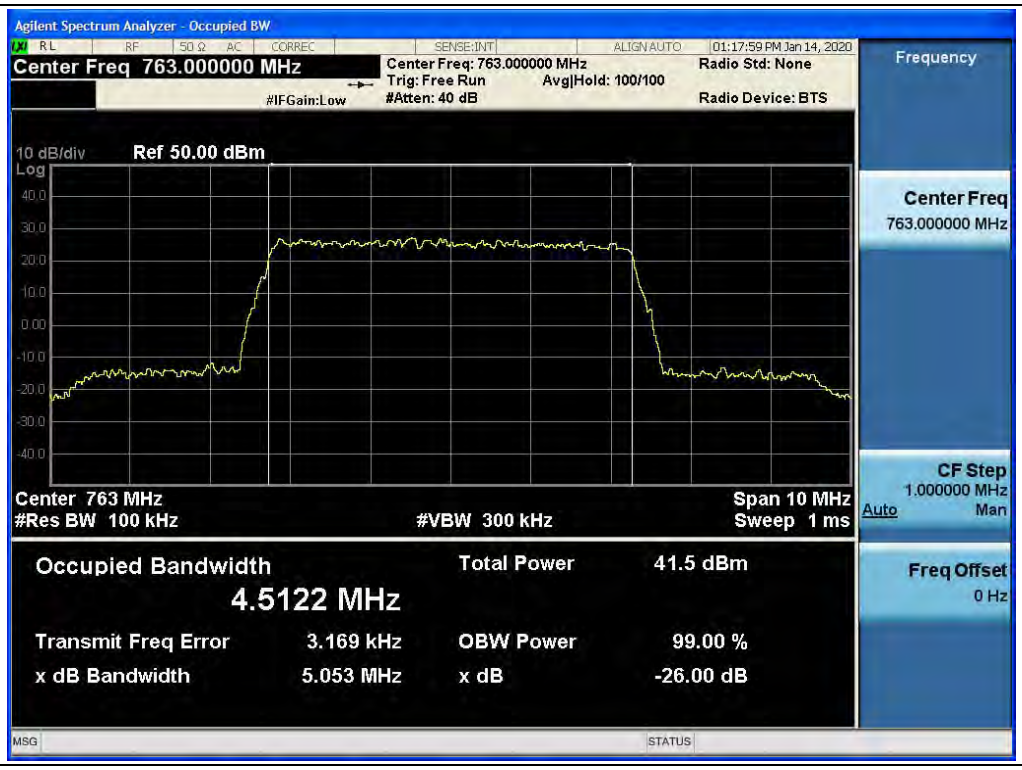
Plot data of Occupied Bandwidth

Output / FirstNet / LTE 5 MHz / Uplink

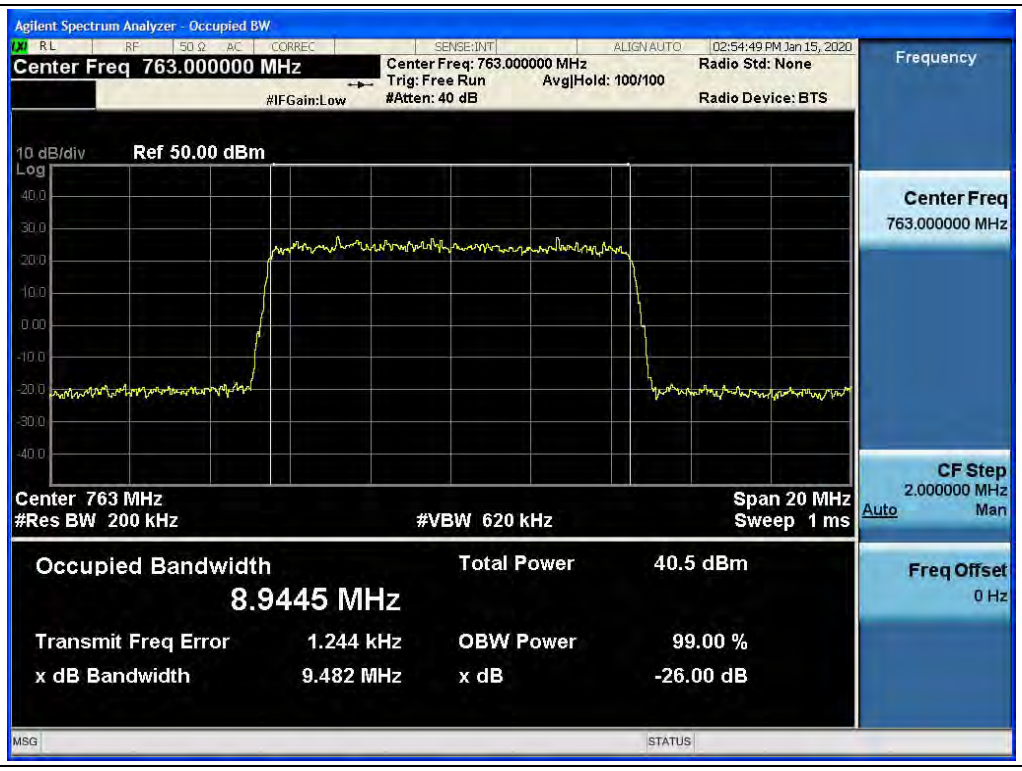
Output / FirstNet / LTE 10 MHz / Uplink



Output / FirstNet / LTE 5 MHz / Downlink

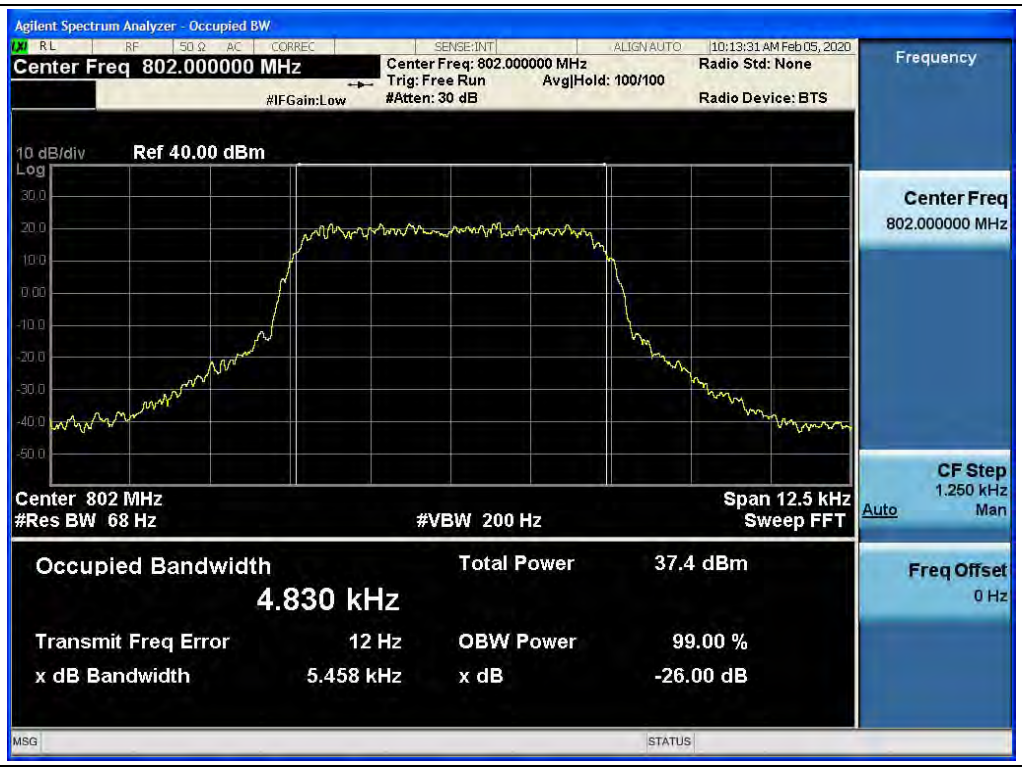


Output / FirstNet / LTE 10 MHz / Downlink

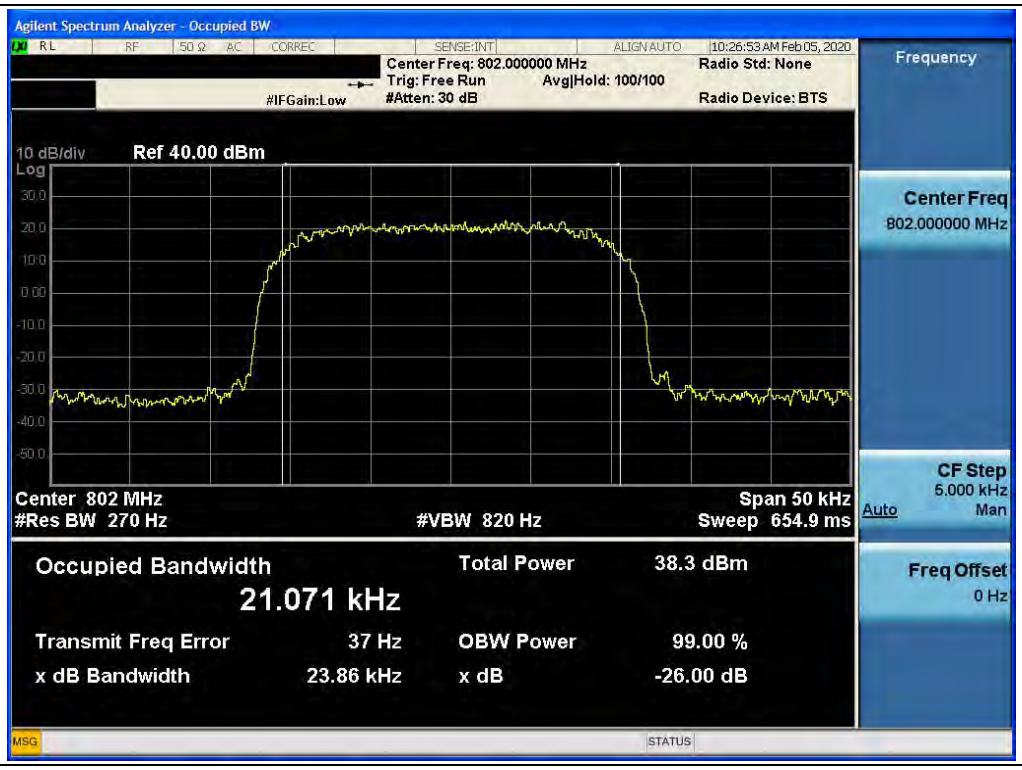


Output / PS700 / P25 Phase 1 / Uplink

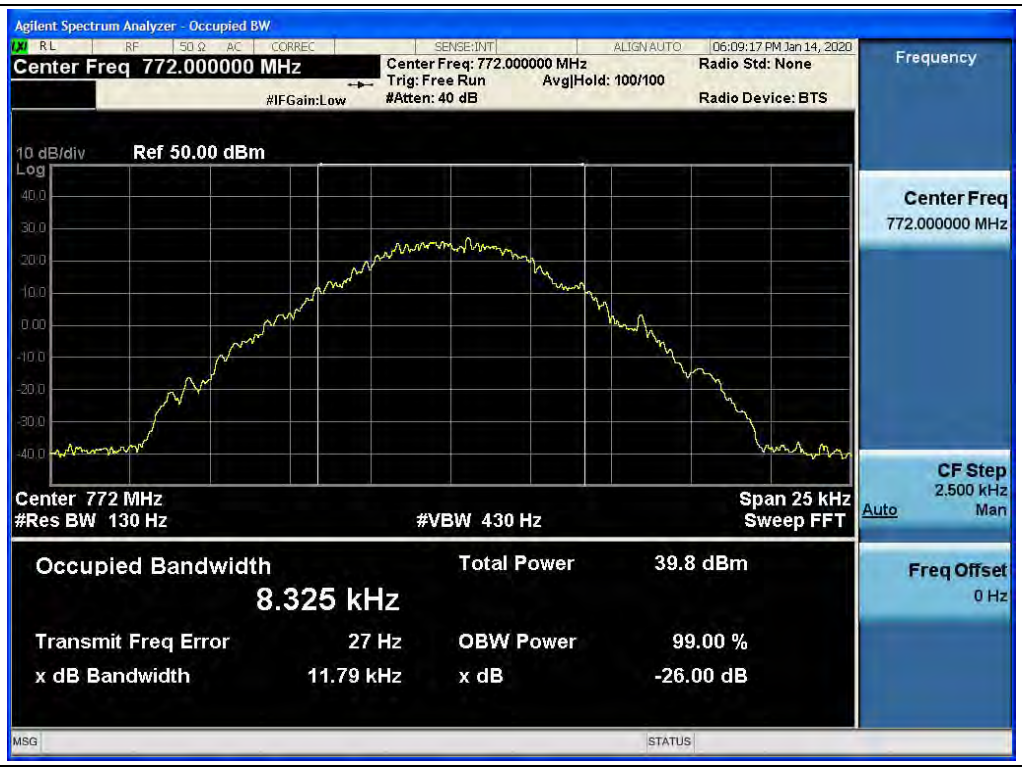
Output / PS700 / P25 Phase 2 / Uplink



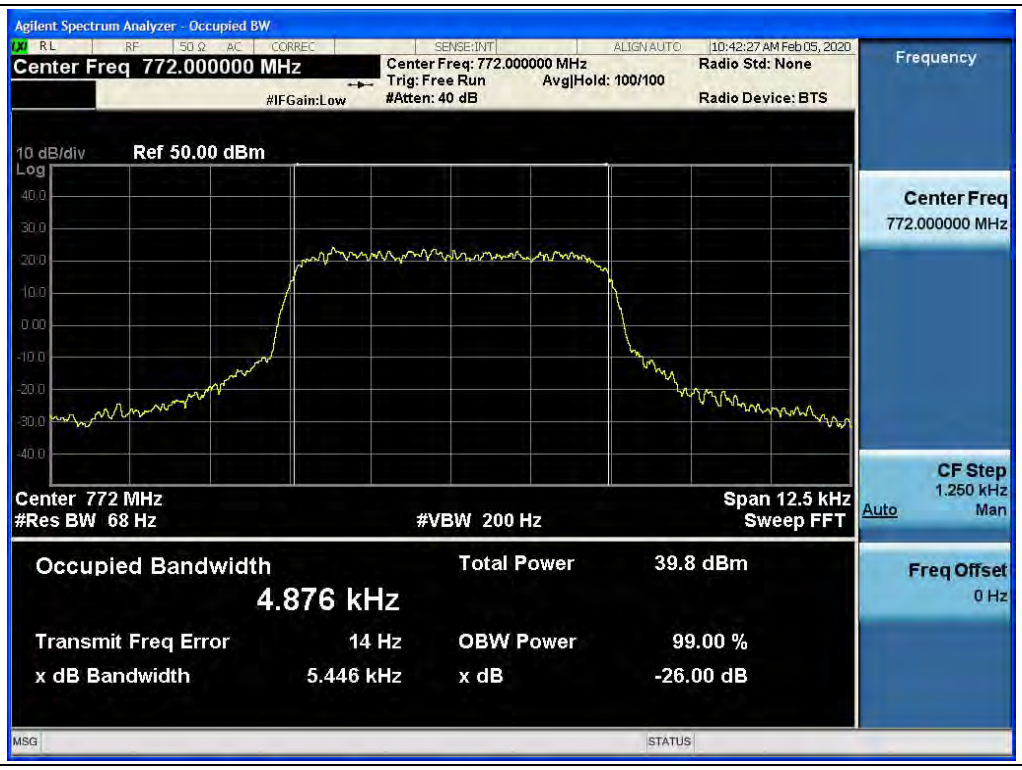
Output / PS700 / TETRA / Uplink



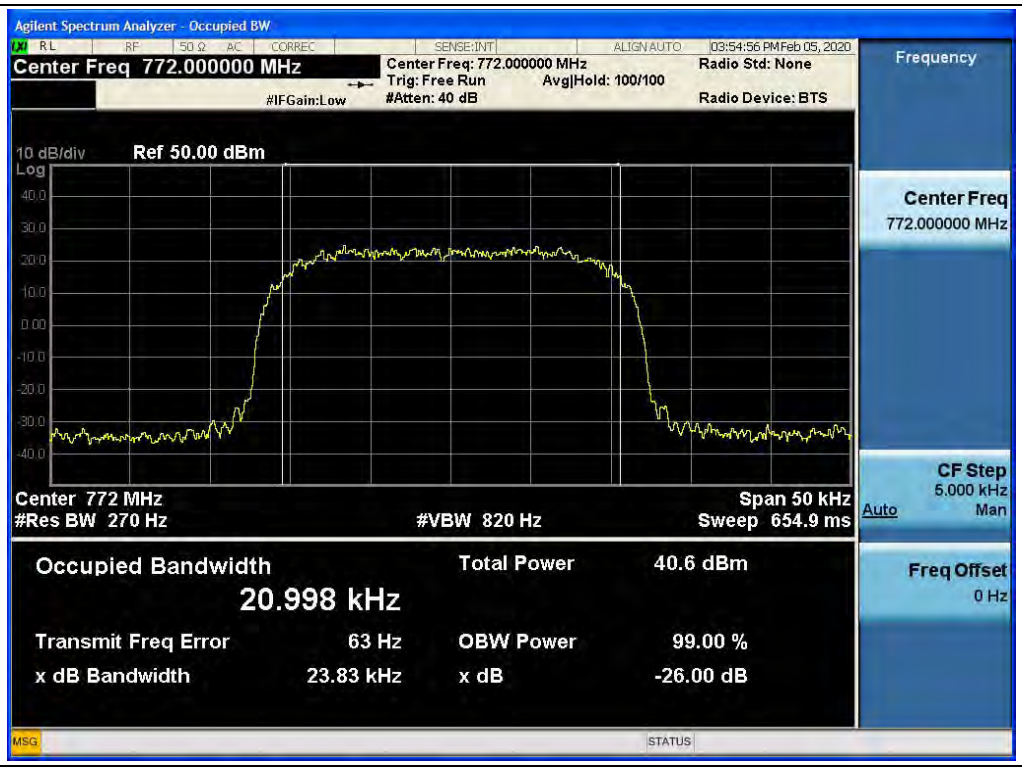
Output / PS700 / P25 Phase 1 / Downlink



Output / PS700 / P25 Phase 2 / Downlink

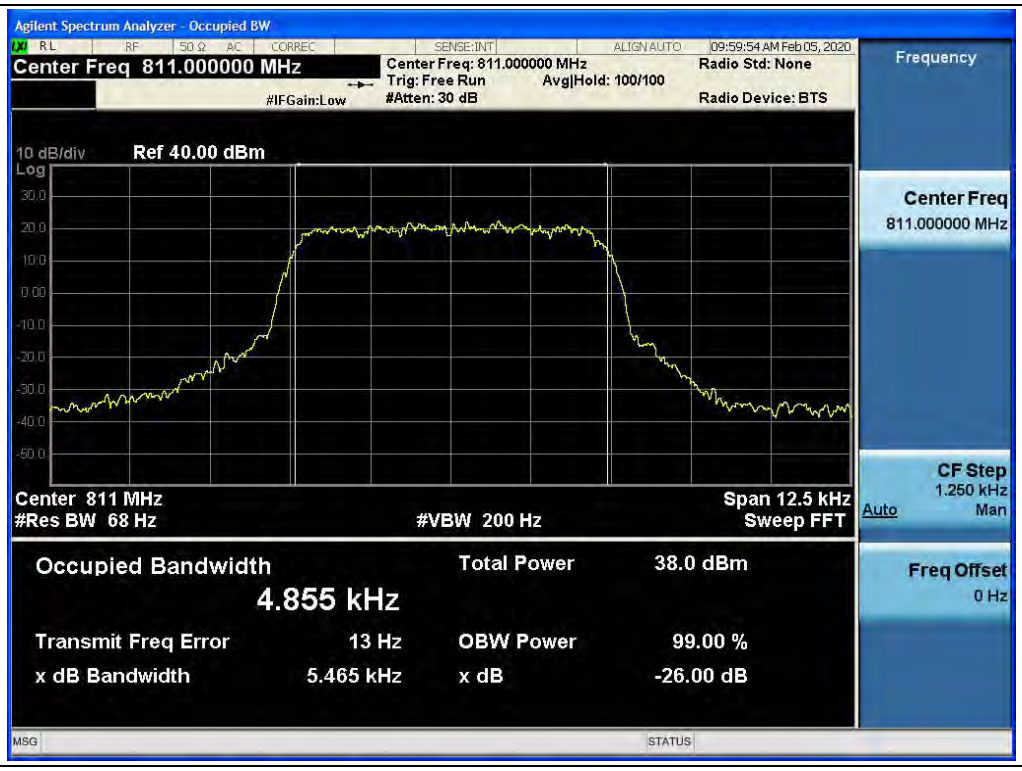


Output / PS700 / TETRA / Downlink

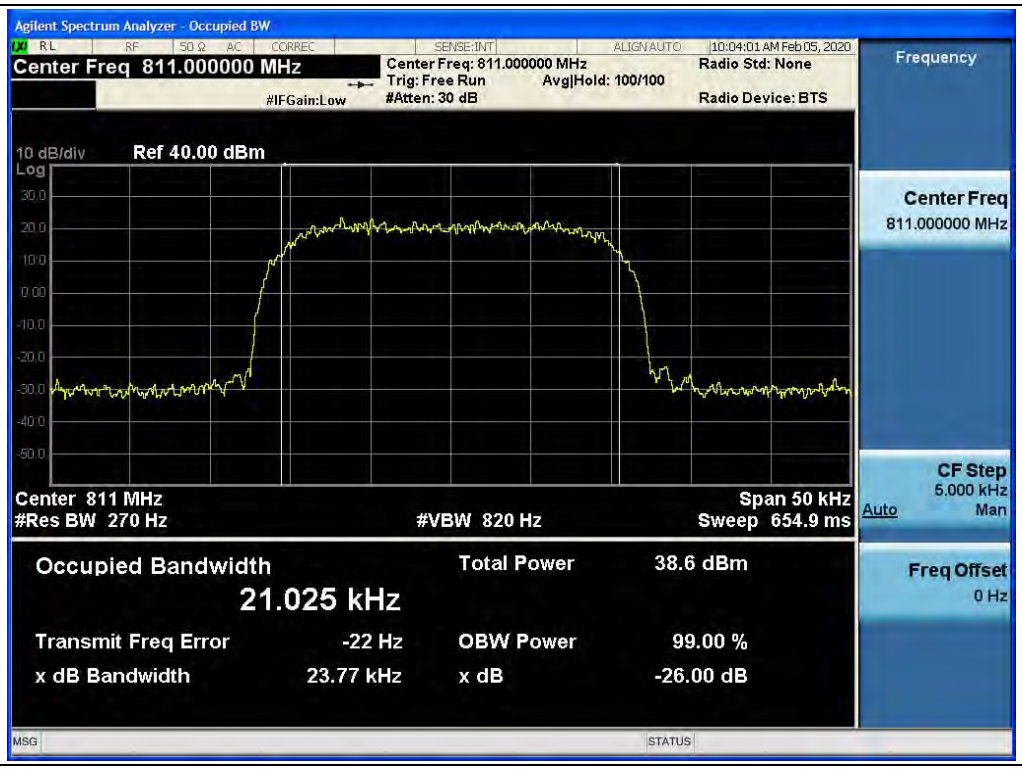


Output / PS800 / P25 Phase 1 / Uplink

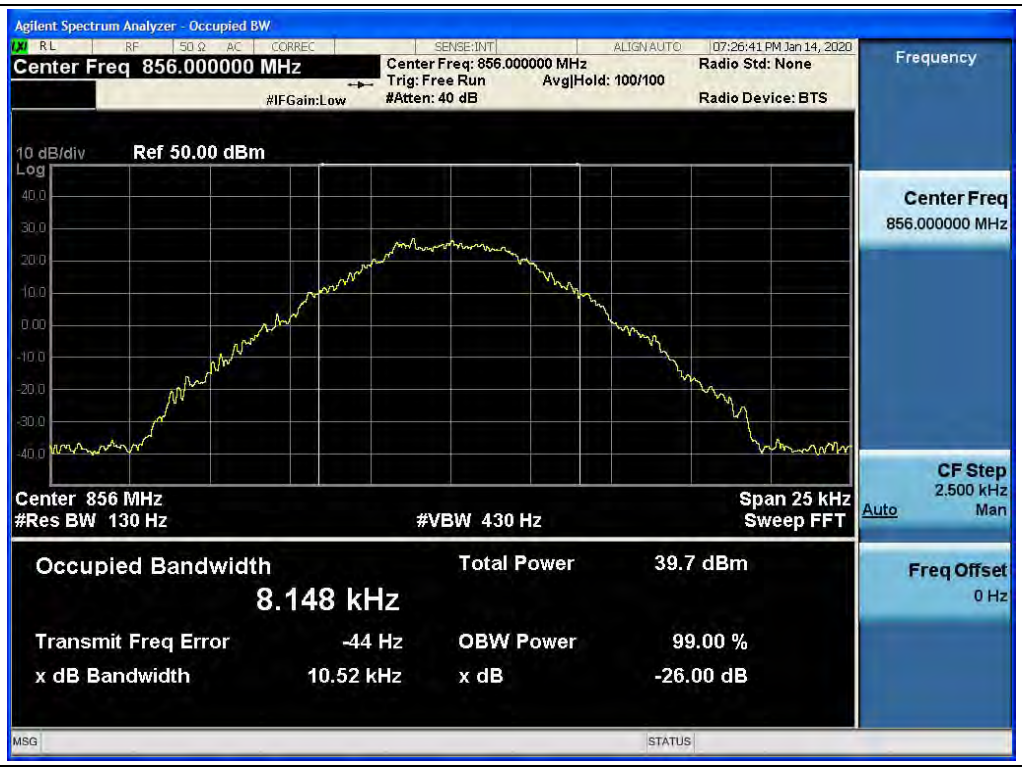
Output / PS800 / P25 Phase 2 / Uplink



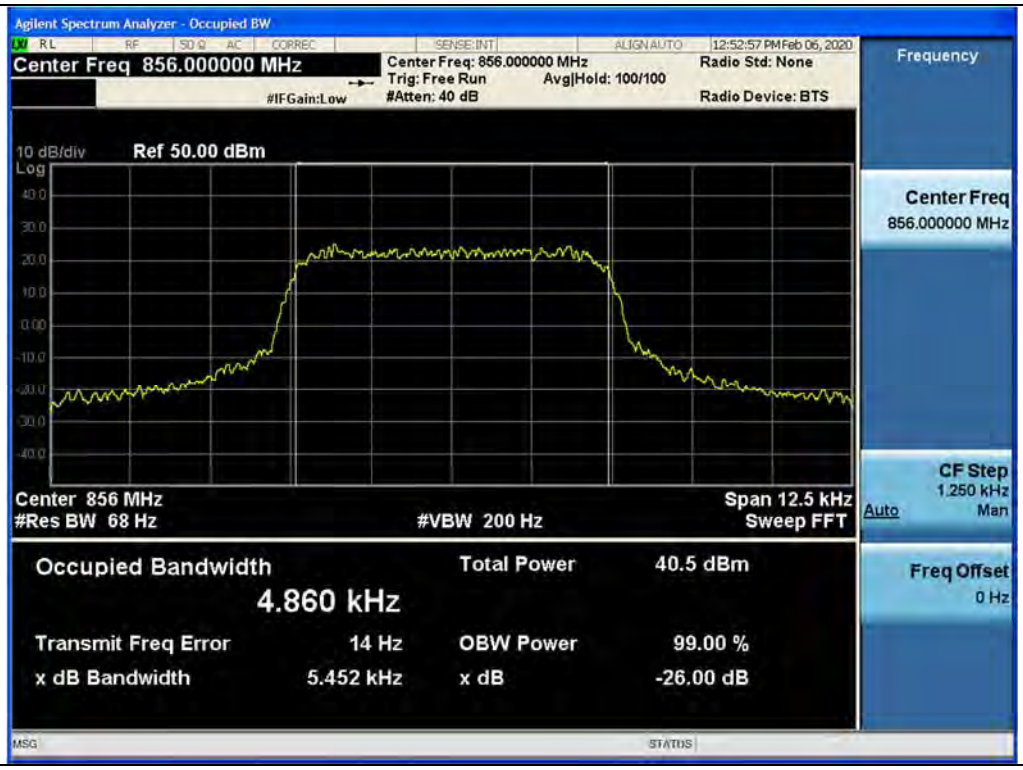
Output / PS800 / TETRA / Uplink



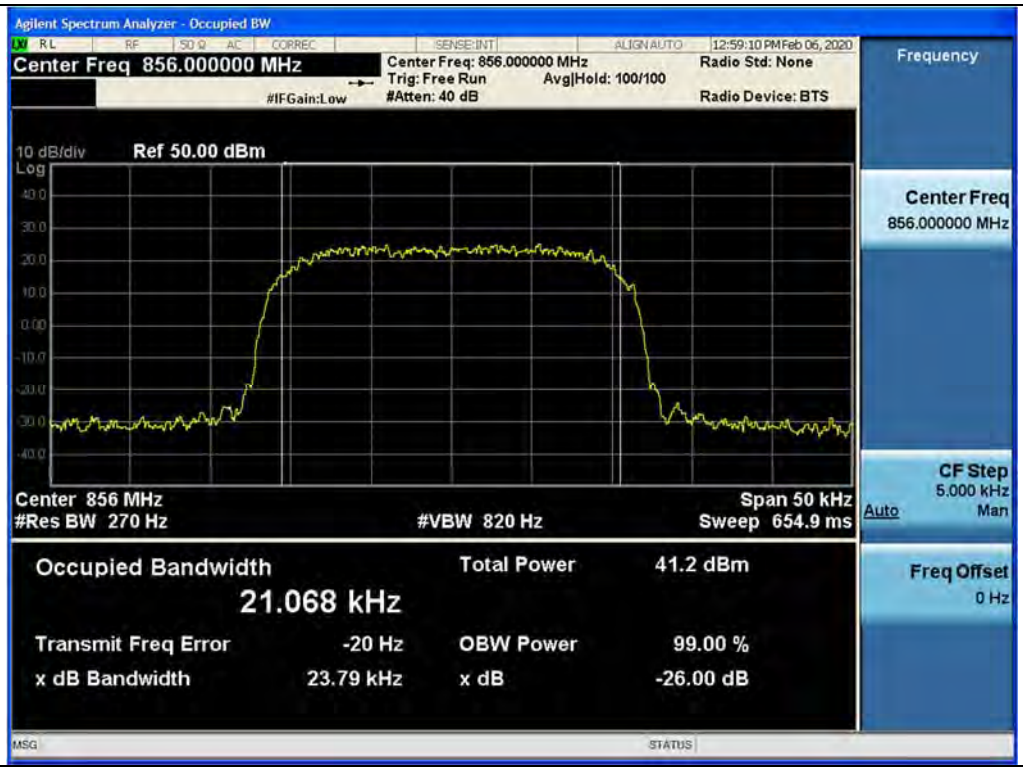
Output / PS800 / P25 Phase 1 / Downlink



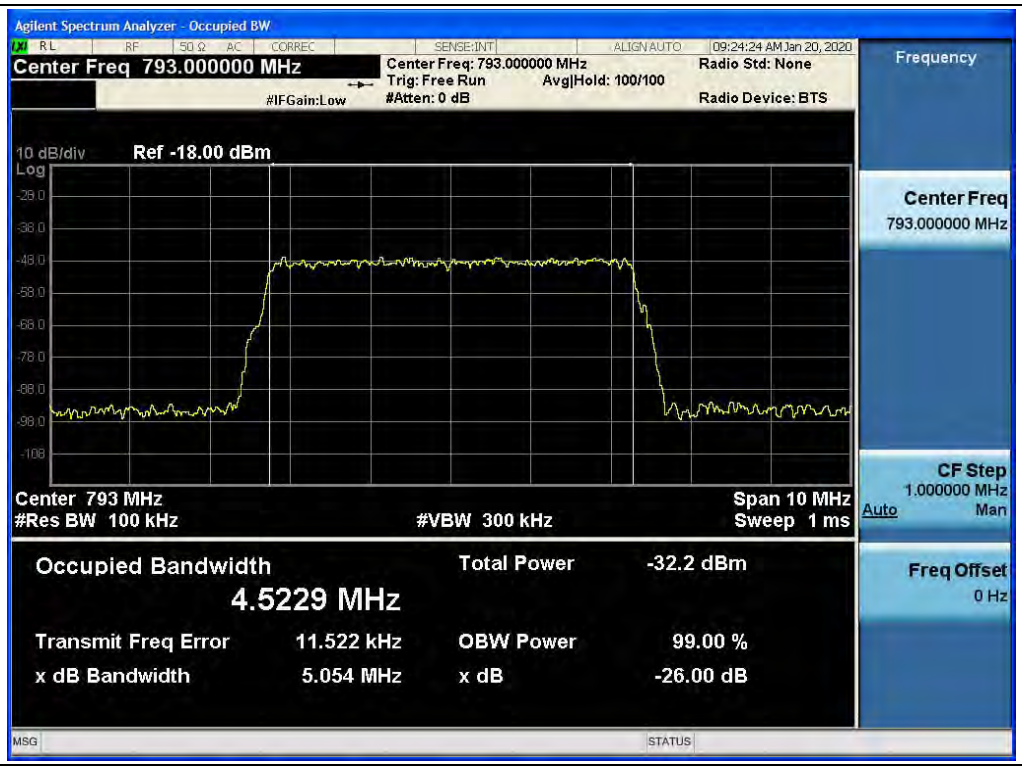
Output / PS800 / P25 Phase 2 / Downlink



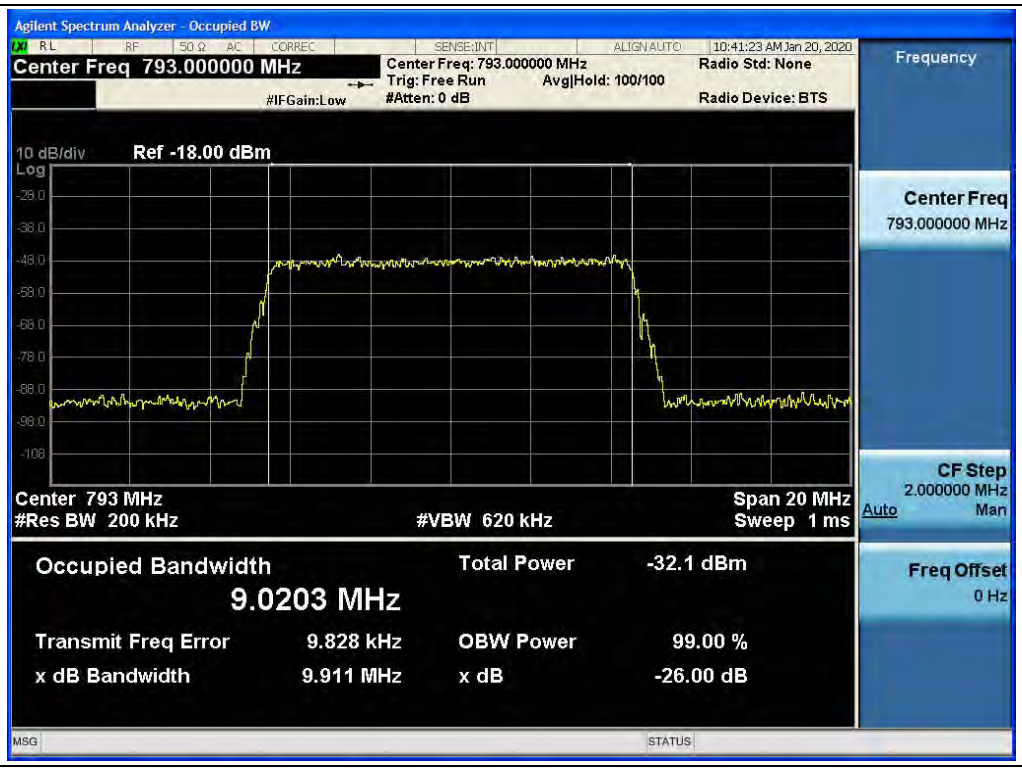
Output / PS800 / TETRA / Downlink



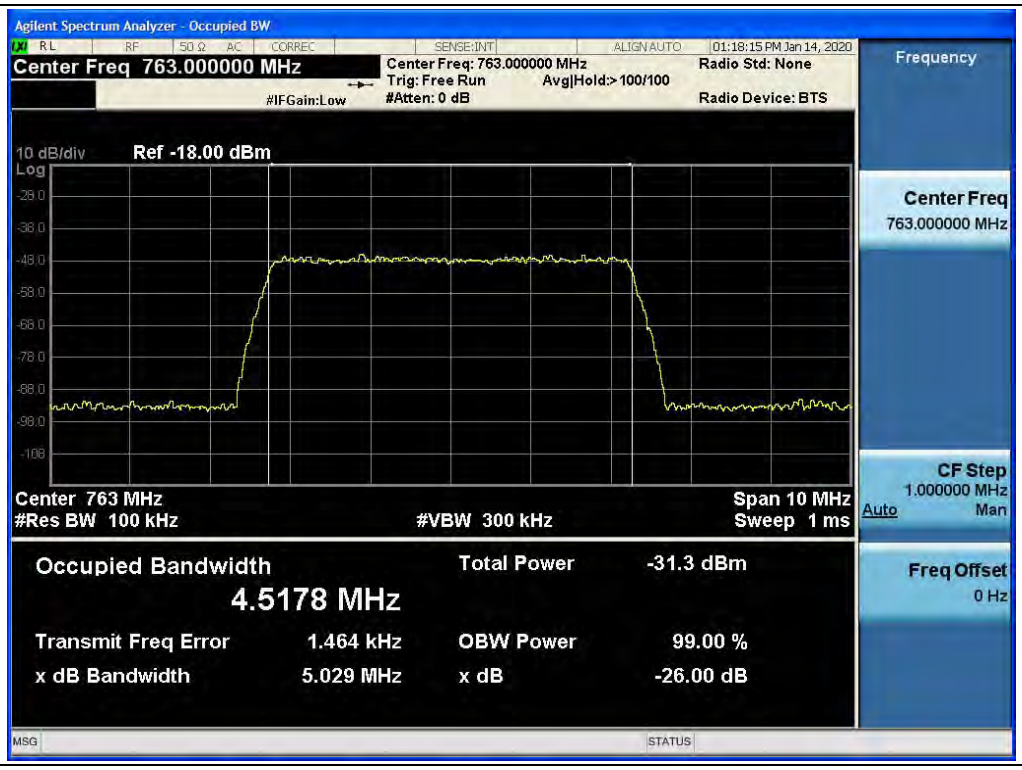
Input / FirstNet / LTE 5 MHz / Uplink



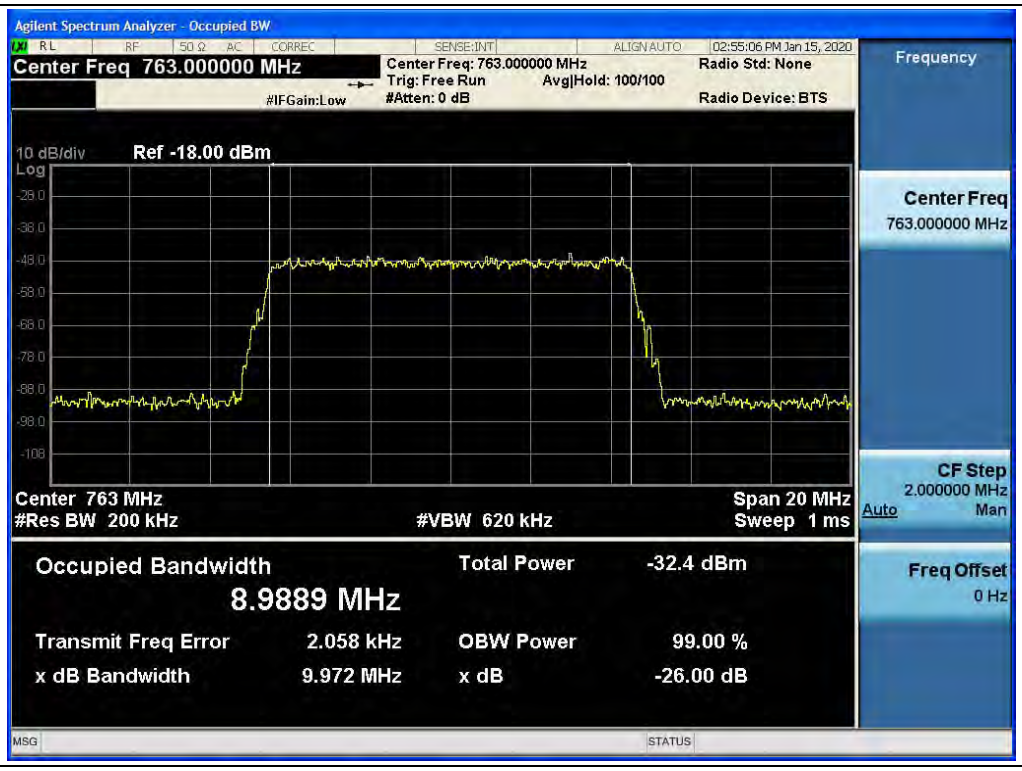
Input / FirstNet / LTE 10 MHz / Uplink



Input / FirstNet / LTE 5 MHz / Downlink

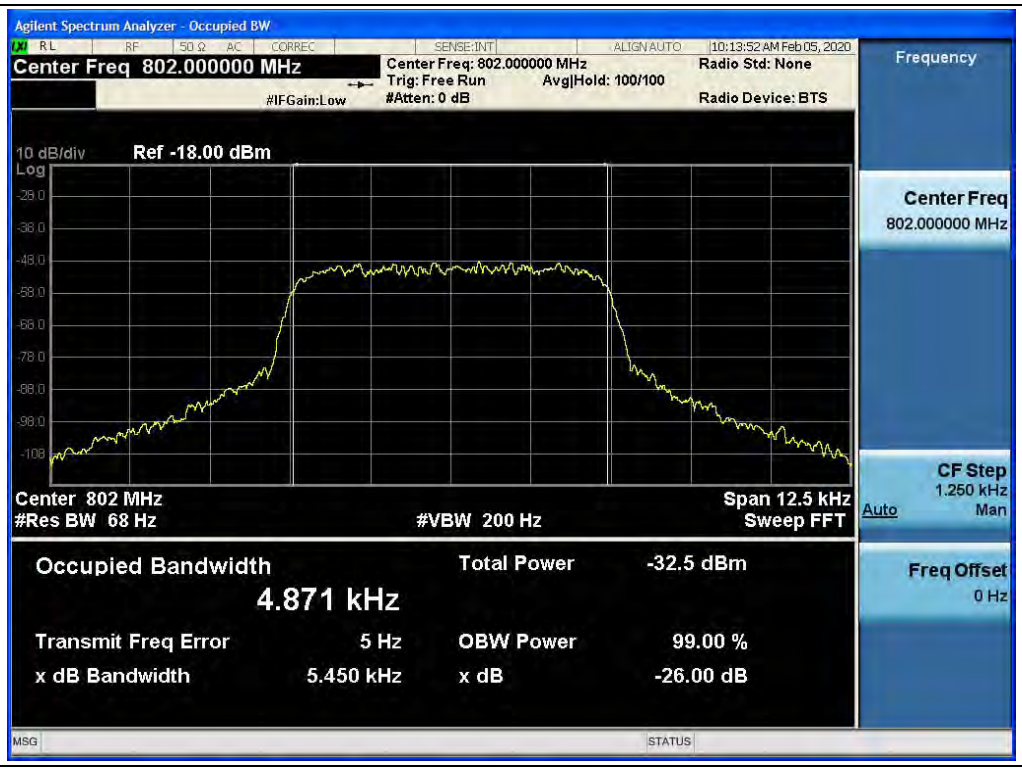


Input / FirstNet / LTE 10 MHz / Downlink

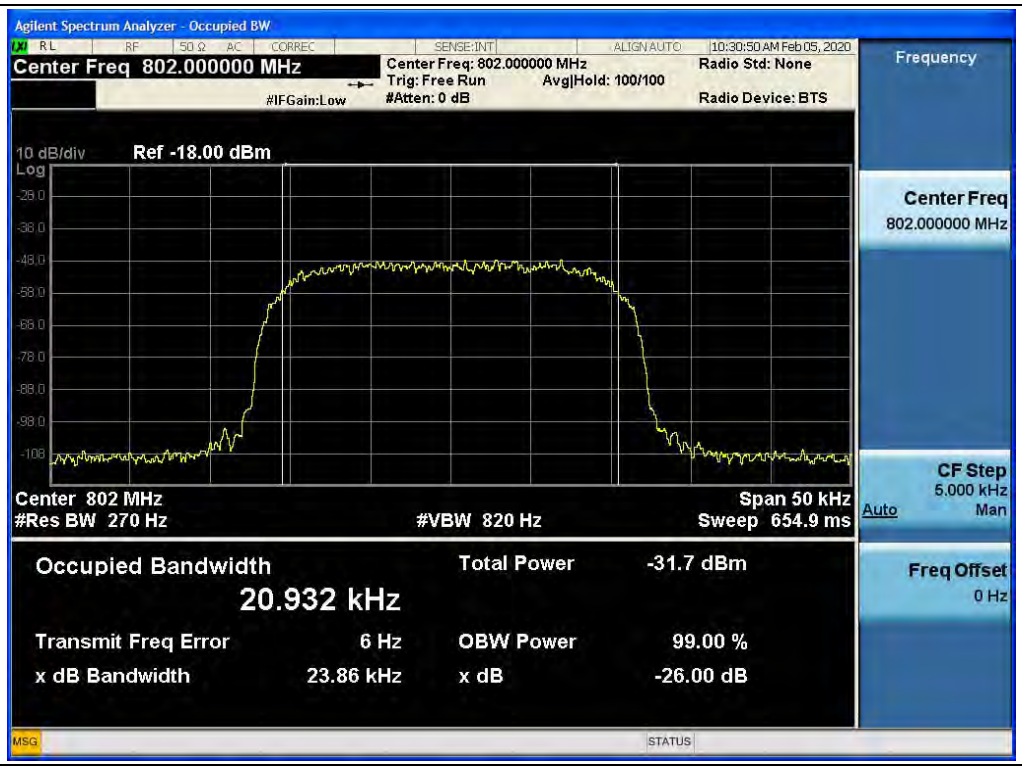


Input / PS700 / P25 Phase 1 / Uplink

Input / PS700 / P25 Phase 2 / Uplink

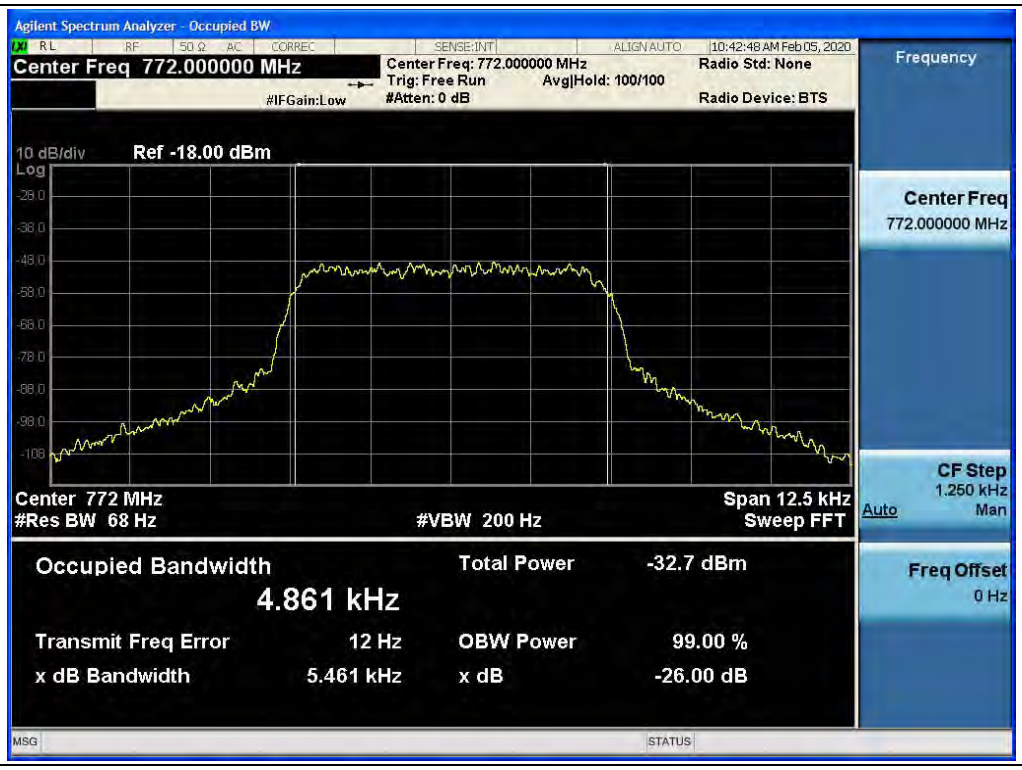


Input / PS700 / TETRA / Uplink

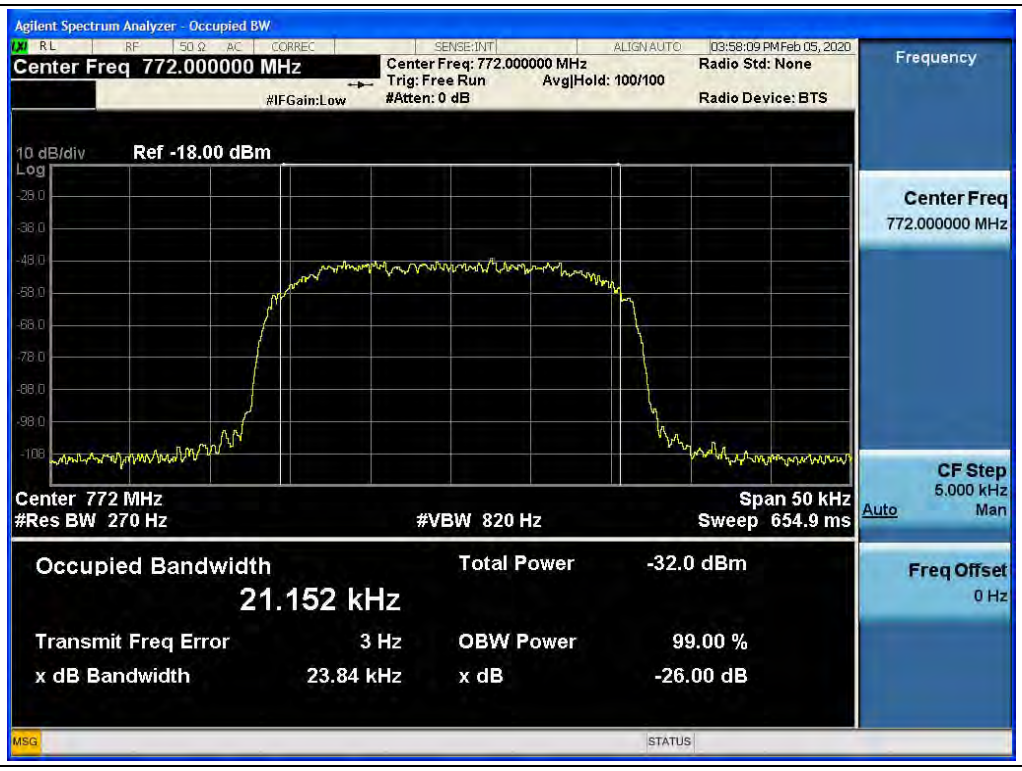


Input / PS700 / P25 Phase 1 / Downlink

Input / PS700 / P25 Phase 2 / Downlink

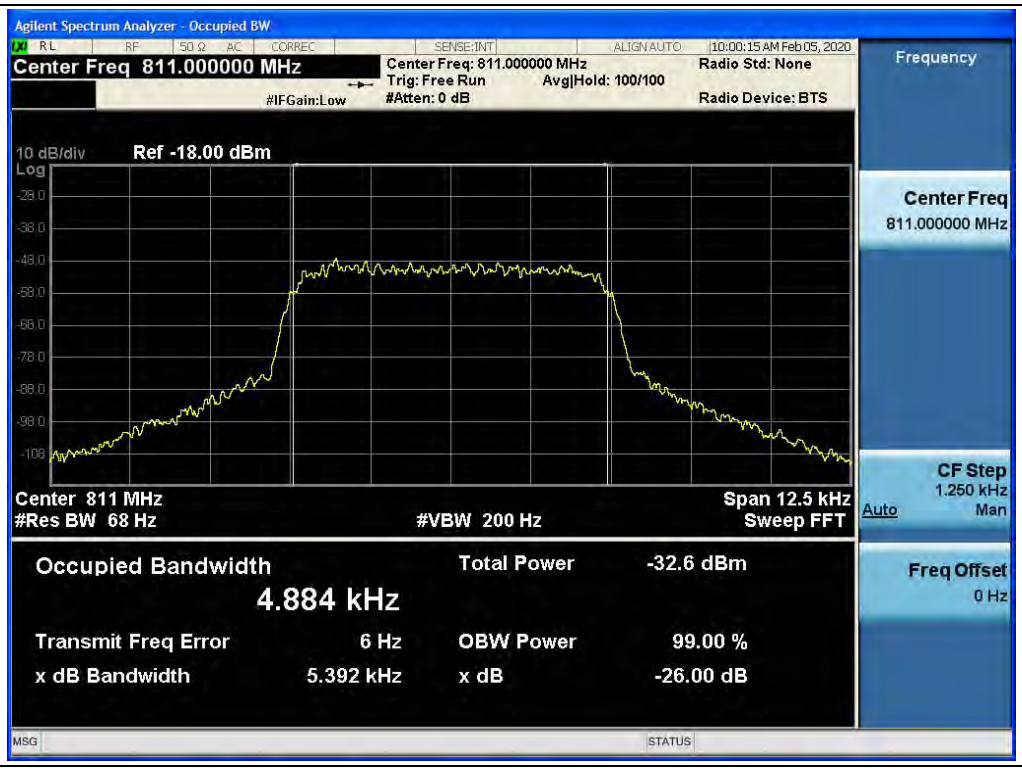


Input / PS700 / TETRA / Downlink

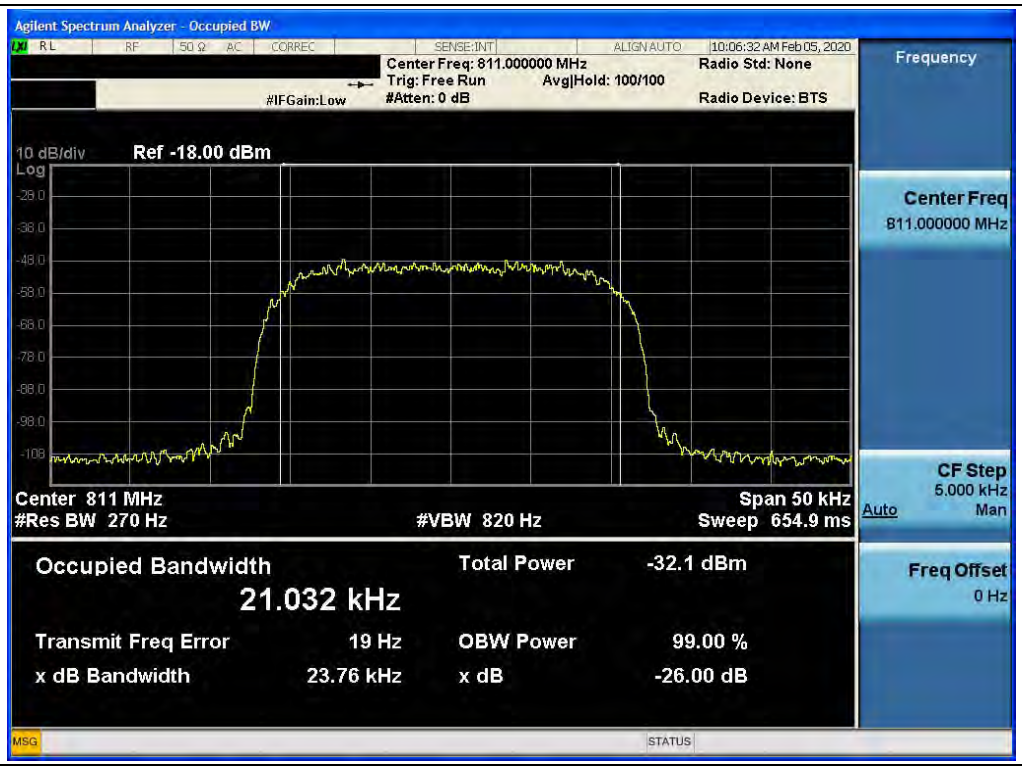


Input / PS800 / P25 Phase 1 / Uplink

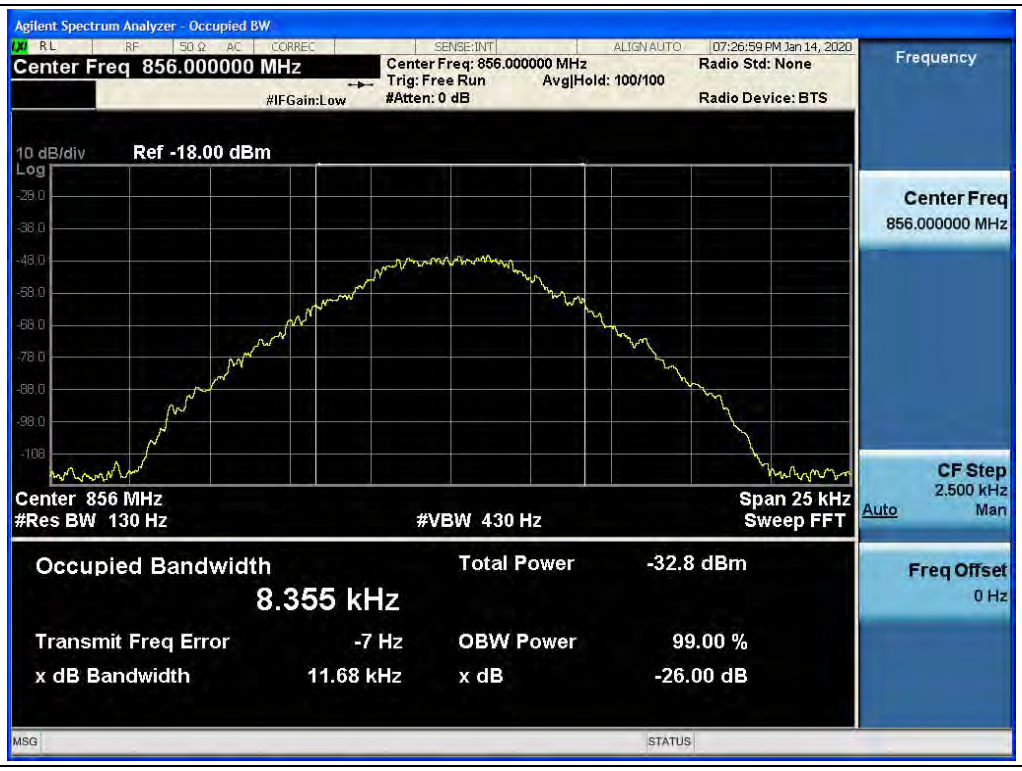
Input / PS800 / P25 Phase 2 / Uplink



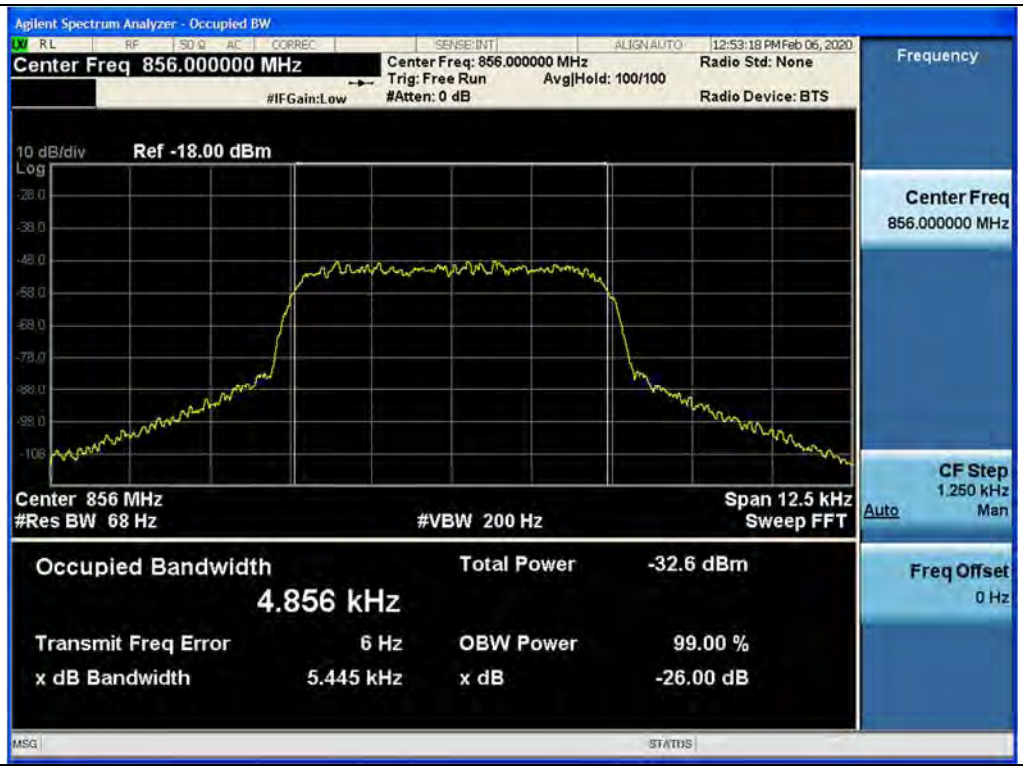
Input / PS800 / TETRA / Uplink



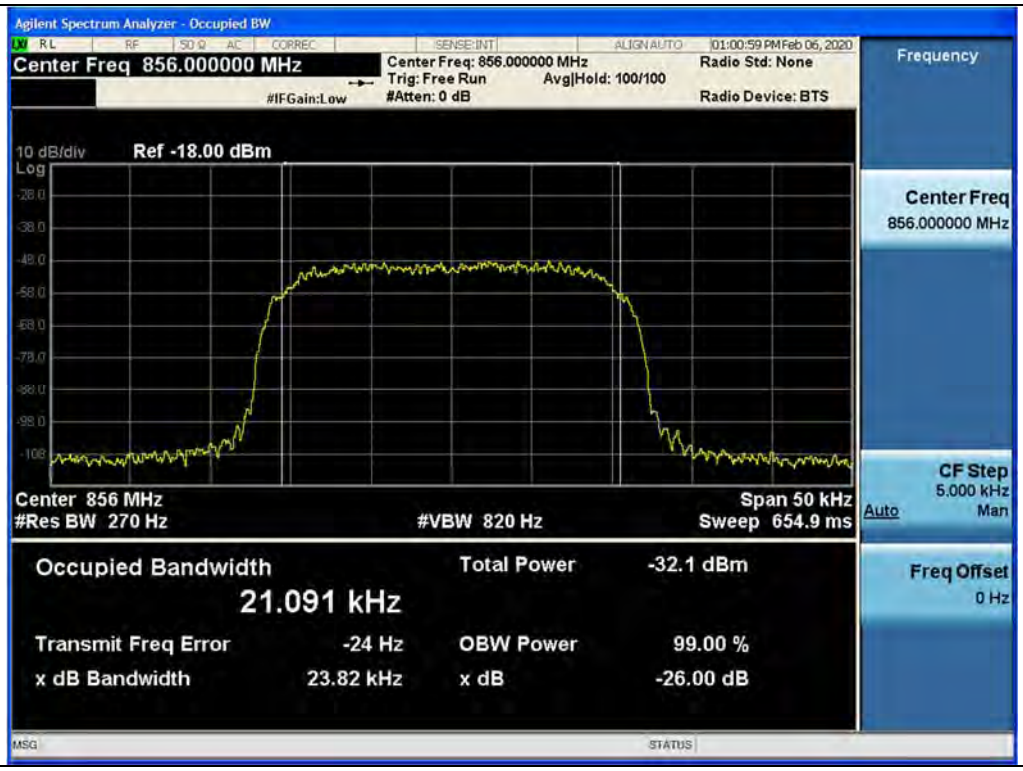
Input / PS800 / P25 Phase 1 / Downlink



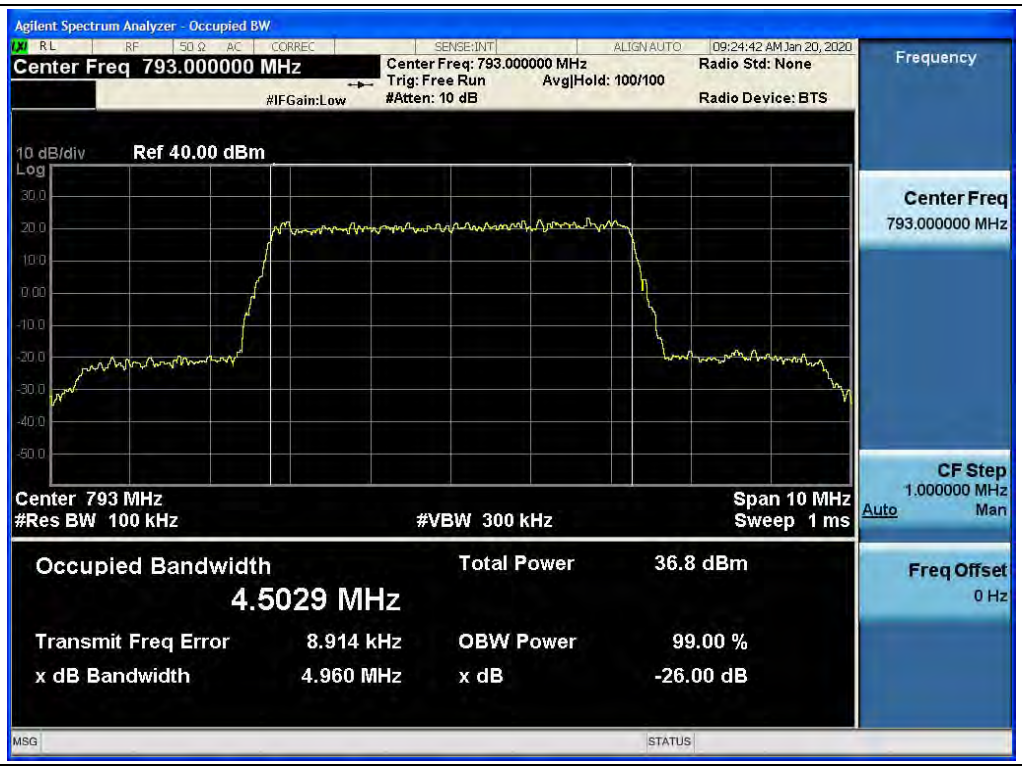
Input / PS800 / P25 Phase 2 / Downlink



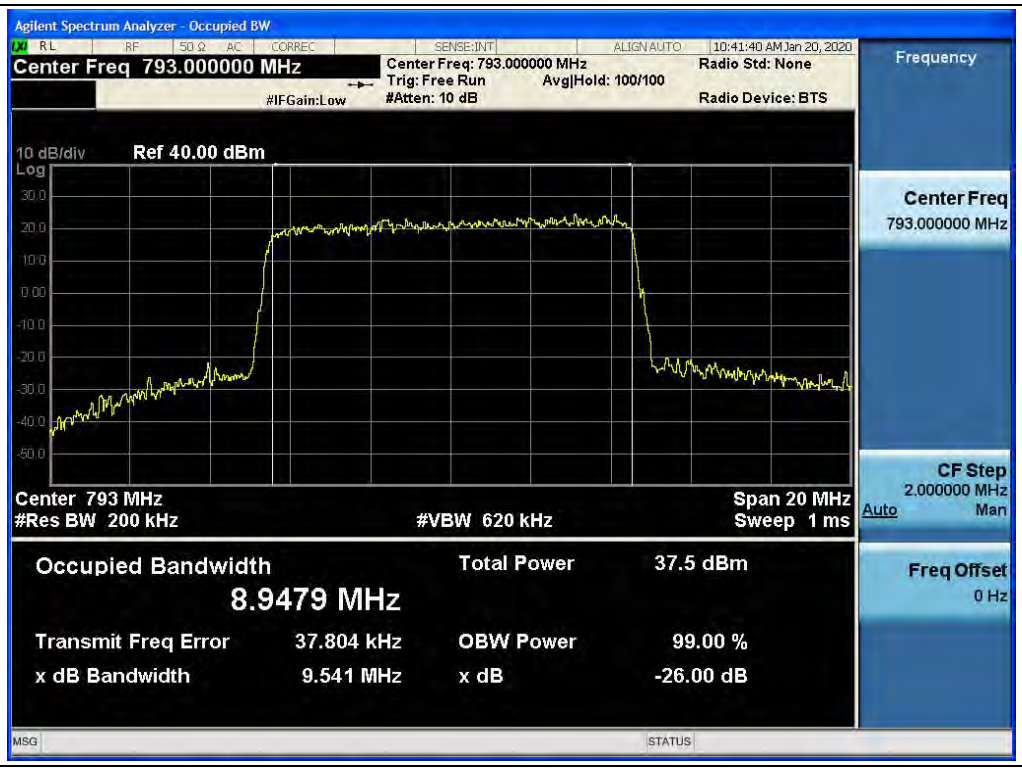
Input / PS800 / TETRA / Downlink



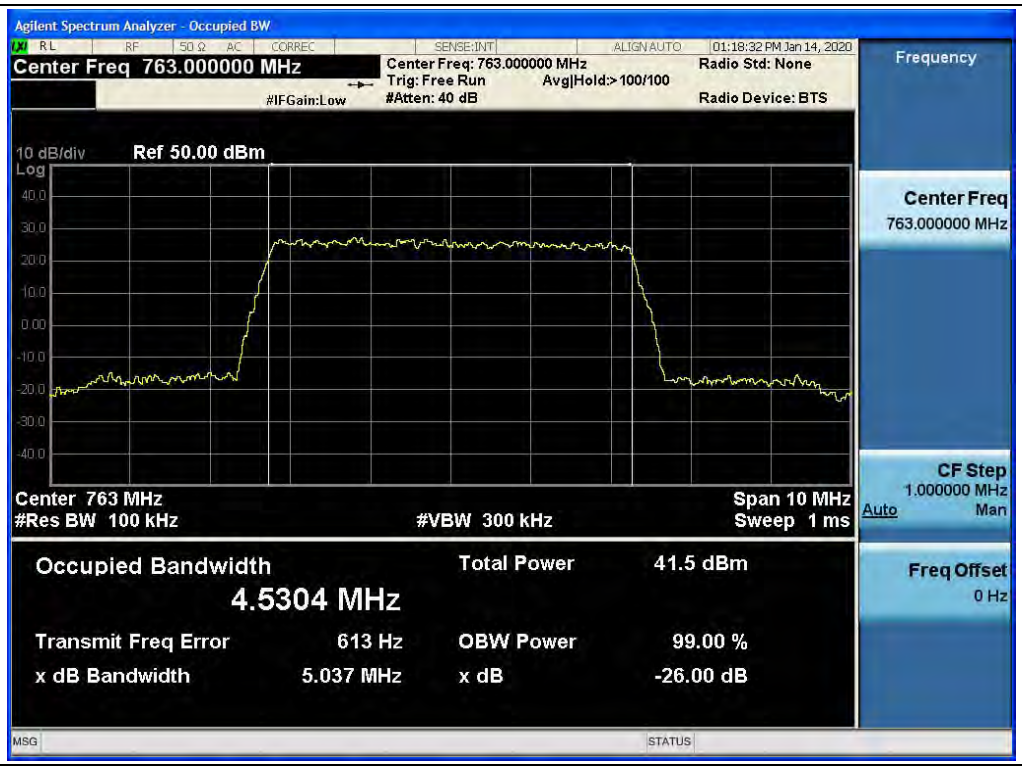
3 dB above the AGC threshold output / FirstNet / LTE 5 MHz / Uplink



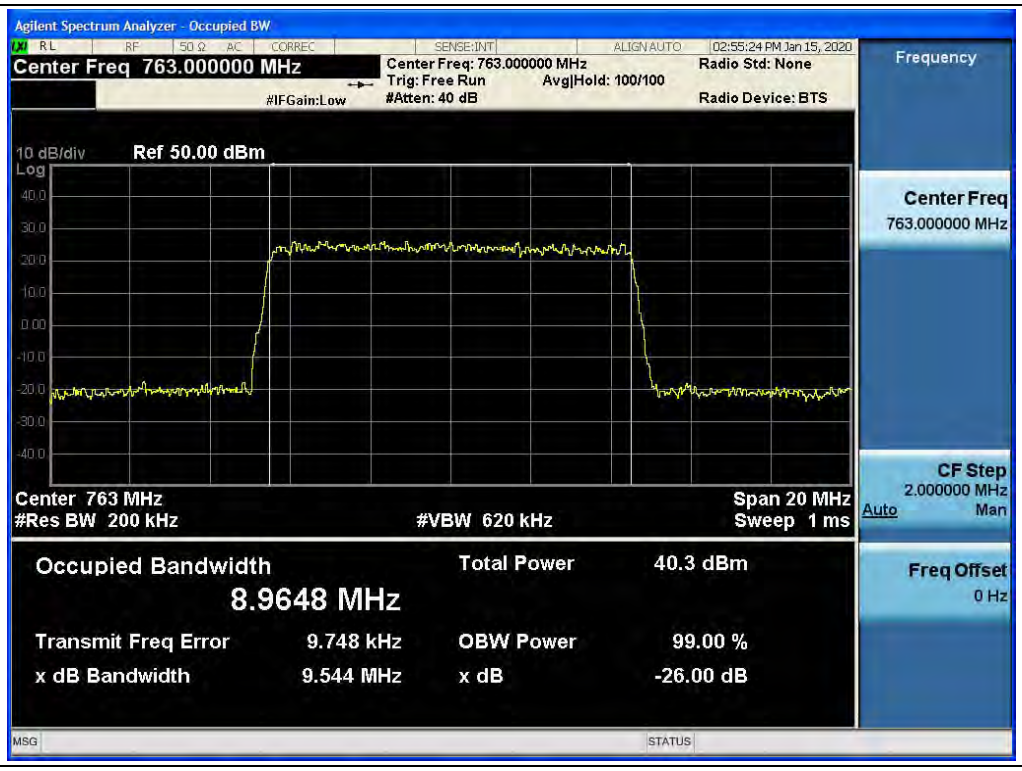
3 dB above the AGC threshold output / FirstNet / LTE 10 MHz / Uplink



3 dB above the AGC threshold output / FirstNet / LTE 5 MHz / Downlink

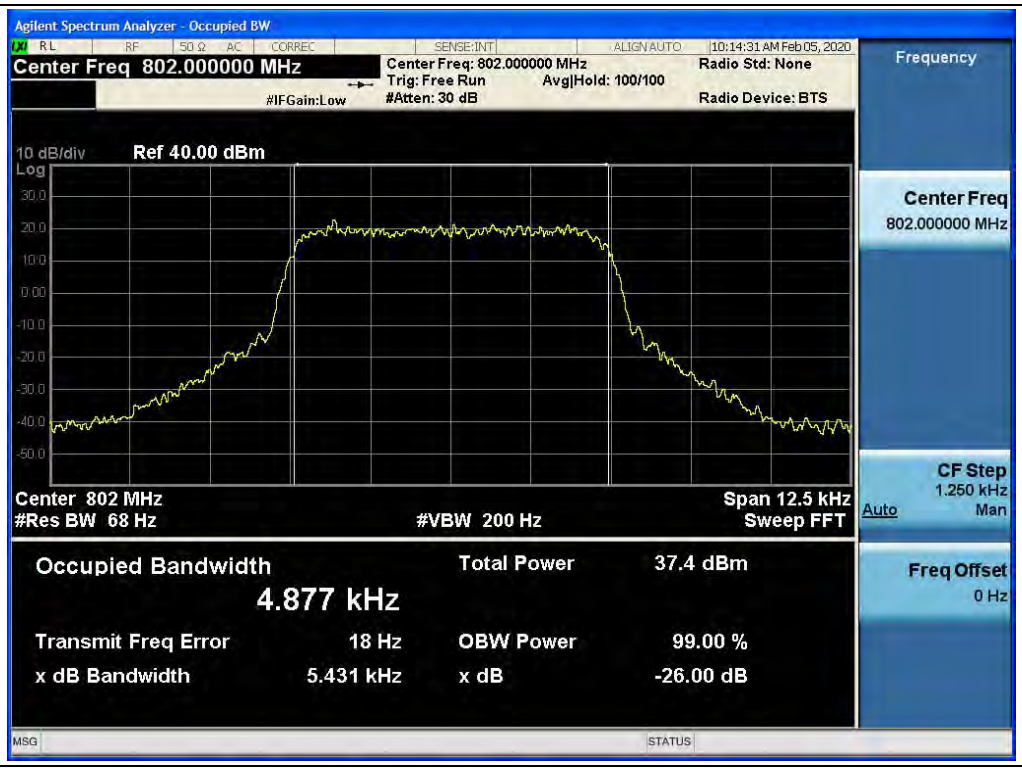


3 dB above the AGC threshold output / FirstNet / LTE 10 MHz / Downlink

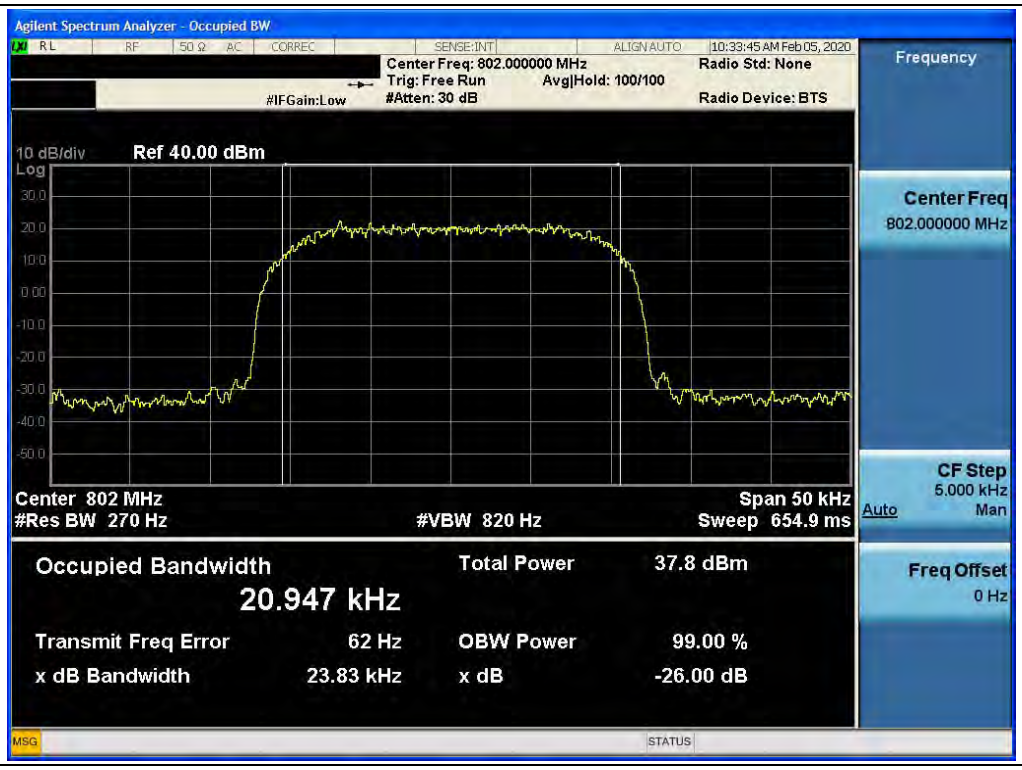


3 dB above the AGC threshold output / PS700 / P25 Phase 1 / Uplink

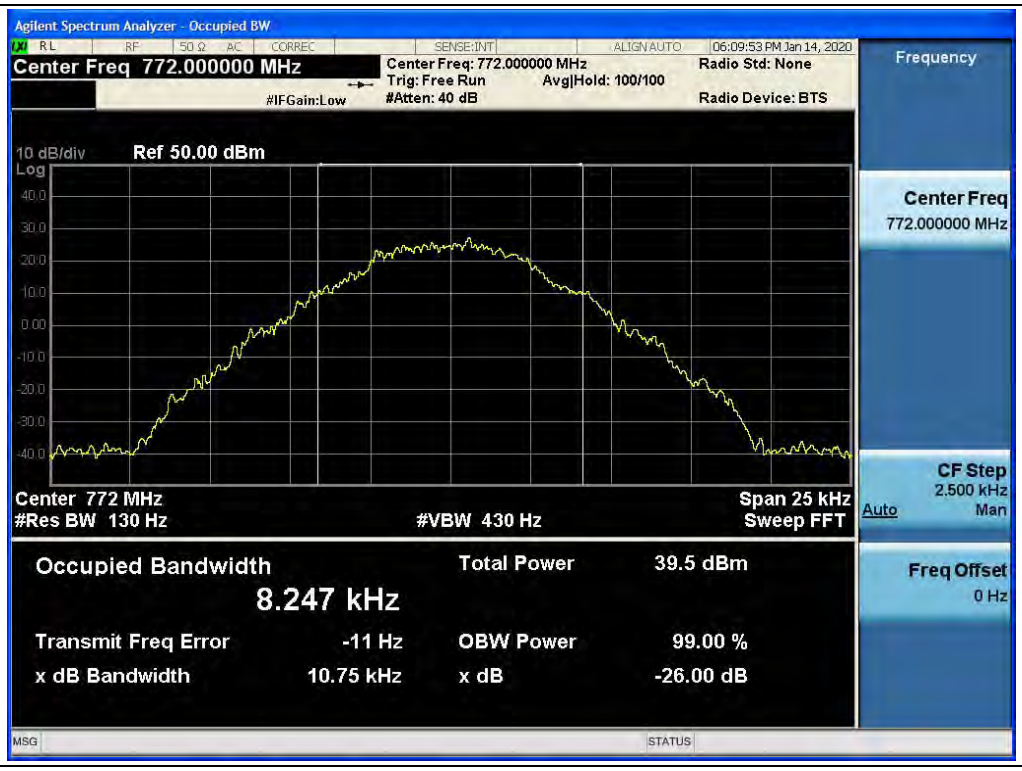
3 dB above the AGC threshold output / PS700 / P25 Phase 2 / Uplink



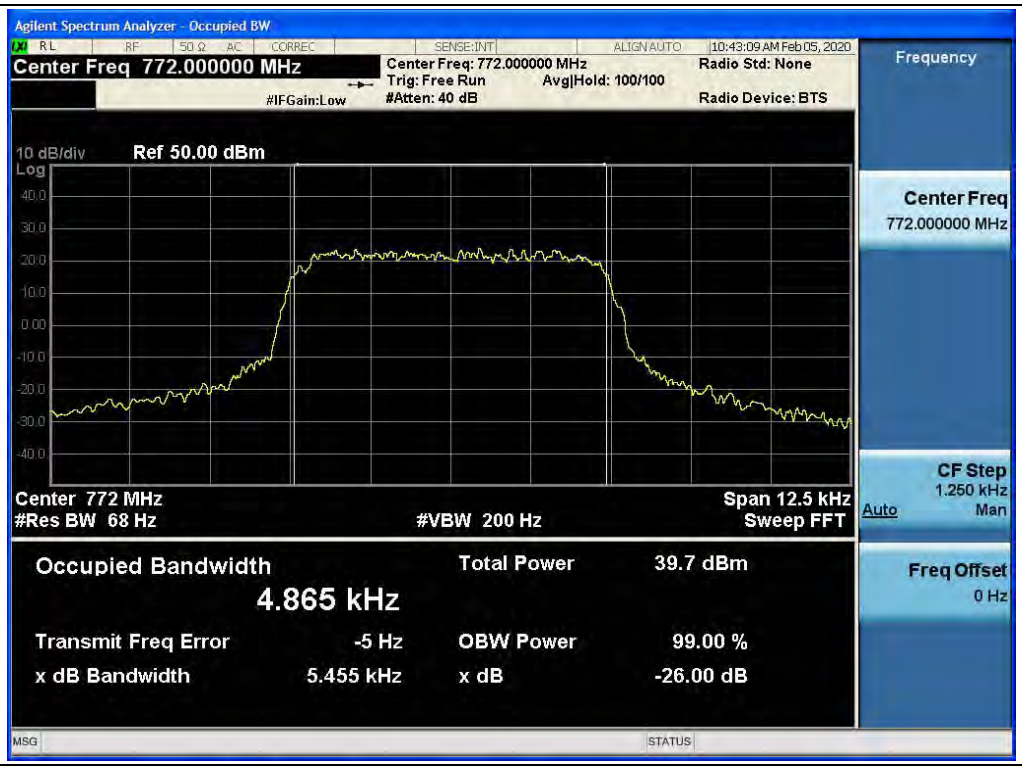
3 dB above the AGC threshold output / PS700 / TETRA / Uplink



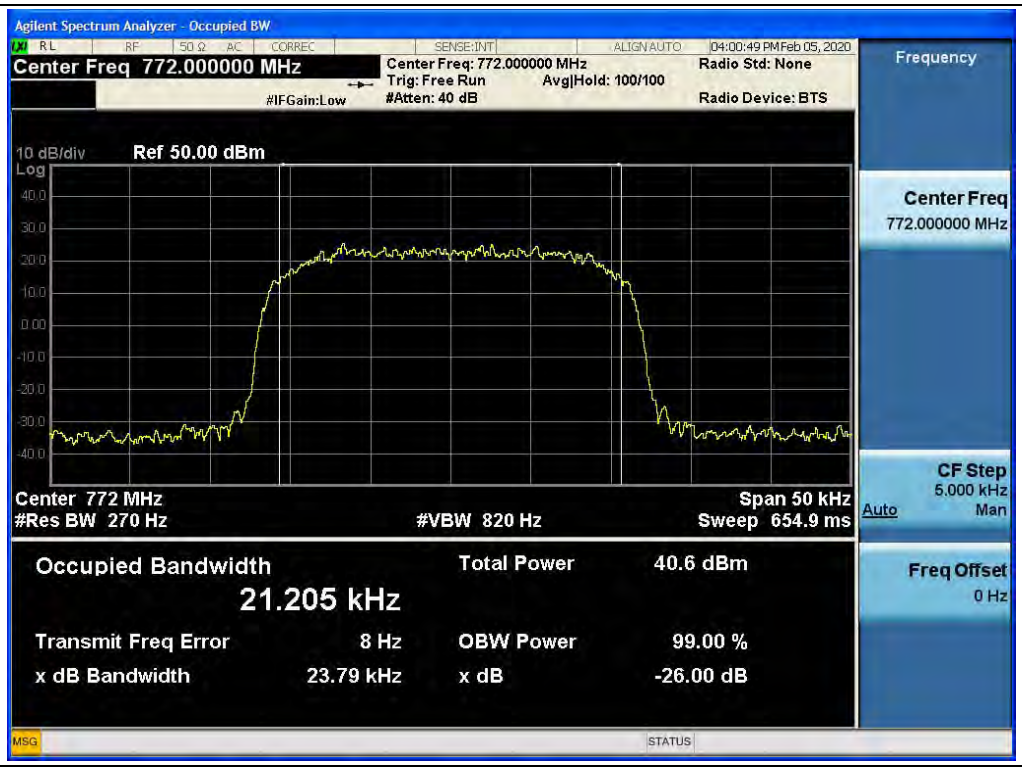
3 dB above the AGC threshold output / PS700 / P25 Phase 1 / Downlink



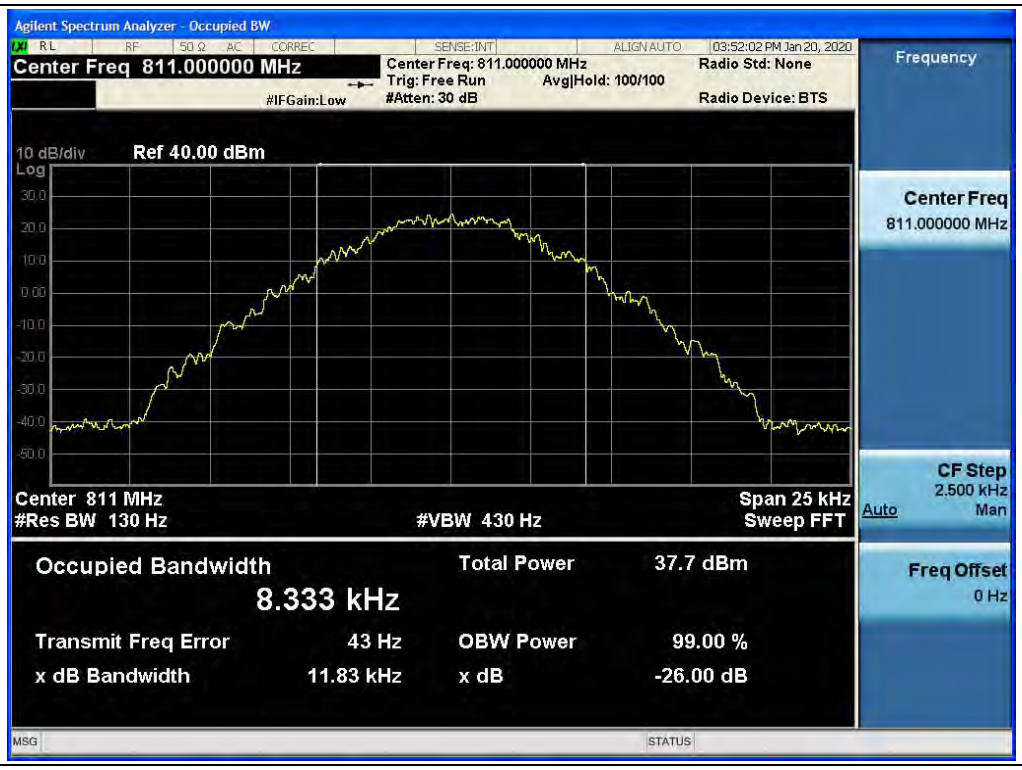
3 dB above the AGC threshold output / PS700 / P25 Phase 2 / Downlink



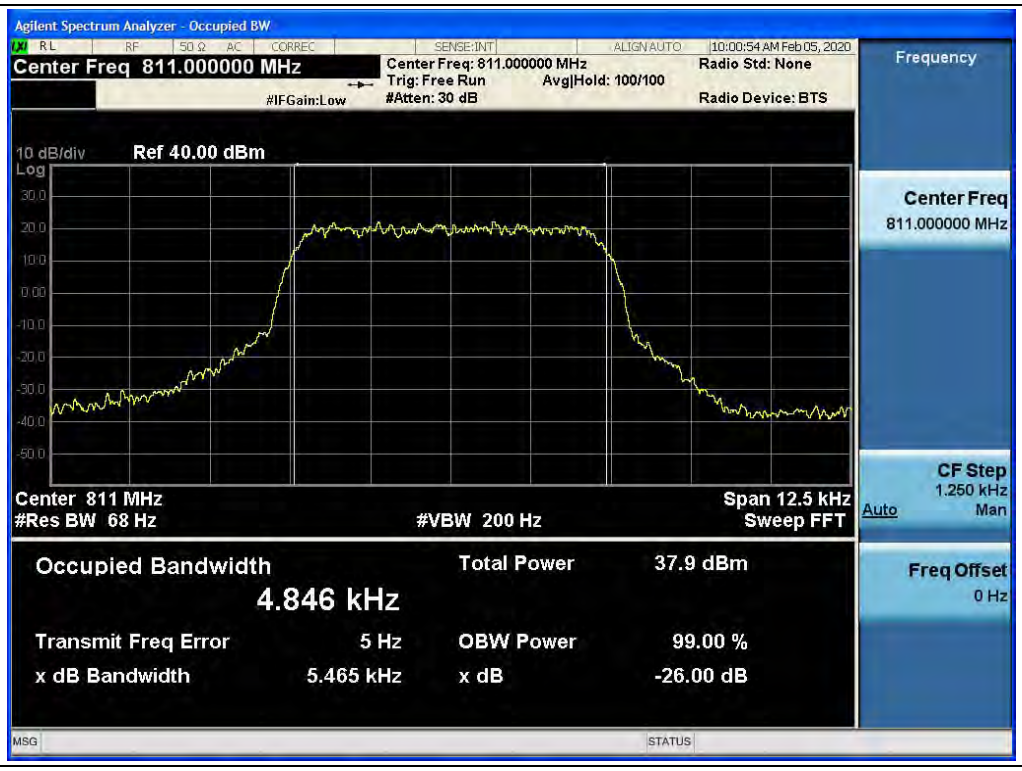
3 dB above the AGC threshold output / PS700 / TETRA / Downlink



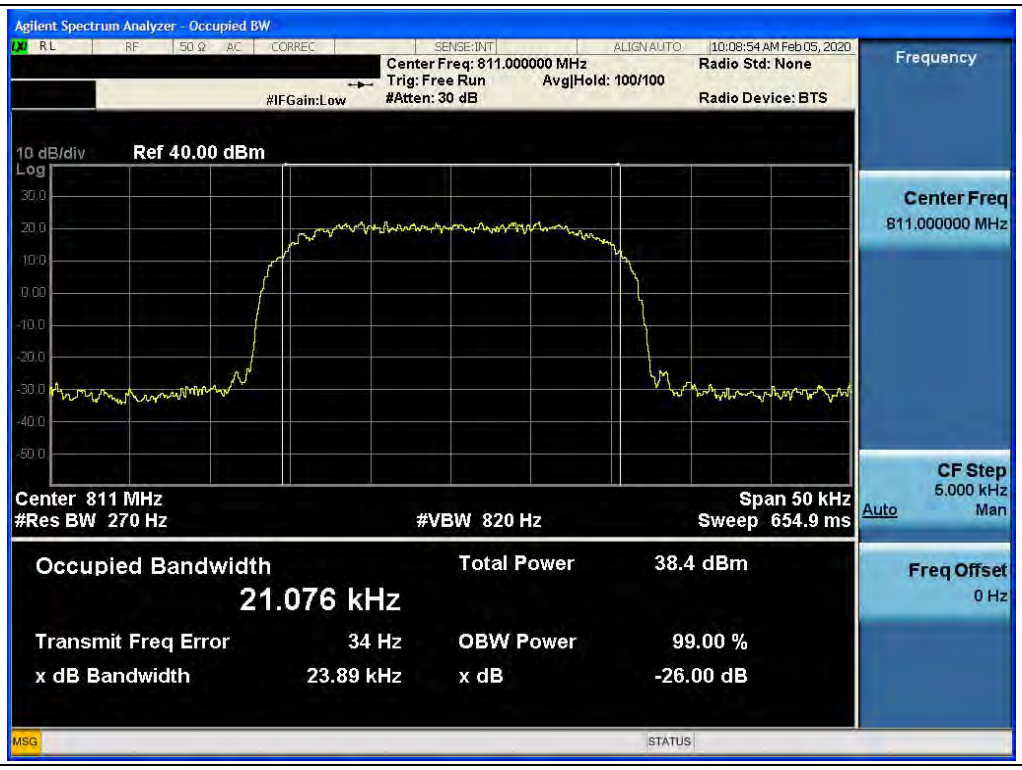
3 dB above the AGC threshold output / PS800 / P25 Phase 1 / Uplink



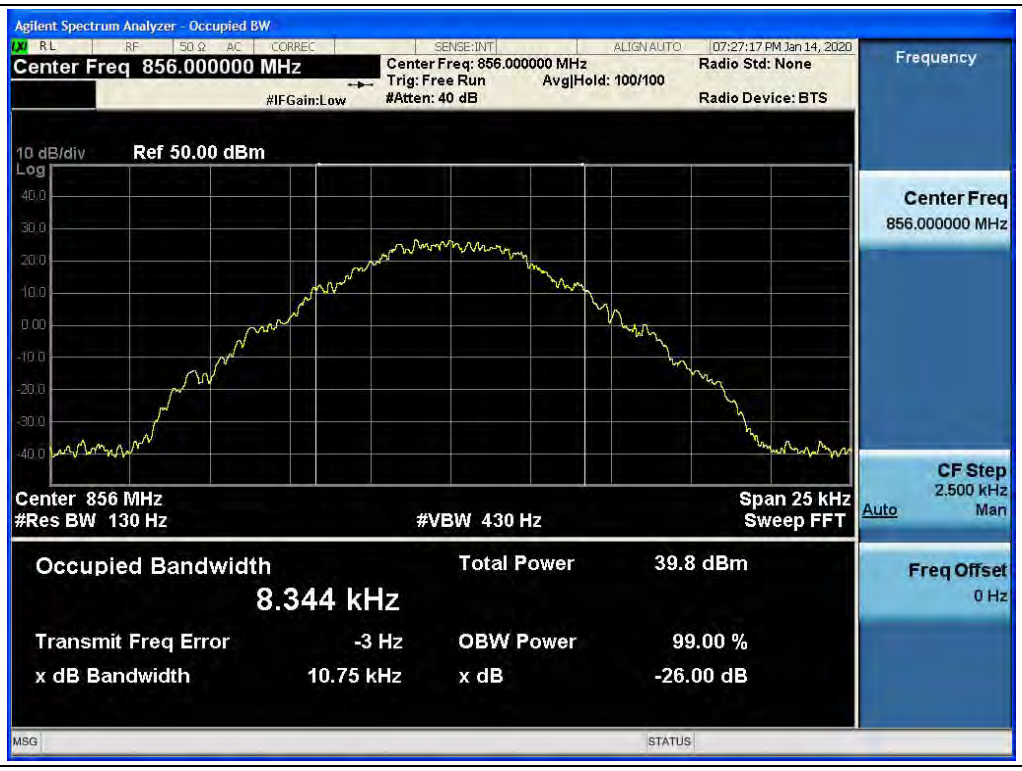
3 dB above the AGC threshold output / PS800 / P25 Phase 2 / Uplink



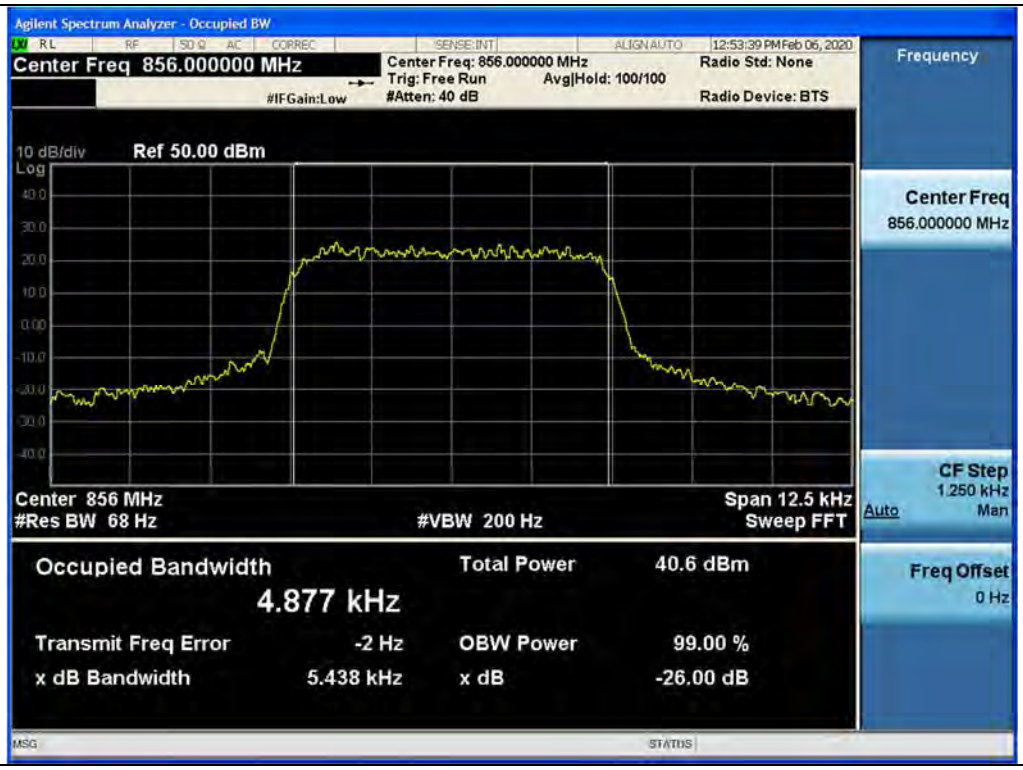
3 dB above the AGC threshold output / PS800 / TETRA / Uplink



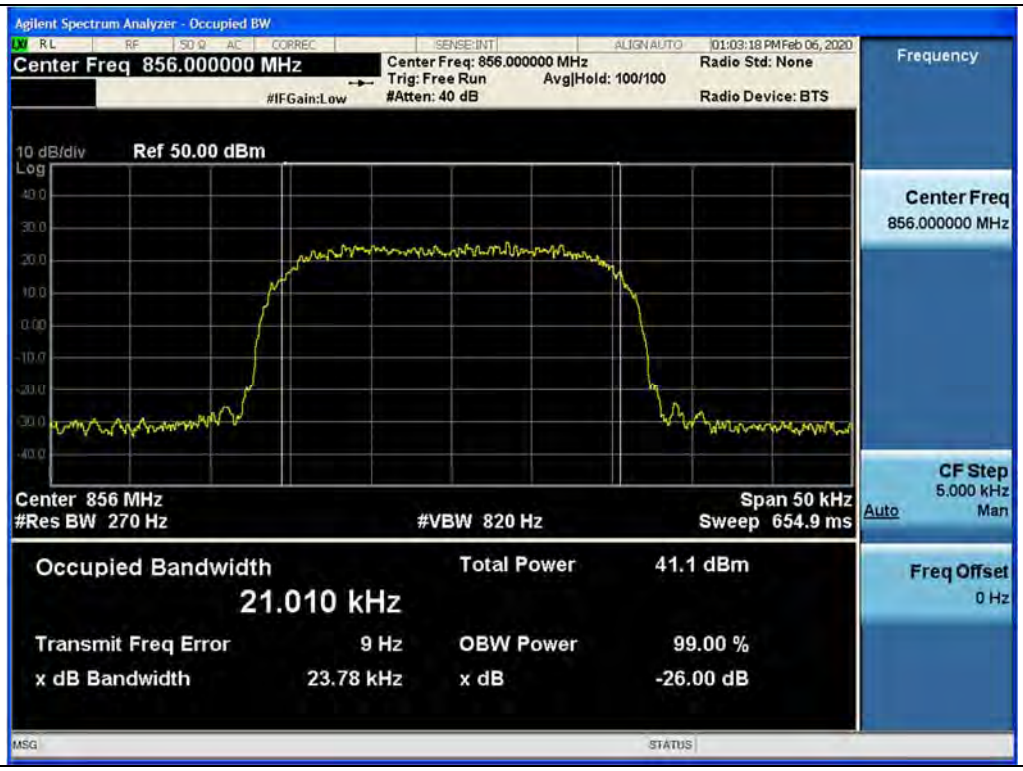
3 dB above the AGC threshold output / PS800 / P25 Phase 1 / Downlink



3 dB above the AGC threshold output / PS800 / P25 Phase 2 / Downlink



3 dB above the AGC threshold output / PS800 / TETRA / Downlink



5.4. INPUT-VERSUS-OUTPUT SIGNAL COMPARISON

Test Requirement:

§ 90.210 Emission masks.

Except as indicated elsewhere in this part, transmitters used in the radio services governed by this part must comply with the emission masks outlined in this section. Unless otherwise stated, per paragraphs (d)(4), (e)(4), and (o) of this section, measurements of emission power can be expressed in either peak or average values provided that emission powers are expressed with the same parameters used to specify the unmodulated transmitter carrier power. For transmitters that do not produce a full power unmodulated carrier, reference to the unmodulated transmitter carrier power refers to the total power contained in the channel bandwidth. Unless indicated elsewhere in this part, the table in this section specifies the emission masks for equipment operating under this part.

Applicable Emission Masks

Frequency band (MHz)	Mask for equipment with audio low pass filter	Mask for equipment without audio low pass filter
Below 25	A or B	A or C
25-50	B	C
72-76	B	C
150-174	B, D, or E	C, D or E
150 paging only	B	C
220-222	F	F
421-512	B, D, or E	C, D, or E
450 paging only	B	G
806-809/851-854	B	H
809-824/854-869	B, D	D, G.
896-901/935-940	I	J
902-928	K	K
929 ~ 930	B	G
4940-4990 MHz	L or M	L or M
5850-5925		
All other bands	B	C

* Equipment designed to operate with a 25 kHz channel bandwidth must meet the requirements of Emission Mask B or C, as applicable. Equipment designed to operate with a 12.5 kHz channel bandwidth must meet the requirements of Emission Mask D, and equipment designed to operate with a 6.25 kHz channel bandwidth must meet the requirements of Emission Mask E.

(c) Emission Mask C. For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows:

(1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5 kHz, but not more than 10 kHz: At least 83 log (fd/5) dB;

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 10 kHz, but not more than 250 percent of the authorized bandwidth: At least 29 log (fd2/11) dB or 50 dB, whichever is the lesser attenuation;

(3) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

(4) In the 1427-1432 MHz band, licensees are encouraged to take all reasonable steps to ensure that unwanted emissions power does not exceed the following levels in the 1400-1427 MHz band:

(i) For stations of point-to-point systems in the fixed service: −45 dBW/27 MHz.

(ii) For stations in the mobile service: −60 dBW/27 MHz.

(d) Emission Mask D—12.5 kHz channel bandwidth equipment. For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

(1) On any frequency from the center of the authorized bandwidth f0 to 5.625 kHz removed from f0: Zero dB.

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least 7.27(fd−2.88 kHz) dB.

(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5 kHz: At least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

(4) The reference level for showing compliance with the emission mask shall be established using a resolution bandwidth sufficiently wide (usually two or three times the channel bandwidth) to capture the true peak emission of the equipment under test. In order to show compliance with the emission mask up to and including 50 kHz removed from the edge of the authorized bandwidth, adjust the resolution bandwidth to 100 Hz with the measuring instrument in a peak hold mode. A sufficient number of sweeps must be measured to insure that the emission profile is developed. If video filtering is used, its bandwidth must not be less than the instrument resolution bandwidth. For emissions beyond 50 kHz from the edge of the authorized bandwidth, see paragraph (o) of this section. If it can be shown that use of the above instrumentation settings do not accurately represent the true interference potential of the equipment under test, an alternate procedure may be used provided prior Commission approval is obtained.

(h) Emission Mask H. For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier power (P) as follows:

(1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of 4 kHz or less: Zero dB.

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 4 kHz, but no more than 8.5 kHz: At least 107 log (fd/4) dB;

(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 8.5 kHz, but no more than 15 kHz: At least 40.5 log (fd/1.16) dB;
(4) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 15 kHz, but no more than 25 kHz: At least 116 log (fd/6.1) dB;
(5) On any frequency removed from the center of the authorized bandwidth by more than 25 kHz: At least 43 + 10 log (P) dB.

§ 90.219 Use of signal boosters.

(e) Device Specifications. In addition to the general rules for equipment certification in § 90.203(a)(2) and part 2, subpart J of this chapter, a signal booster must also meet the rules in this paragraph.

(4) A signal booster must be designed such that all signals that it retransmits meet the following requirements:

(iii) The retransmitted signals continue to meet the unwanted emissions limits of § 90.210 applicable to the corresponding received signals (assuming that these received signals meet the applicable unwanted emissions limits by a reasonable margin).

Test Procedures:

Measurements were in accordance with the test methods section 4.4 of KDB 935210 D05 v01r03.

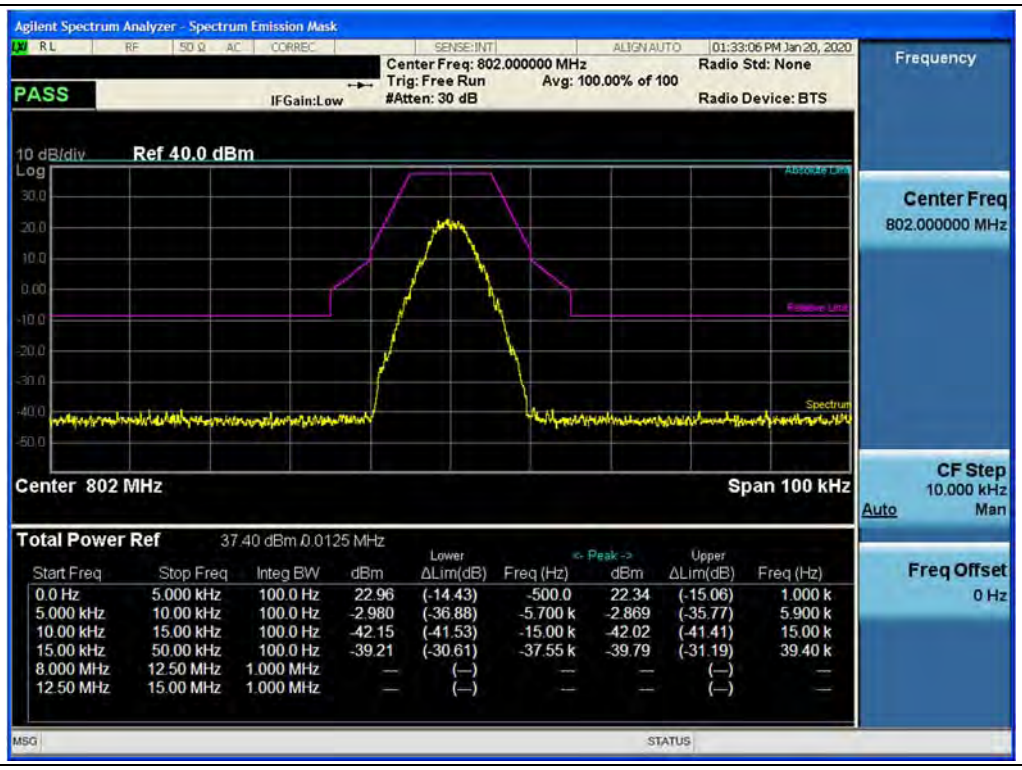
a) Connect a signal generator to the input of the EUT.
b) Configure the signal generator to transmit the appropriate test signal associated with the public safety emission designation.
c) Configure the signal level to be just below the AGC threshold.
d) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation as necessary.
e) Set the spectrum analyzer center frequency to the nominal EUT channel center frequency. The span range for the spectrum analyzer shall be between 2 times to 5 times the EBW (or OBW).
f) The nominal RBW shall be 300 Hz for 16K0F3E, and 100 Hz for all other emissions types.
g) Set the reference level of the spectrum analyzer to accommodate the maximum input amplitude level, i.e., the level at f_0 per Out-of-band rejection test.
h) Set spectrum analyzer detection mode to peak, and trace mode to max hold.
i) Allow the trace to fully stabilize.
j) Confirm that the signal is contained within the appropriate emissions mask.
k) Use the marker function to determine the maximum emission level and record the associated frequency.
l) Capture the emissions mask plot for inclusion in the test report (output signal spectra).
m) Measure the EUT input signal power (signal generator output signal) directly from the signal generator using power measurement guidance provided in KDB Publication 971168 [R8] (input signal spectra).
n) Compare the spectral plot of the output signal (determined in step k), to the input signal (determined in step l) to affirm they are similar (in passband and rolloff characteristic features and relative spectral locations).
o) Repeat steps d) to n) with the input signal amplitude set 3 dB above the AGC threshold.
p) Repeat steps b) to o) for all authorized operational bands and emissions types (see applicable regulatory

specifications, e.g., Section 90.210).

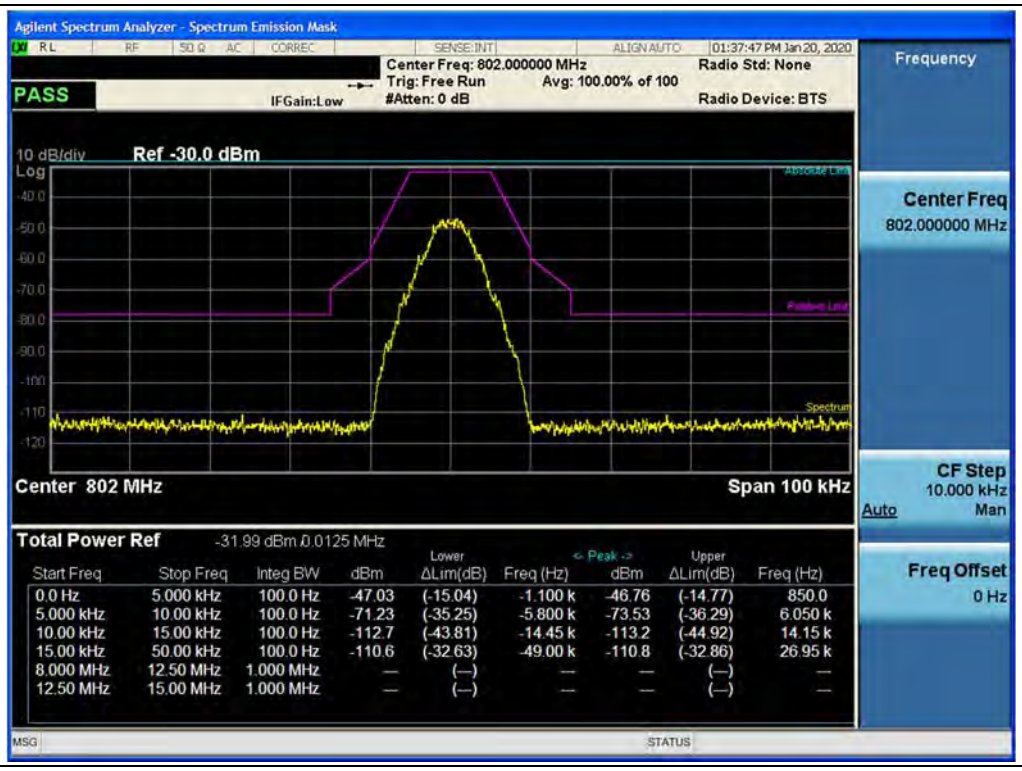
q) Include all accumulated spectral plots depicting EUT input signal and EUT output signal in the test report, and note any observed dissimilarities.

Plot data of Emission mask:

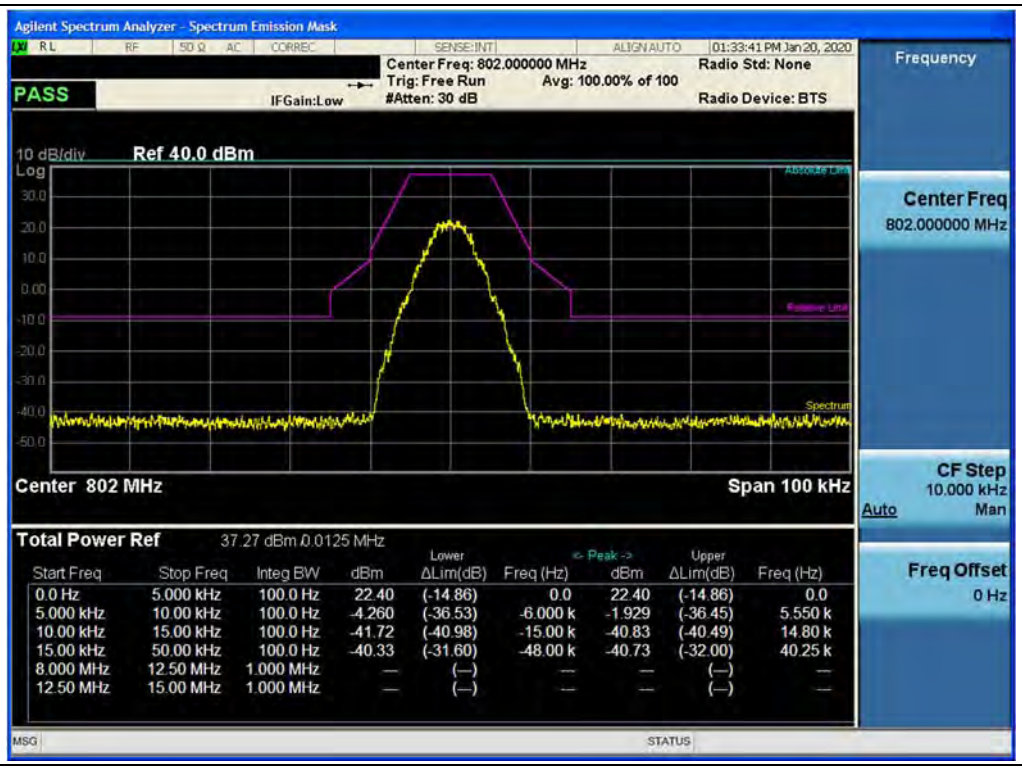
Output / PS700 / P25 Phase 1 / Uplink / Mask C



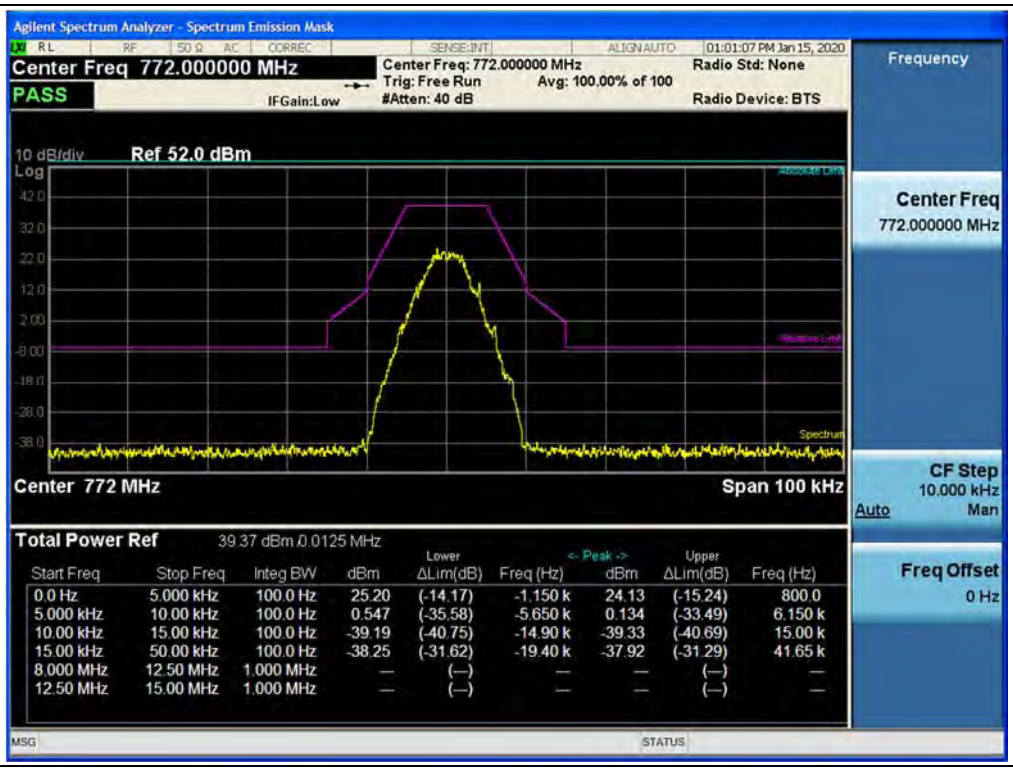
Input / PS700 / P25 Phase 1 / Uplink / Mask C



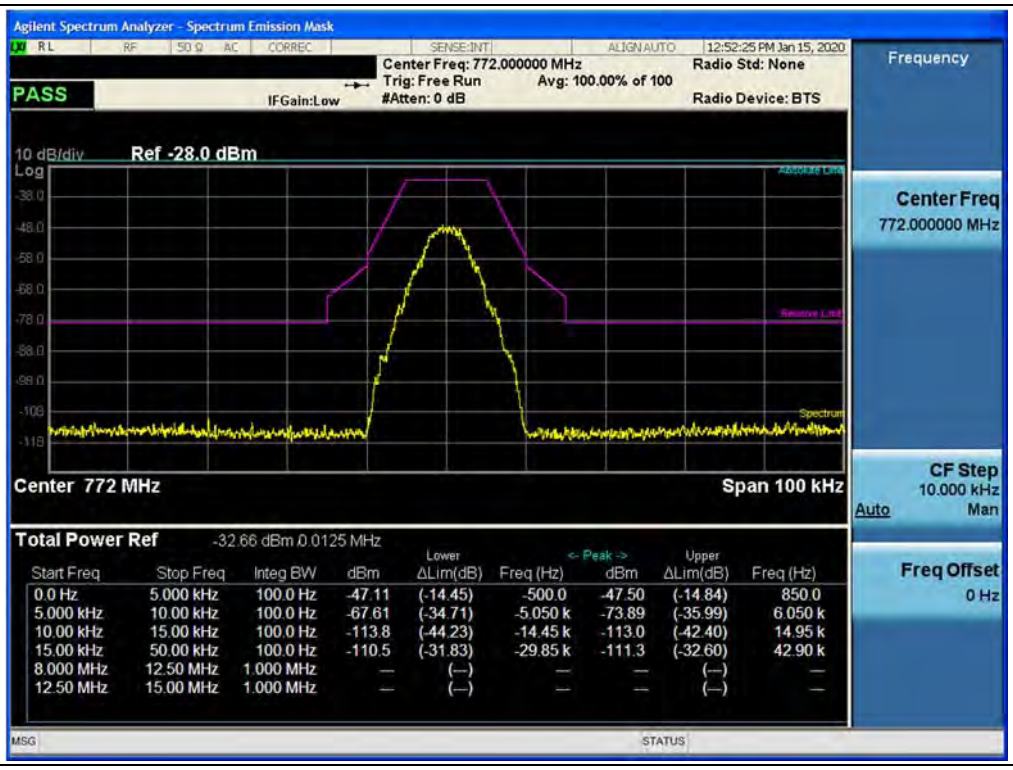
3 dB above the AGC threshold Output / PS700 / P25 Phase 1 / Uplink / Mask C



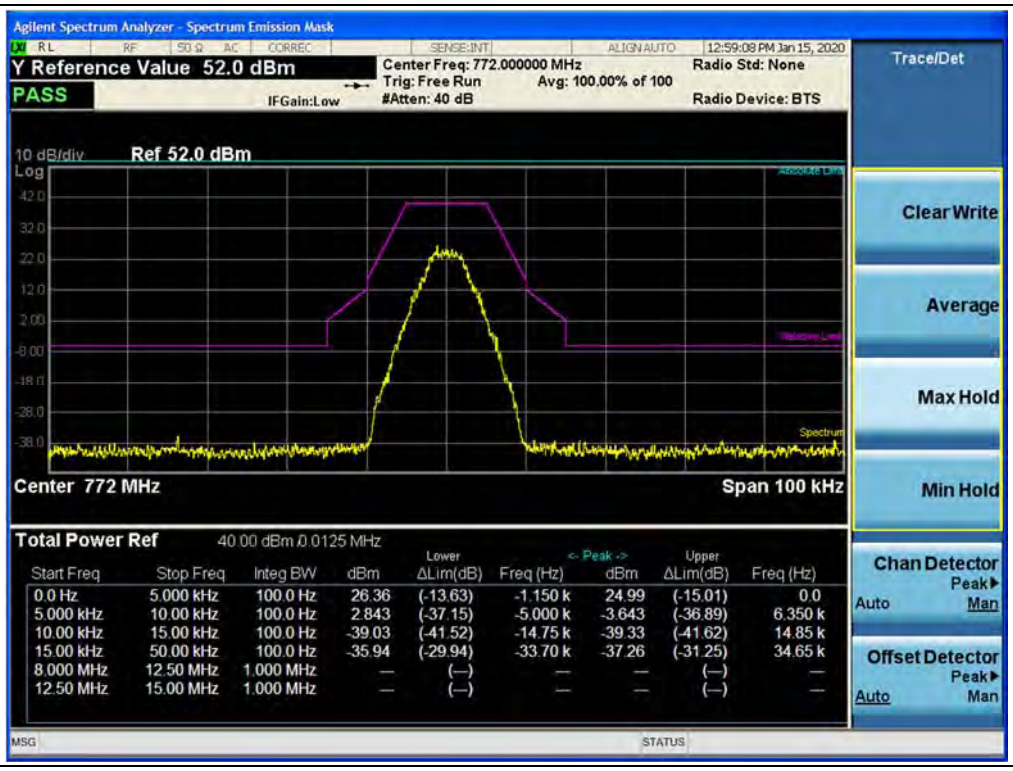
Output / PS700 / P25 Phase 1 / Downlink / Mask C



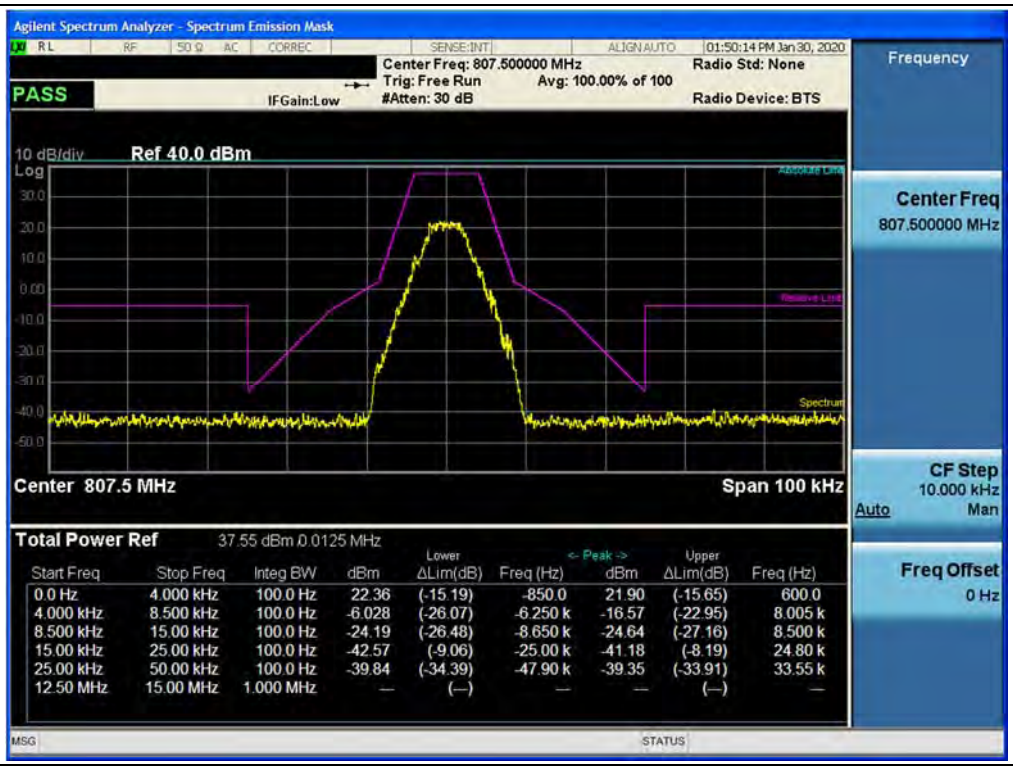
Input / PS700 / P25 Phase 1 / Downlink / Mask C



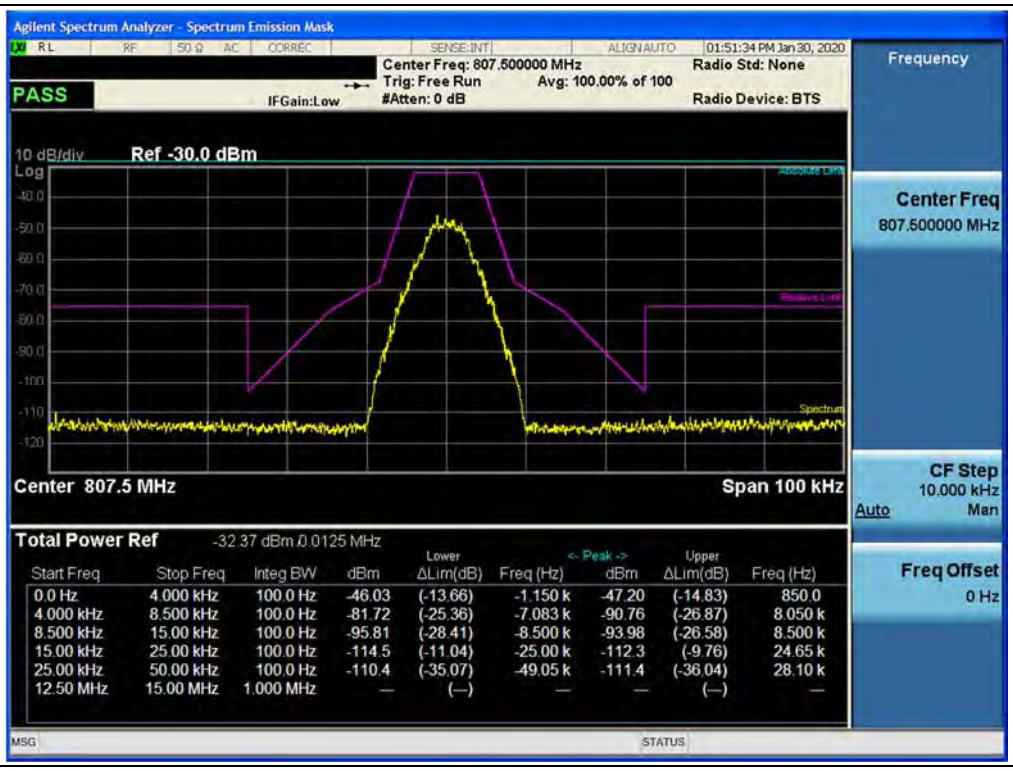
3 dB above the AGC threshold Output / PS700 / P25 Phase 1 / Downlink / Mask C



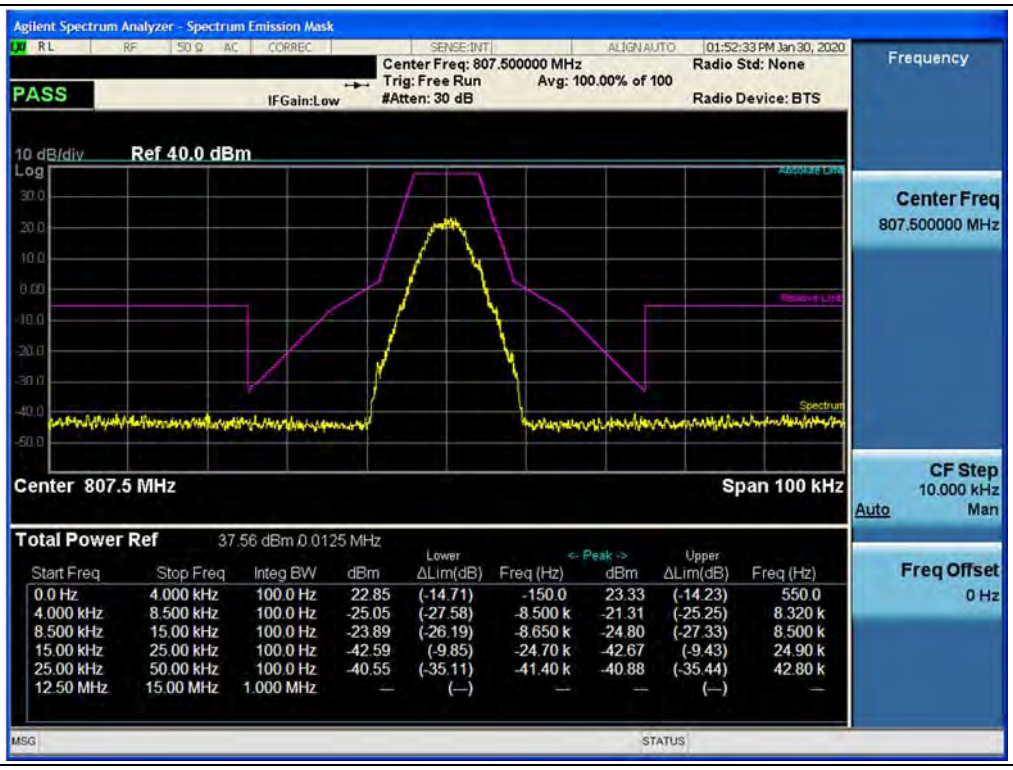
Output / PS800 / P25 Phase 1 / Uplink / Mask H



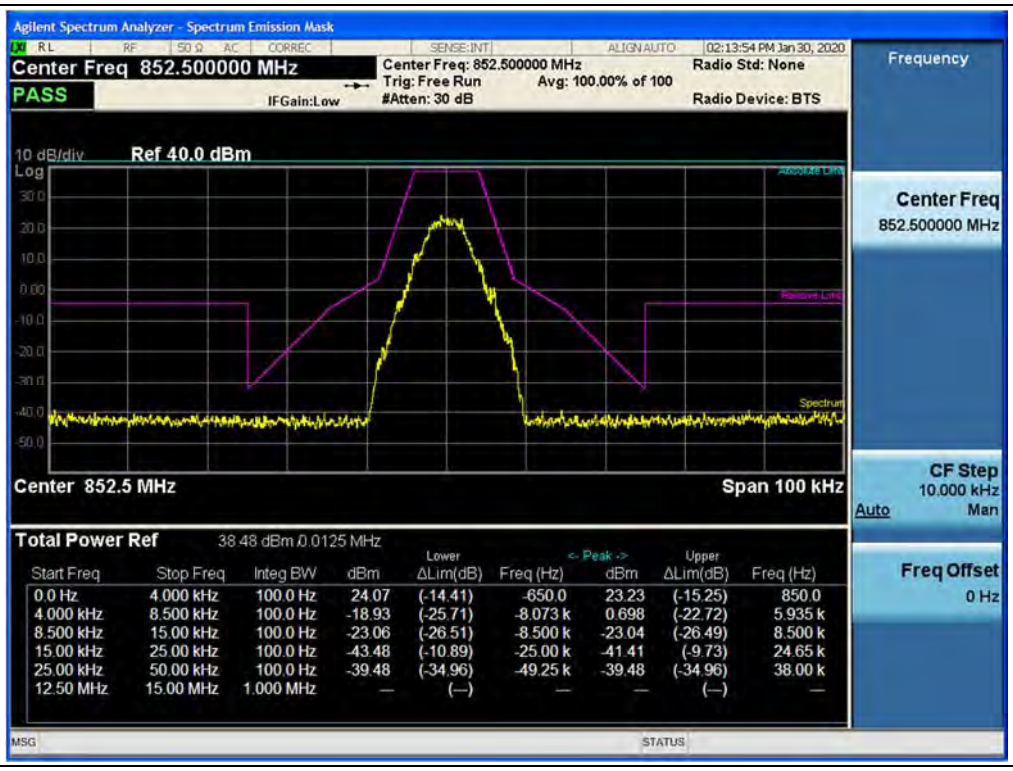
Input / PS800 / P25 Phase 1 / Uplink / Mask H



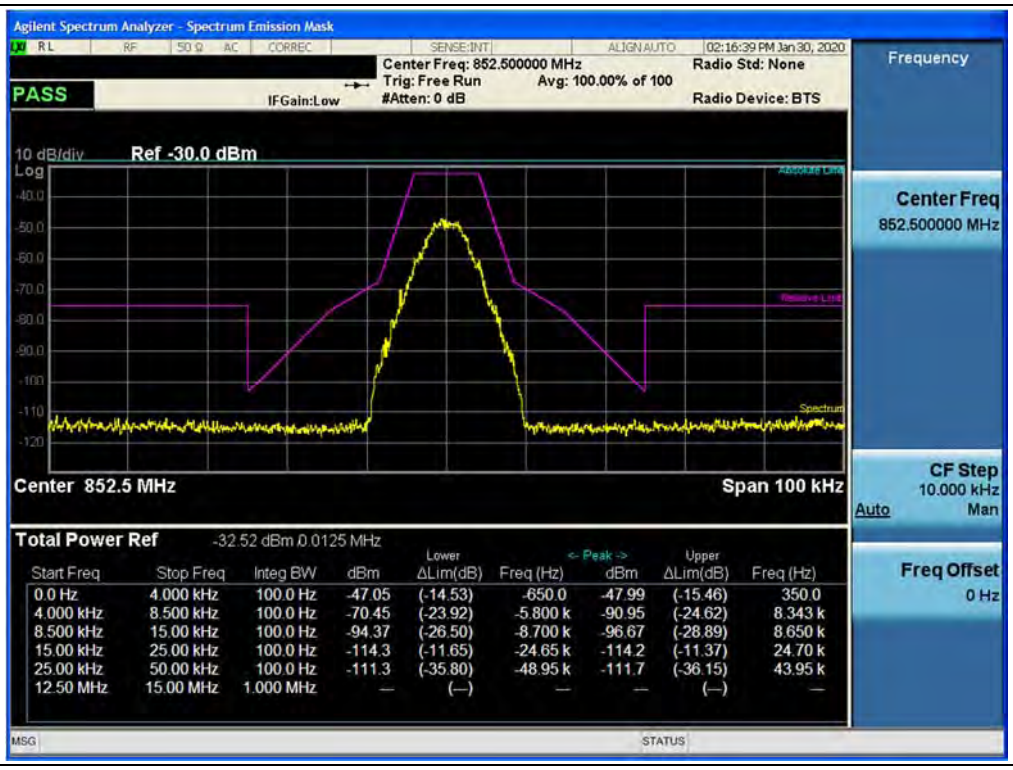
3 dB above the AGC threshold Output / PS800 / P25 Phase 1 / Uplink / Mask H



Output / PS800 / P25 Phase 1 / Downlink / Mask H

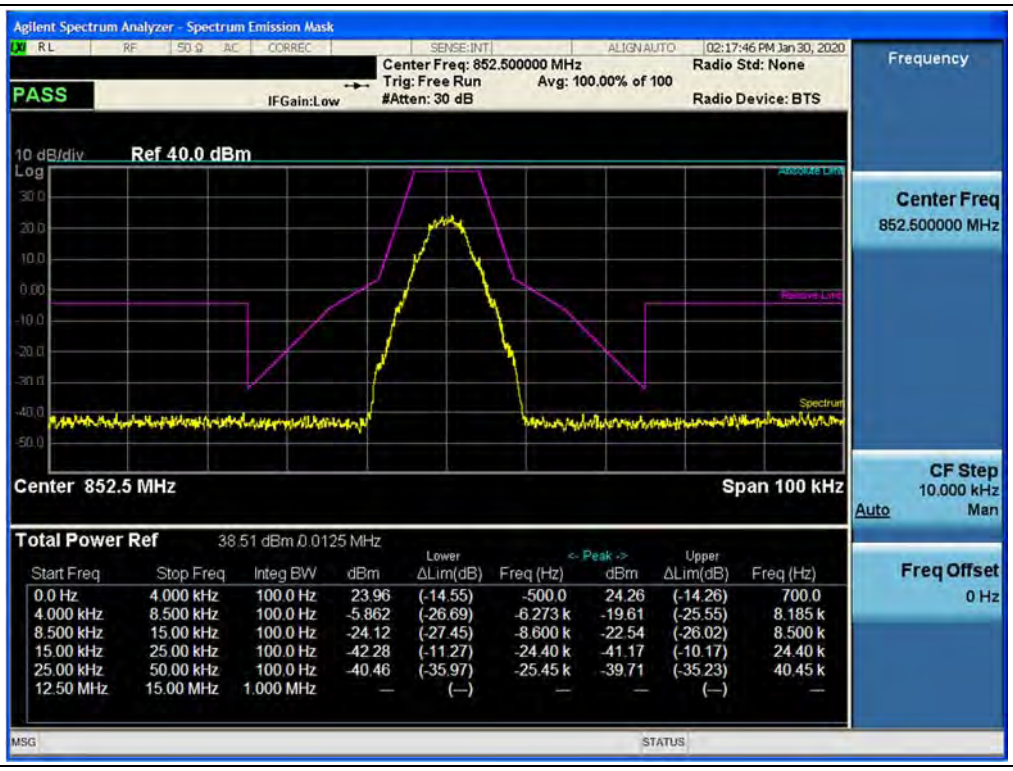


Input / PS800 / P25 Phase 1 / Downlink / Mask H



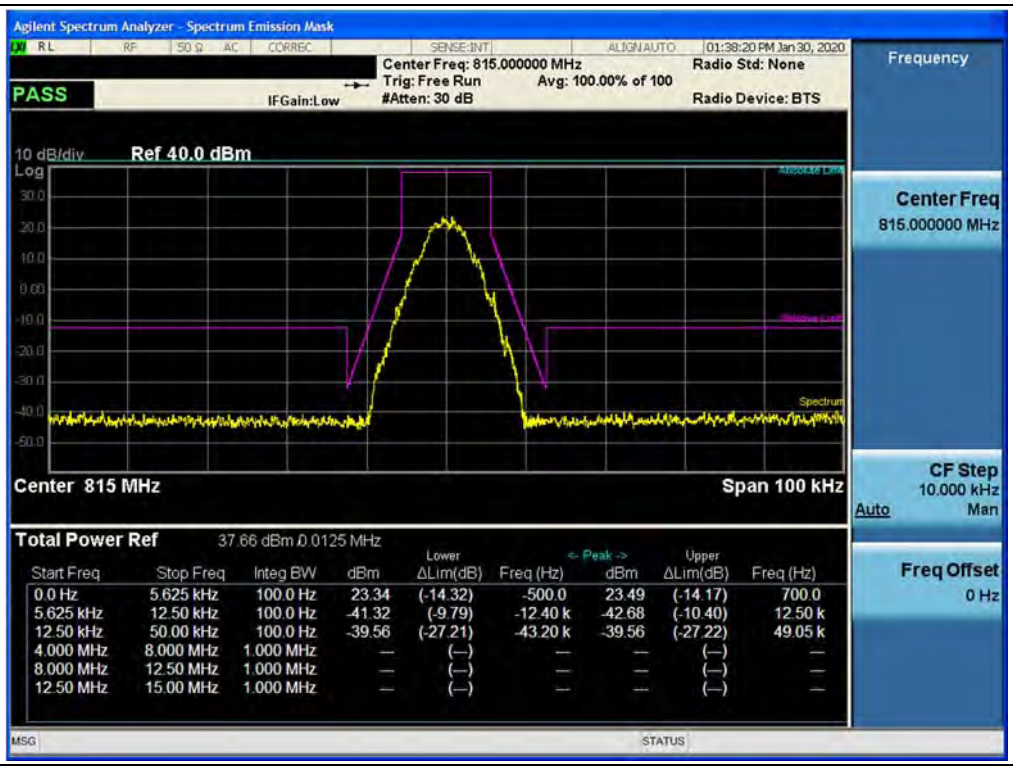
Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLim(dB)	Lower Freq (Hz)	Peak dBm	Upper ΔLim(dB)	Upper Freq (Hz)
0.0 Hz	4.000 kHz	100.0 Hz	-47.05	(-14.53)	-650.0	-47.99	(-15.46)	350.0
4.000 kHz	8.500 kHz	100.0 Hz	-70.45	(-23.92)	-5.800 k	-90.95	(-24.62)	8.343 k
8.500 kHz	15.00 kHz	100.0 Hz	-94.37	(-26.50)	-8.700 k	-96.67	(-28.89)	8.650 k
15.00 kHz	25.00 kHz	100.0 Hz	-114.3	(-11.65)	-24.65 k	-114.2	(-11.37)	24.70 k
25.00 kHz	50.00 kHz	100.0 Hz	-111.3	(-35.80)	-48.95 k	-111.7	(-36.15)	43.95 k
12.50 MHz	15.00 MHz	1.000 MHz	—	(—)	—	—	(—)	—

3 dB above the AGC threshold Output / PS800 / P25 Phase 1 / Downlink / Mask H

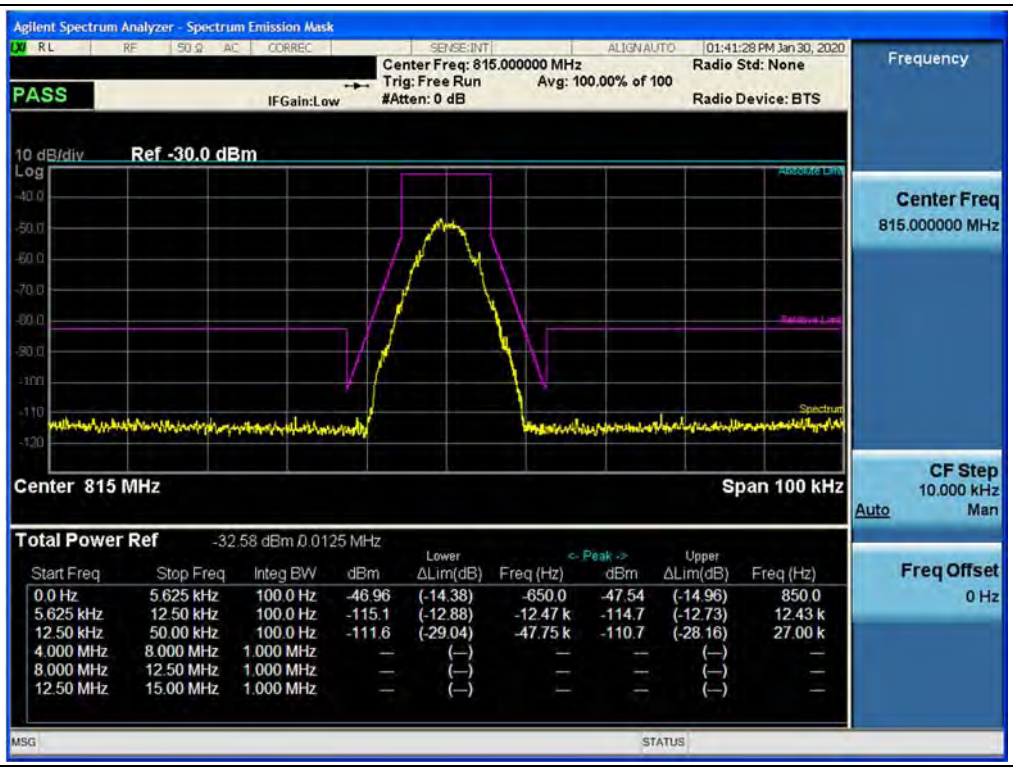


Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLim(dB)	Lower Freq (Hz)	Peak dBm	Upper ΔLim(dB)	Upper Freq (Hz)
0.0 Hz	4.000 kHz	100.0 Hz	23.96	(-14.55)	-500.0	24.26	(-14.26)	700.0
4.000 kHz	8.500 kHz	100.0 Hz	-5.862	(-26.69)	-6.273 k	-19.61	(-25.55)	8.185 k
8.500 kHz	15.00 kHz	100.0 Hz	-24.12	(-27.45)	-8.600 k	-22.54	(-26.02)	8.500 k
15.00 kHz	25.00 kHz	100.0 Hz	-42.28	(-11.27)	-24.40 k	-41.17	(-10.17)	24.40 k
25.00 kHz	50.00 kHz	100.0 Hz	-40.46	(-35.97)	-25.45 k	-39.71	(-35.23)	40.45 k
12.50 MHz	15.00 MHz	1.000 MHz	—	(—)	—	—	(—)	—

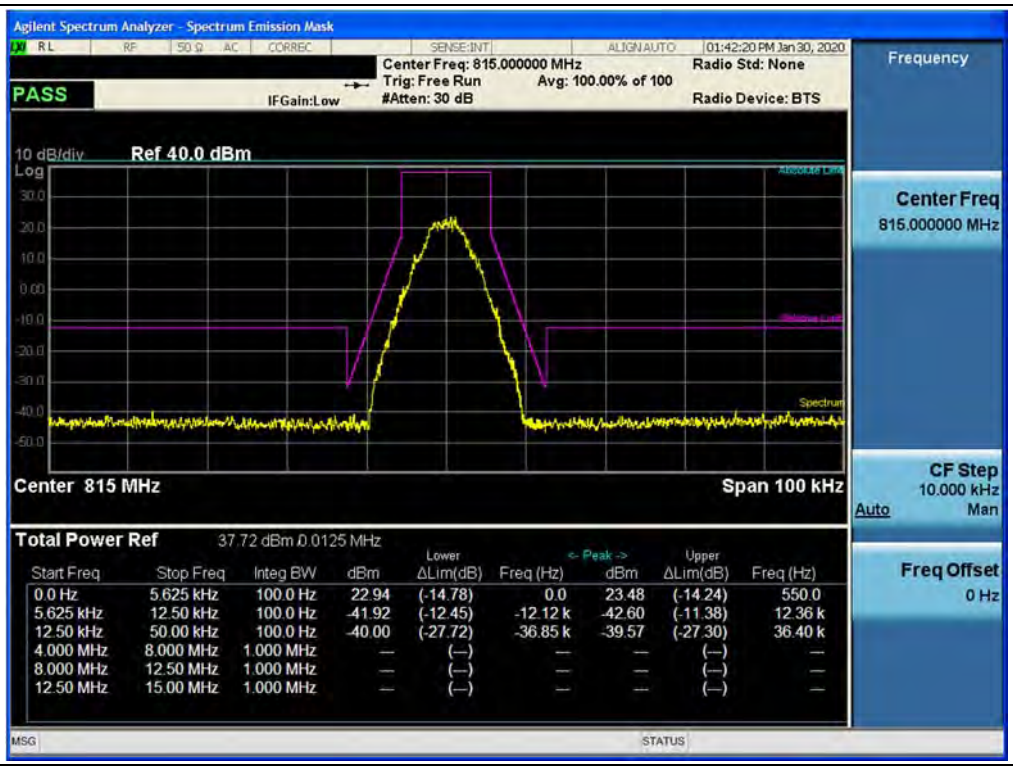
Output / PS800 / P25 Phase 1 / Uplink / Mask D



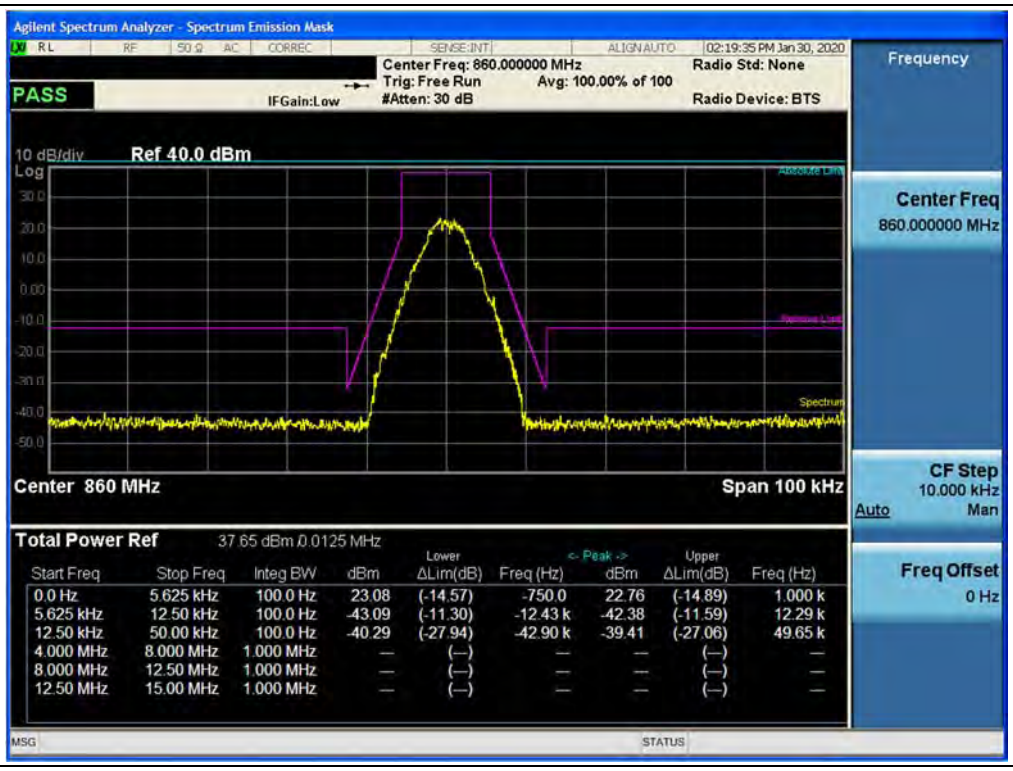
Input / PS800 / P25 Phase 1 / Uplink / Mask D



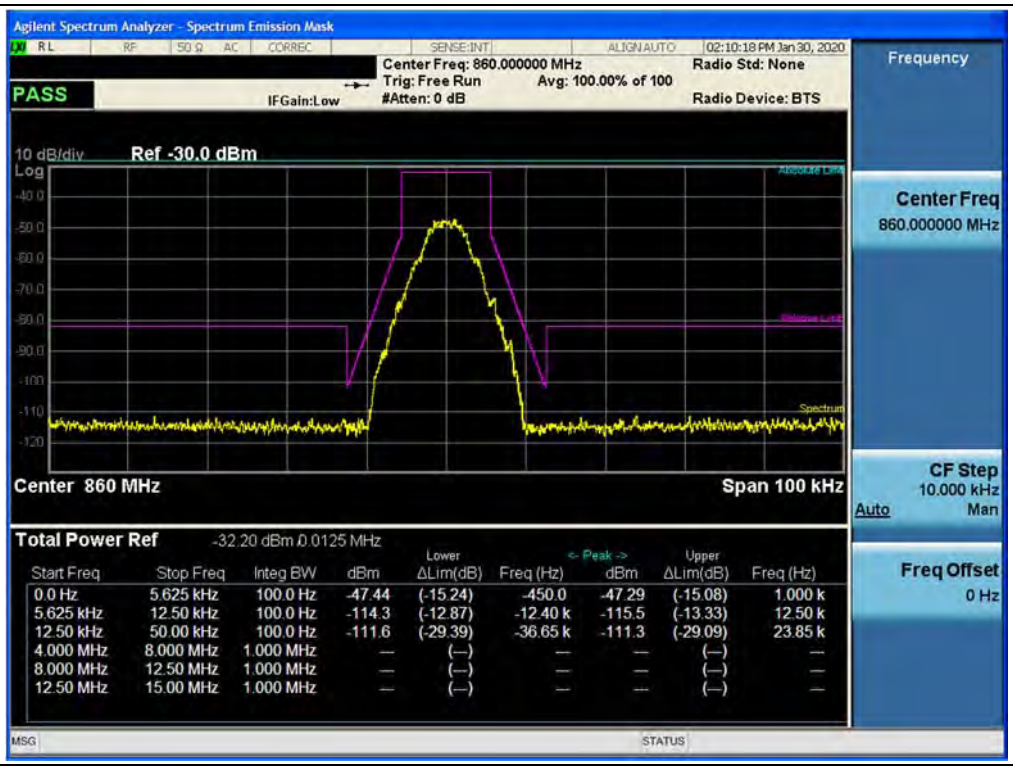
3 dB above the AGC threshold Output / PS800 / P25 Phase 1 / Uplink / Mask D



Output / PS800 / P25 Phase 1 / Downlink / Mask D

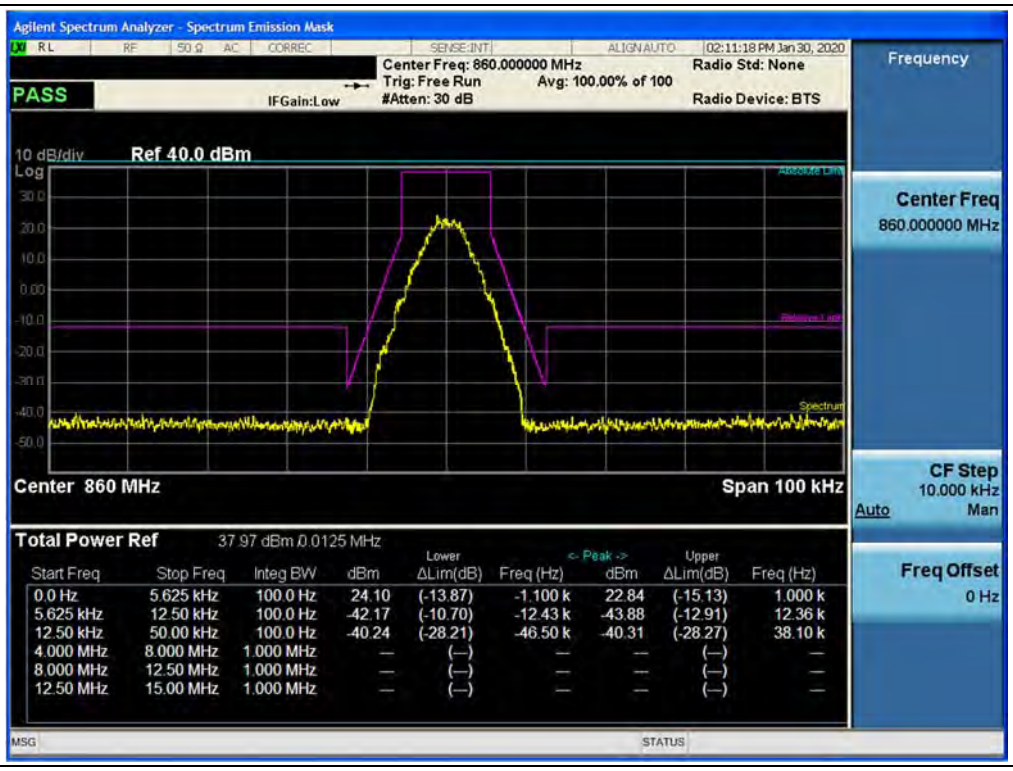


Input / PS800 / P25 Phase 1 / Downlink / Mask D



Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLim(dB)	Lower Freq (Hz)	Peak dBm	Upper ΔLim(dB)	Upper Freq (Hz)
0.0 Hz	5.625 kHz	100.0 Hz	-47.44	(-15.24)	-450.0	-47.29	(-15.08)	1.000 k
5.625 kHz	12.50 kHz	100.0 Hz	-114.3	(-12.87)	-12.40 k	-115.5	(-13.33)	12.50 k
12.50 kHz	50.00 kHz	100.0 Hz	-111.6	(-29.39)	-36.65 k	-111.3	(-29.09)	23.85 k
4.000 MHz	8.000 MHz	1.000 MHz	—	(—)	—	—	(—)	—
8.000 MHz	12.50 MHz	1.000 MHz	—	(—)	—	—	(—)	—
12.50 MHz	15.00 MHz	1.000 MHz	—	(—)	—	—	(—)	—

3 dB above the AGC threshold Output / PS800 / P25 Phase 1 / Downlink / Mask D



Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLim(dB)	Lower Freq (Hz)	Peak dBm	Upper ΔLim(dB)	Upper Freq (Hz)
0.0 Hz	5.625 kHz	100.0 Hz	24.10	(-13.87)	-1.100 k	22.84	(-15.13)	1.000 k
5.625 kHz	12.50 kHz	100.0 Hz	-42.17	(-10.70)	-12.43 k	-43.88	(-12.91)	12.36 k
12.50 kHz	50.00 kHz	100.0 Hz	-40.24	(-28.21)	-46.50 k	-40.31	(-28.27)	38.10 k
4.000 MHz	8.000 MHz	1.000 MHz	—	(—)	—	—	(—)	—
8.000 MHz	12.50 MHz	1.000 MHz	—	(—)	—	—	(—)	—
12.50 MHz	15.00 MHz	1.000 MHz	—	(—)	—	—	(—)	—

5.5. INPUT/OUTPUT POWER AND AMPLIFIER/BOOSTER GAIN

Test Requirement:

§ 2.1046 Measurements required: RF power output.

(a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in § 2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

(b) For single sideband, independent sideband, and single channel, controlled carrier radiotelephone transmitters the procedure specified in paragraph (a) of this section shall be employed and, in addition, the transmitter shall be modulated during the test as specified and applicable in § 2.1046 (b) (1-5). In all tests, the input level of the modulating signal shall be such as to develop rated peak envelope power or carrier power, as appropriate, for the transmitter.

(c) For measurements conducted pursuant to paragraphs (a) and (b) of this section, all calculations and methods used by the applicant for determining carrier power or peak envelope power, as appropriate, on the basis of measured power in the radio frequency load attached to the transmitter output terminals shall be shown. Under the test conditions specified, no components of the emission spectrum shall exceed the limits specified in the applicable rule parts as necessary for meeting occupied bandwidth or emission limitations.

§ 90.219 Use of signal boosters.

(e) Device Specifications. In addition to the general rules for equipment certification in § 90.203(a)(2) and part 2, subpart J of this chapter, a signal booster must also meet the rules in this paragraph.

(1) The output power capability of a signal booster must be designed for deployments providing a radiated power not exceeding 5 Watts ERP for each retransmitted channel.

§ 90.541 Transmitting power and antenna height limits.

The transmitting power and antenna height of base, mobile, portable and control stations operating in the 769-775 MHz and 799-805 MHz frequency bands must not exceed the maximum limits in this section. Power limits are listed in effective radiated power (ERP).

(a) The transmitting power and antenna height of base stations must not exceed the limits given in paragraph (a) of § 90.635.

§ 90.542 Broadband transmitting power limits.

(a) The following power limits apply to the 758-768/788-798 MHz band:

(1) Fixed and base stations transmitting a signal in the 758-768 MHz band with an emission bandwidth of 1 MHz or less must not exceed an ERP of 1000 watts and an antenna height of 305 m HAAT, except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 1000 watts ERP in accordance with Table 1 of this section.

(2) Fixed and base stations located in a county with population density of 100 or fewer persons per square mile, based upon the most recently available population statistics from the Bureau of the Census, and transmitting a signal in the 758-768 MHz band with an emission bandwidth of 1 MHz or less must not exceed an ERP of 2000 watts and an antenna height of 305 m HAAT, except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 2000 watts ERP in accordance with Table 2 of this section.

(3) Fixed and base stations transmitting a signal in the 758-768 MHz band with an emission bandwidth greater than 1 MHz must not exceed an ERP of 1000 watts/MHz and an antenna height of 305 m HAAT, except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 1000 watts/MHz ERP accordance with Table 3 of this section.

(4) Fixed and base stations located in a county with population density of 100 or fewer persons per square mile, based upon the most recently available population statistics from the Bureau of the Census, and transmitting a signal in the 758-768 MHz band with an emission bandwidth greater than 1 MHz must not exceed an ERP of 2000 watts/MHz and an antenna height of 305 m HAAT, except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 2000 watts/MHz ERP in accordance with Table 4 of this section.

(5) Licensees of fixed or base stations transmitting a signal in the 758-768 MHz band at an ERP greater than 1000 watts must comply with the provisions set forth in paragraph (b) of this section.

(6) Control stations and mobile stations transmitting in the 758-768 MHz band and the 788-798 MHz band are limited to 30 watts ERP.

(7) Portable stations (hand-held devices) transmitting in the 758-768 MHz band and the 788-798 MHz band are limited to 3 watts ERP.

(8) For transmissions in the 758-768 MHz and 788-798 MHz bands, licensees may employ equipment operating in compliance with either of the following measurement techniques:

(i) The maximum composite transmit power shall be measured over any interval of continuous transmission using instrumentation calibrated in terms of RMS-equivalent voltage. The measurement results shall be properly adjusted for any instrument limitations, such as detector response times, limited resolution bandwidth capability when compared to the emission bandwidth, etc., so as to obtain a true maximum composite measurement for the emission in question over the full bandwidth of the channel.

(ii) A Commission-approved average power technique.

Table 1 to § 90.542(a)—Permissible Power and Antenna Heights for Base and Fixed Stations in the 758-768 MHz Band Transmitting a Signal With an Emission Bandwidth of 1 MHz or Less

Antenna height (AAT) in meters (feet)	Effective radiated power (ERP) (watts)
Above 1372 (4500)	65
Above 1220 (4000) To 1372 (4500)	70
Above 1067 (3500) To 1220 (4000)	75
Above 915 (3000) To 1067 (3500)	100
Above 763 (2500) To 915 (3000)	140
Above 610 (2000) To 763 (2500)	200
Above 458 (1500) To 610 (2000)	350
Above 305 (1000) To 458 (1500)	600
Up to 305 (1000)	1000

Table 2 to § 90.542(a)—Permissible Power and Antenna Heights for Base and Fixed Stations in the 758-768 MHz Band Transmitting a Signal With an Emission Bandwidth of 1 MHz or Less

Antenna height (AAT) in meters (feet)	Effective radiated power (ERP) (watts)
Above 1372 (4500)	130
Above 1220 (4000) To 1372 (4500)	140
Above 1067 (3500) To 1220 (4000)	150
Above 915 (3000) To 1067 (3500)	200
Above 763 (2500) To 915 (3000)	280
Above 610 (2000) To 763 (2500)	400
Above 458 (1500) To 610 (2000)	700
Above 305 (1000) To 458 (1500)	1200
Up to 305 (1000)	2000

Table 3 to § 90.542(a)—Permissible Power and Antenna Heights for Base and Fixed Stations in the 758-768 MHz Band Transmitting a Signal With an Emission Bandwidth Greater Than 1 MHz

Antenna height (AAT) in meters (feet)	Effective radiated power (ERP) per MHz (watts/MHz)
Above 1372 (4500)	65
Above 1220 (4000) To 1372 (4500)	70
Above 1067 (3500) To 1220 (4000)	75
Above 915 (3000) To 1067 (3500)	100
Above 763 (2500) To 915 (3000)	140
Above 610 (2000) To 763 (2500)	200
Above 458 (1500) To 610 (2000)	350
Above 305 (1000) To 458 (1500)	600
Up to 305 (1000)	1000

Table 4 to § 90.542(a)—Permissible Power and Antenna Heights for Base and Fixed Stations in the 758-768 MHz Band Transmitting a Signal With an Emission Bandwidth Greater Than 1 MHz

Antenna height (AAT) in meters (feet)	Effective radiated power (ERP) per MHz (watts/MHz)
Above 1372 (4500)	130
Above 1220 (4000) To 1372 (4500)	140
Above 1067 (3500) To 1220 (4000)	150
Above 915 (3000) To 1067 (3500)	200
Above 763 (2500) To 915 (3000)	280
Above 610 (2000) To 763 (2500)	400
Above 458 (1500) To 610 (2000)	700
Above 305 (1000) To 458 (1500)	1200
Up to 305 (1000)	2000

(b) For base and fixed stations operating in the 758-768 MHz band in accordance with the provisions of paragraph (a)(5) of this section, the power flux density that would be produced by such stations through a combination of antenna height and vertical gain pattern must not exceed 3000 microwatts per square meter on the ground over the area extending to 1 km from the base of the antenna mounting structure.

§ 90.635 Limitations on power and antenna height.

(a) The effective radiated power and antenna height for base stations may not exceed 1 kilowatt (30 dBw) and 304 m. (1,000 ft.) above average terrain (AAT), respectively, or the equivalent thereof as determined from the Table. These are maximum values, and applicants will be required to justify power levels and antenna heights requested.

Table—Equivalent Power and Antenna Heights for Base Stations in the 851-869 MHz and 935-940 MHz Bands Which Have a Requirement for a 32 km (20 mi) Service Area Radius

Antenna height (ATT) meters (feet)	Effective radiated power (watts)
Above 1,372 (4,500)	65
Above 1,220 (4,000) to 1,372 (4,500)	70
Above 1,067 (3,500) to 1,220 (4,000)	75
Above 915 (3,000) to 1,067 (3,500)	100
Above 763 (2,500) to 915 (3,000)	140
Above 610 (2,000) to 763 (2,500)	200
Above 458 (1,500) to 610 (2,000)	350
Above 305 (1,000) to 458 (1,500)	600
Up to 305 (1,000)	1,000

Test Procedures:

Measurements were in accordance with the test methods section 3.5 of KDB 935210 D05 v01r03.

Adjust the internal gain control of the EUT to the maximum gain for which the equipment certification is being sought. Any EUT attenuation settings shall be set to their minimum value.

Input power levels (uplink and downlink) should be set to maximum input ratings while confirming that the device is not capable of operating in saturation (non-linear mode) at the rated input levels, including during the performance of the input/output power measurements.

3.5.2 Measuring the EUT mean input and output power

a) Connect a signal generator to the input of the EUT.
b) Configure to generate the test signal.
c) The frequency of the signal generator shall be set to the frequency f0 as determined from out-of-band rejection test.
d) Connect a spectrum analyzer or power meter to the output of the EUT using appropriate attenuation as necessary.
e) Set the signal generator output power to a level that produces an EUT output level that is just below the AGC threshold, but not more than 0.5 dB below.

f) Measure and record the output power of the EUT; use ANSI C63.26-2015 subclause 5.2.4.4.1, for power measurement.

g) Remove the EUT from the measurement setup. Using the same signal generator settings, repeat the power measurement at the signal generator port, which was used as the input signal to the EUT, and record as the input power. EUT gain may be calculated as described in 3.5.5.

h) Repeat steps f) and g) with input signal amplitude set to 3 dB above the AGC threshold level.

i) Repeat steps e) to h) with the narrowband test signal.

j) Repeat steps e) to i) for all frequency bands authorized for use by the EUT.

3.5.5 Calculating amplifier, repeater, or industrial booster gain

After the input and output power levels have been measured as described in the preceding subclauses, the gain of the EUT can be determined from:

Gain (dB) = output power (dBm) − input power (dBm).

Report the gain for each authorized operating frequency band, and each test signal stimulus.

Measurements were in accordance with the test methods section 4.5 of KDB 935210 D05 v01r03.

4.5.2 Measuring input and output power levels for determining amplifier/booster gain

a) Connect a signal generator to the input of the EUT.

b) Configure to generate the CW test signal.

c) The frequency of the signal generator shall be set to the frequency f_0 as determined from Out-of-band rejection test.

d) Connect a spectrum analyzer or power meter to the output of the EUT using appropriate attenuation as necessary.

e) Set the signal generator output power to a level that produces a EUT output level that is just below the AGC threshold, but not more than 0.5 dB below.

f) Measure and record the output power of the EUT; use 4.5.3 for power measurement.

g) Remove the EUT from the measurement setup. Using the same signal generator settings, repeat the power measurement at the signal generator port, which was used as the input signal to the EUT, and record as the input power. EUT gain may be calculated as described in 3.5.5.

h) Repeat steps f) and g) with input signal amplitude set to 3 dB above the AGC threshold level.

i) Omit

j) Repeat steps e) to i) for all frequency bands authorized for use by the EUT.

4.5.3 Power measurement Method 1: using a spectrum or signal analyzer

a) Set the span to at least 1 MHz.

b) Set the RBW 100 kHz.

c) Set the VBW to ≥ 3 × RBW.

d) Set the detector to PEAK with the trace to MAX HOLD.

e) Place a marker on the peak of the signal, and record the value as the maximum power.

f) Repeat step e) but with the EUT in place.

g) EUT gain may be calculated as described in 4.5.5.

4.5.5 Calculating amplifier, repeater, or industrial booster gain

After the input and output power levels have been measured as described in the preceding subclauses, the gain of the EUT can be determined from:

Gain (dB) = output power (dBm) − input power (dBm).

Report the gain for each authorized operating frequency band, and each test signal stimulus.

Test Results:

Tabular data of Input / Output Power and Gain

Test Band	Link	Tested signals	f_0 Frequency (MHz)	Input Power (dBm)	Output Power (dBm)	Gain (dB)
FirstNet	Uplink	LTE 5 MHz	795.50	-64.61	30.00	94.61
		LTE 10 MHz	793.00	-64.60	29.33	93.93
	Downlink	LTE 5 MHz	760.50	-61.87	33.36	95.23
		LTE 10 MHz	763.00	-61.78	33.06	94.84

Test Band	Link	f_0 Frequency (MHz)	Input Power (dBm)	Output Power (dBm)	Gain (dB)
PS700	Uplink	800.61	-64.159	30.230	94.39
	Downlink	772.50	-61.477	32.733	94.21
PS800	Uplink	814.58	-64.606	30.169	94.78
	Downlink	854.95	-61.573	32.840	94.41

Tabular data of Input / 3 dB above AGC threshold Output Power and Gain

Test Band	Link	Tested signals	f_0 Frequency (MHz)	Input Power (dBm)	Output Power (dBm)	Gain (dB)
FirstNet	Uplink	LTE 5 MHz	795.50	-64.61	30.16	94.77
		LTE 10 MHz	793.00	-64.60	29.74	94.34
	Downlink	LTE 5 MHz	760.50	-61.87	33.31	95.18
		LTE 10 MHz	763.00	-61.78	33.06	94.84

5.6. NOISE FIGURE

Test Requirements:

§ 90.219 Use of signal boosters.

(e) Device Specifications. In addition to the general rules for equipment certification in § 90.203(a)(2) and part 2, subpart J of this chapter, a signal booster must also meet the rules in this paragraph.

(2) The noise figure of a signal booster must not exceed 9 dB in either direction.

Test Procedures:

Measurements were in accordance with Agilent Application Note 57-1, 'The Direct Noise Measurement Method".

The output power of the device is measured with an input termination at a temperature of approximately 290K. If the gain of the device and noise bandwidth of the measurement system is known, the noise factor can be determined.

$$F_{sys} = \frac{N_o}{kT_oBG}$$

F_{sys} = System Noise Factor

N_0 = Output Noise Power

k = Boltzmann's Constant

T_0 = Standard Noise Temperature (290K)

B = Noise Bandwidth

G = Gain

'kT_0B' calculation result for 1 MHz noise bandwidth is -114 dBm/MHz.

'Gain' value can be obtained from the test performed previously.

For measure the 'output noise power', perform the following procedure.

a) Remove a signal generator from the input port of EUT then terminate it.

b) Turn off the AGC function in EUT.

c) Connect a spectrum analyzer to output port of EUT.

e) Set the RBW 1 MHz. and set the VBW to ≥ 3 × RBW.

f) Measure the maximum output noise power for EUT pass band.

After the measurement, calculate the noise figure according to the following formular.

Noise Figure = Noise Output Power - kT0B - Gain

Test Results:

Test Band	Link	Input Power (dBm)	Output Power (dBm)	Gain (dB)	kT_0B (dBm/MHz)	Measured Value (dBm)	Noise Figure (dB)
PS700	Uplink	-64.159	30.230	94.39	-114	-13.049	6.56
	Downlink	-61.477	32.733	94.21	-114	-11.842	7.95
PS800	Uplink	-64.606	30.169	94.78	-114	-12.526	6.70
	Downlink	-61.573	32.840	94.41	-114	-11.760	7.83

*** This test was performed on a single RDU unit.**

5.7. OUT-OF-BAND/OUT-OF-BLOCK EMISSIONS AND SPURIOUS EMISSIONS

§ 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.

§ 90.219 Use of signal boosters.

(e) Device Specifications. In addition to the general rules for equipment certification in § 90.203(a)(2) and part 2, subpart J of this chapter, a signal booster must also meet the rules in this paragraph.

(3) Spurious emissions from a signal booster must not exceed －13 dBm within any 100 kHz measurement bandwidth.

§ 90.543 Emission limitations.

Transmitters designed to operate in 769-775 MHz and 799-805 MHz frequency bands must meet the emission limitations in paragraphs (a) through (d) of this section. Class A and Class B signal boosters retransmitting signals in the 769-775 MHz and 799-805 MHz frequency bands are exempt from the limits listed in paragraph (a) of this section when simultaneously retransmitting multiple signals and instead shall be subject to the limit listed in paragraph (c) of this section when operating in this manner. Transmitters operating in 758-768 MHz and 788-798 MHz bands must meet the emission limitations in (e) of this section.

(c) Out-of-band emission limit. On any frequency outside of the frequency ranges covered by the ACP tables in this section, the power of any emission must be reduced below the mean output power (P) by at least 43 + 10log (P) dB measured in a 100 kHz bandwidth for frequencies less than 1 GHz, and in a 1 MHz bandwidth for frequencies greater than 1 GHz.

(e) For operations in the 758-768 MHz and the 788-798 MHz bands, the power of any emission outside the licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, in accordance with the following:

(1) On all frequencies between 769-775 MHz and 799-805 MHz, by a factor not less than 76 + 10 log (P) dB in a 6.25 kHz band segment, for base and fixed stations.

(3) On any frequency between 775-788 MHz, above 805 MHz, and below 758 MHz, by at least 43 + 10 log (P) dB.

(4) Compliance with the provisions of paragraphs (e)(1) and (2) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

(5) Compliance with the provisions of paragraph (e)(3) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of 30 kHz may be employed.

(f) For operations in the 758-775 MHz and 788-805 MHz bands, all emissions including harmonics in the band 1559-1610 MHz shall be limited to −70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and −80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

Test Procedures:

Measurements were in accordance with the test methods section 3.6 of KDB 935210 D05 v01r03.

Spurious emissions shall be measured using a single test signal sequentially tuned to the low, middle, and high channels or frequencies within each authorized frequency band of operation.
Out-of-band/out-of-block emissions (including intermodulation products) shall be measured under each of the following two stimulus conditions:
two adjacent test signals sequentially tuned to the lower and upper frequency band/block edges;
a single test signal, sequentially tuned to the lowest and highest frequencies or channels within the frequency band/block under examination.
NOTE—Single-channel boosters that cannot accommodate two simultaneous signals within the passband may be excluded from the test stipulated in step a).

3.6.2 Out-of-band/out-of-block emissions conducted measurements

a) Connect a signal generator to the input of the EUT.
If the signal generator is not capable of generating two modulated carriers simultaneously, then two discrete signal generators can be connected with an appropriate combining network to support this two-signal test.
b) Set the signal generator to produce two AWGN signals as previously described.
c) Set the center frequencies such that the AWGN signals occupy adjacent channels, as defined by industry standards such as 3GPP or 3GPP2, at the upper edge of the frequency band or block under test.
d) Set the composite power levels such that the input signal is just below the AGC threshold, but not more than 0.5 dB below. The composite power can be measured using the procedures provided in KDB Publication 971168, but it will be necessary to expand the power integration bandwidth so as to include both of the transmit channels.
e) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation as necessary.
f) Set the RBW = reference bandwidth in the applicable rule section for the supported frequency band.
g) Set the VBW = 3 × RBW.
h) Set the detector to power averaging (rms) detector.
i) Set the Sweep time = auto-couple.
j) Set the spectrum analyzer start frequency to the upper block edge frequency, and the stop frequency to the upper block edge frequency plus 300 kHz or 3 MHz, for frequencies below and above 1 GHz, respectively.
k) Trace average at least 100 traces in power averaging (rms) mode.
l) Use the marker function to find the maximum power level.

m) Capture the spectrum analyzer trace of the power level for inclusion in the test report.

n) Repeat steps k) to m) with the composite input power level set to 3 dB above the AGC threshold.

o) Reset the frequencies of the input signals to the lower edge of the frequency block or band under test.

p) Reset the spectrum analyzer start frequency to the lower block edge frequency minus 300 kHz or 3 MHz, for frequencies below and above 1 GHz, respectively, and the stop frequency to the lower band or block edge frequency.

q) Repeat steps k) to n).

r) Repeat steps a) to q) with the signal generator configured for a single test signal tuned as close as possible to the block edges.

s) Repeat steps a) to r) with the narrowband test signal.

t) Repeat steps a) to s) for all authorized frequency bands or blocks used by the EUT.

3.6.3 Spurious emissions conducted measurements

a) Connect a signal generator to the input of the EUT.

b) Set the signal generator to produce the broadband test signal as previously described.

c) Set the center frequency of the test signal to the lowest available channel within the frequency band or block.

d) Set the EUT input power to a level that is just below the AGC threshold, but not more than 0.5 dB below.

e) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation as necessary.

f) Set the RBW = reference bandwidth in the applicable rule section for the supported frequency band of operation.

g) Set the VBW ≥ 3 × RBW.

h) Set the Sweep time = auto-couple.

i) Set the spectrum analyzer start frequency to the lowest RF signal generated in the equipment, without going below 9 kHz, and the stop frequency to the lower band/block edge frequency minus 100 kHz or 1 MHz, as specified in the applicable rule part.

The number of measurement points in each sweep must be ≥ (2 × span/RBW), which may require that the measurement range defined by the start and stop frequencies be subdivided, depending on the available number of measurement points provided by the spectrum analyzer.

j) Select the power averaging (rms) detector function.

k) Trace average at least 10 traces in power averaging (rms) mode.

l) Use the peak marker function to identify the highest amplitude level over each measured frequency range. Record the frequency and amplitude and capture a plot for inclusion in the test report.

m) Reset the spectrum analyzer start frequency to the upper band/block edge frequency plus 100 kHz or 1 MHz, as specified in the applicable rule part, and the spectrum analyzer stop frequency to 10 times the highest frequency of the fundamental emission. The number of measurement points in each sweep must be ≥ (2 × span/RBW), which may require that the measurement range defined by the start and stop frequencies be subdivided, depending on the available number of measurement points provided by the spectrum analyzer.

n) Trace average at least 10 traces in power averaging (rms) mode.

o) Use the peak marker function to identify the highest amplitude level over each of the measured frequency

ranges. Record the frequency and amplitude and capture a plot for inclusion in the test report; also provide tabular data, if required.

p) Repeat steps i) to o) with the input test signals firstly tuned to a middle band/block frequency/channel, and then tuned to a high band/block frequency/channel.

q) Repeat steps b) to p) with the narrowband test signal.

r) Repeat steps b) to q) for all authorized frequency bands/blocks used by the EUT.

Measurements were in accordance with the test methods section 4.7 of KDB 935210 D05 v01r03.

Spurious emissions shall be measured using a single test signal sequentially tuned to frequencies within each authorized frequency band of operation.

Intermodulation products shall be measured using two CW signals with all available channel spacing with the center between these channels being equal to the center frequency f0 as determined from Out-of-band rejection test.

4.7.2 Out-of-band/out-of-block emissions conducted measurements

a) Connect a signal generator to the input of the EUT.
If the signal generator is not capable of producing two independent modulated carriers simultaneously, then two discrete signal generators can be connected, with an appropriate combining network to support the two-signal test.

b) Configure the two signal generators to produce CW on frequencies spaced consistent with f_0, with amplitude levels set to just below the AGC threshold.

c) Connect a spectrum analyzer to the EUT output.

d) Set the span to 100 kHz.

e) Set RBW = 300 Hz with VBW ≥ 3 × RBW.

f) Set the detector to power averaging (rms).

g) Place a marker on highest intermodulation product amplitude.

h) Capture the plot for inclusion in the test report.

i) Repeat steps c) to h) with the composite input power level set to 3 dB above the AGC threshold.

j) Repeat steps b) to i) for all operational bands.

4.7.3 EUT spurious emissions conducted measurements

a) Connect a signal generator to the input of the EUT.

b) Configure the signal generator to produce a CW signal.

c) Set the frequency of the CW signal to the center channel of the EUT passband.

d) Set the output power level so that the resultant signal is just below the AGC threshold.

e) Connect a spectrum analyzer to the output of the EUT, using appropriate attenuation as necessary.

f) Set the RBW = 100 kHz. (i.e., for 30 MHz to 1 GHz PLMRS and/or PSRS booster devices)

g) Set the VBW = 3 × RBW.

h) Set the Sweep time = auto-couple.

i) Set the detector to PEAK.

j) Set the spectrum analyzer start frequency to 30 MHz (or the lowest radio frequency signal generated in the EUT, without going below 9 kHz if the EUT has additional internal clock frequencies), and the stop frequency to 10 times the highest allowable frequency of the EUT passband.

k) Select MAX HOLD, and use the marker peak function to find the highest emission(s) outside the passband. (This

could be either at a frequency lesser or greater than the passband frequencies.)

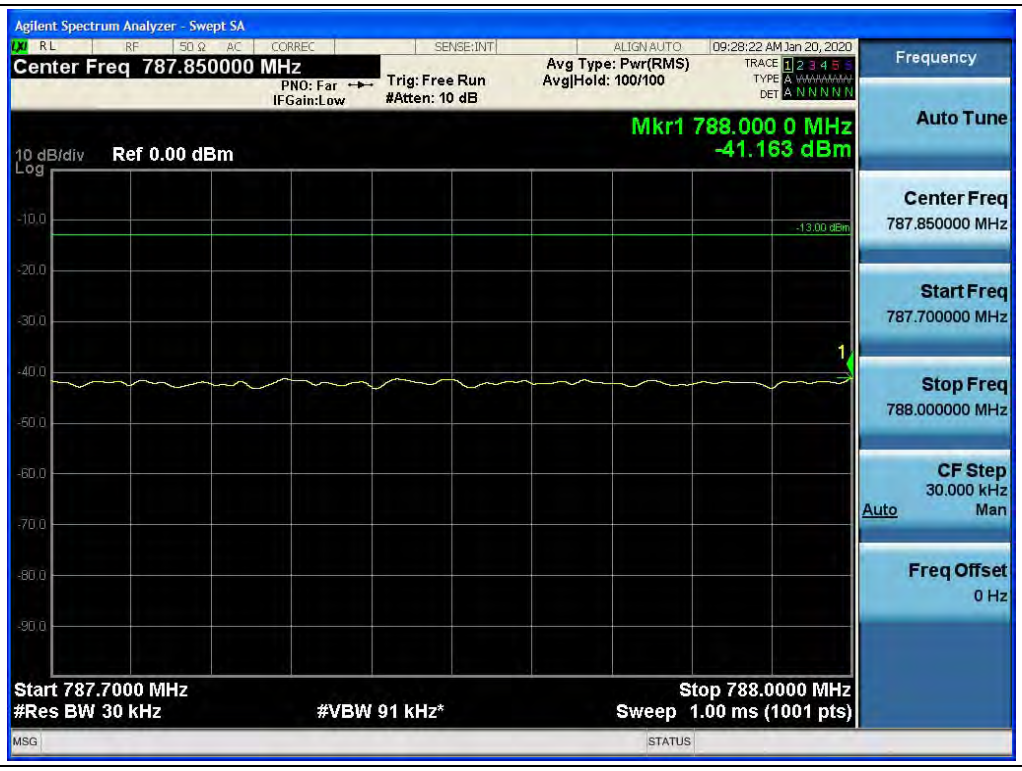
l) Capture a plot for inclusion in the test report.

m) Repeat steps c) to l) for each authorized frequency band/block of operation.

Test Results: Plot data of Out-of-band/out-of-block emissions

Out-of-band (two adjacent test signals) / FirstNet / LTE 5 MHz / Uplink / Upper

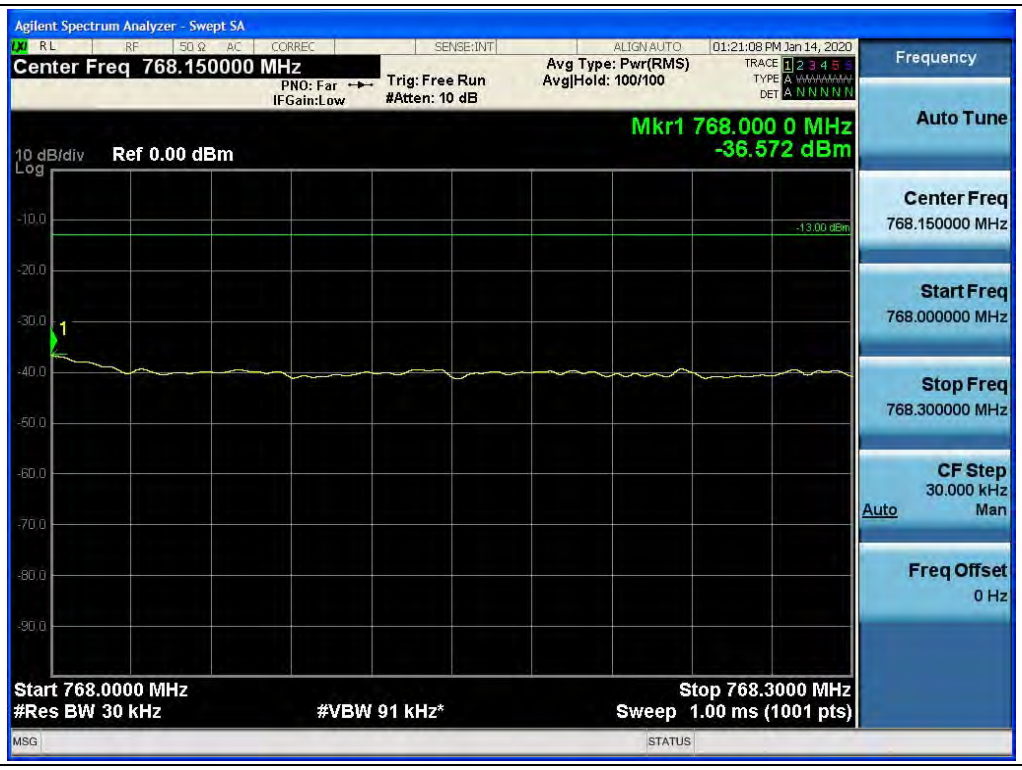
Out-of-band (two adjacent test signals) / FirstNet / LTE 5 MHz / Uplink / Lower



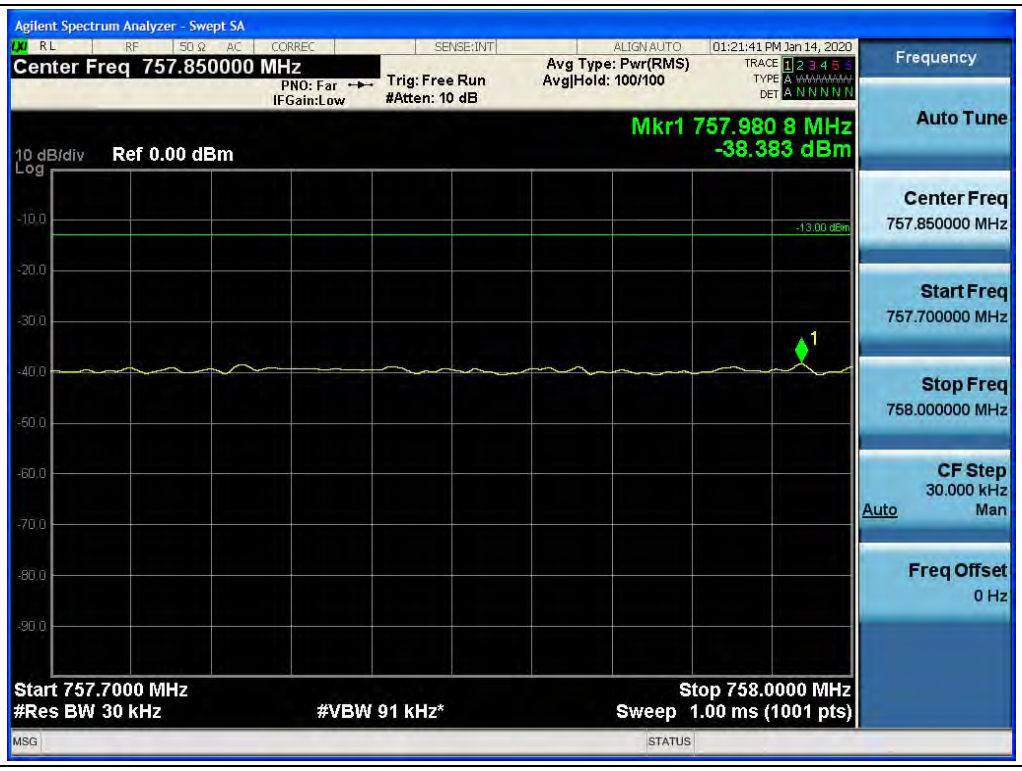
Out-of-band (two adjacent test signals) / FirstNet / LTE 10 MHz / Uplink / Upper

Out-of-band (two adjacent test signals) / FirstNet / LTE 10 MHz / Uplink / Lower

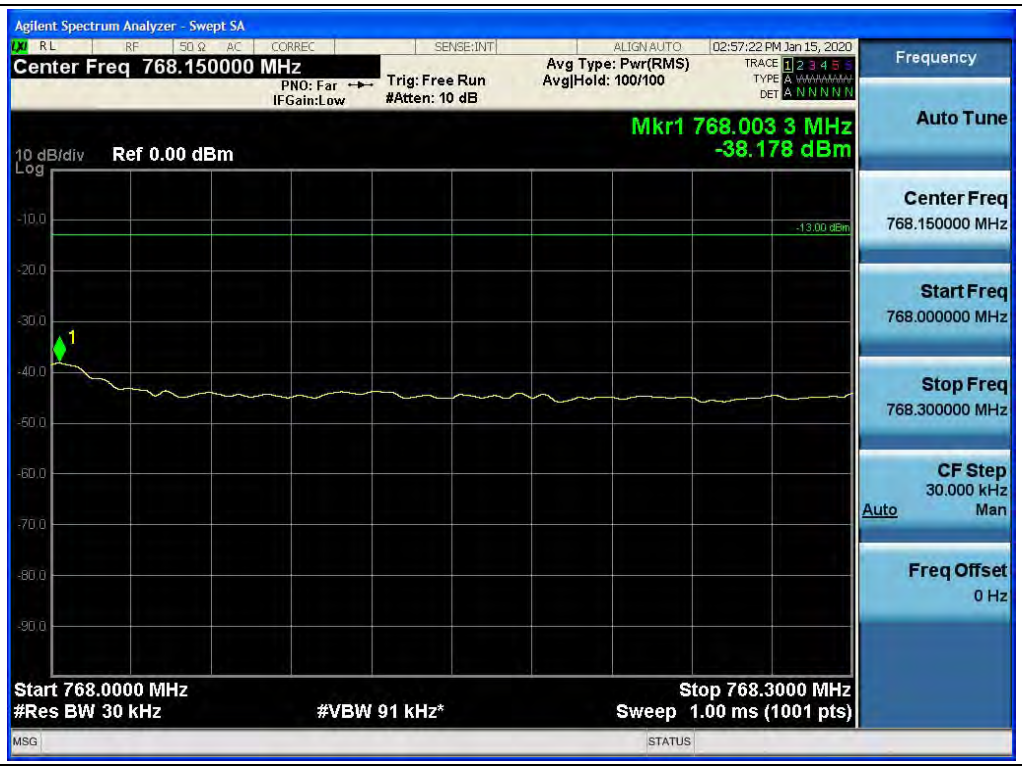
Out-of-band (two adjacent test signals) / FirstNet / LTE 5 MHz / Downlink / Upper



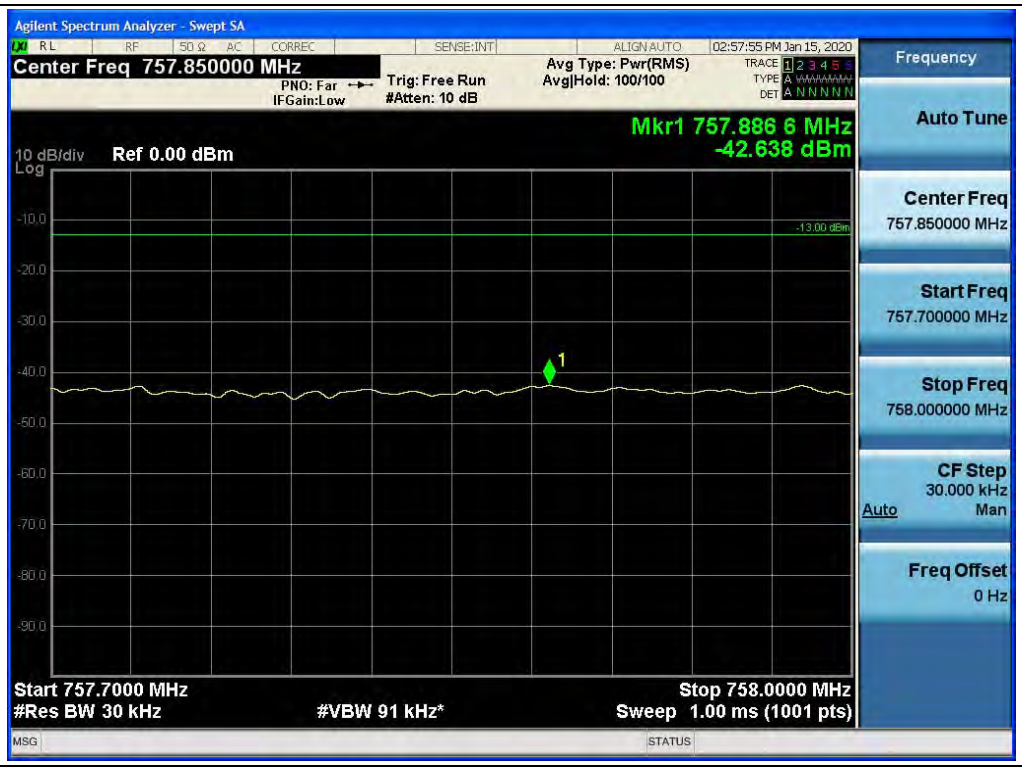
Out-of-band (two adjacent test signals) / FirstNet / LTE 5 MHz / Downlink / Lower



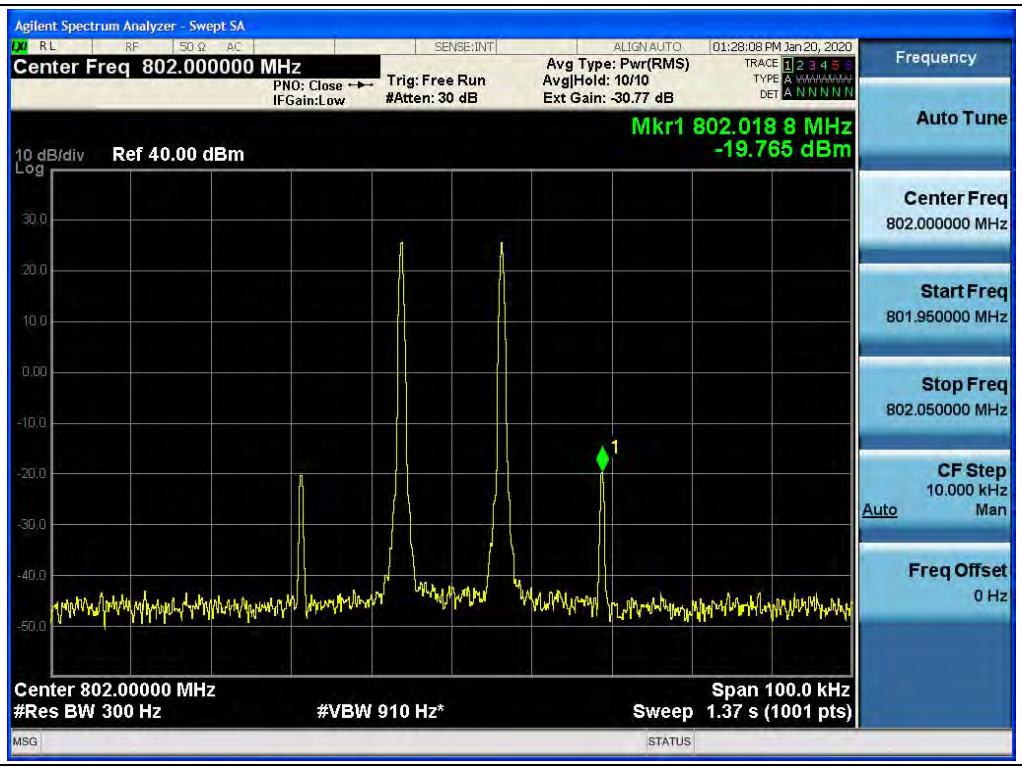
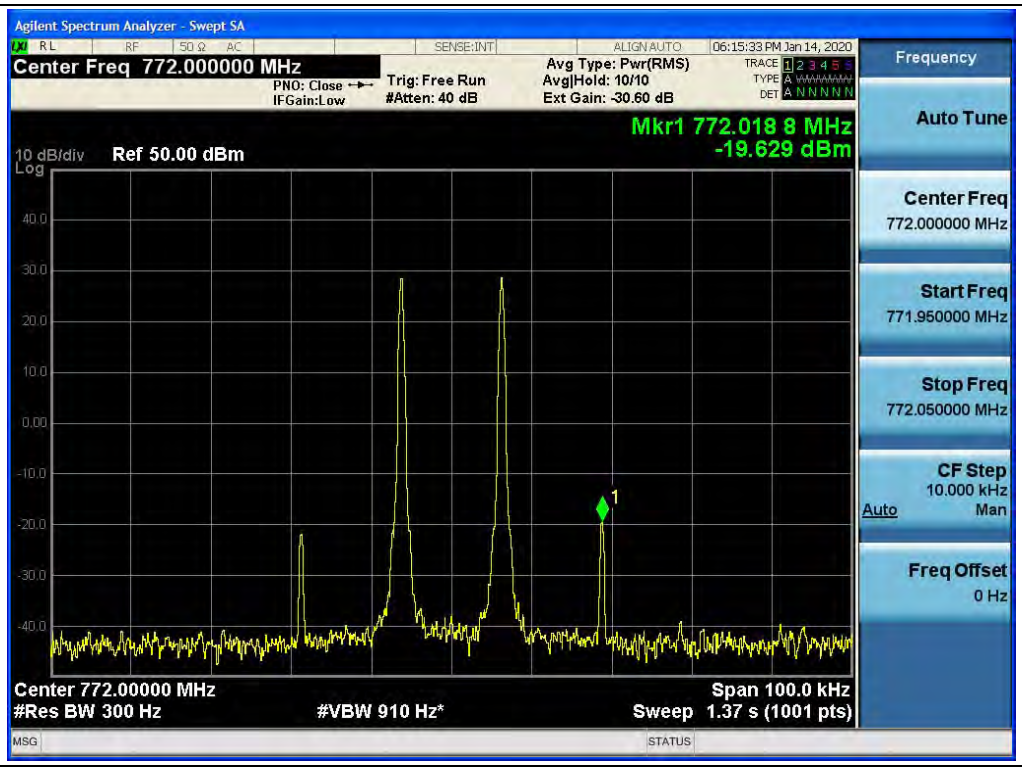
Out-of-band (two adjacent test signals) / FirstNet / LTE 10 MHz / Downlink / Upper



Out-of-band (two adjacent test signals) / FirstNet / LTE 10 MHz / Downlink / Lower



Out-of-band (two adjacent test signals) / PS700 / Uplink



Out-of-band (two adjacent test signals) / PS700 / Downlink