

TEST REPORT

FCC Test for 460084
Certification

APPLICANT
Wilson Electronics, LLC

REPORT NO.
HCT-RF-2507-FC004-R1

DATE OF ISSUE
July 14, 2025

Tested by
Kyung Soo Kang



Technical Manager
Jong Seok Lee



HCT CO., LTD.
Bongjai Huh
BongJai Huh / CEO

**HCT CO.,LTD.**

2-6, 73, 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Republic of Korea
Tel. +82 31 645 6300 Fax. +82 31 645 6401

TEST REPORT

REPORT NO.

HCT-RF-2507-FC004-R1

DATE OF ISSUE

July 14, 2025

Applicant**Wilson Electronics, LLC**

3301 E Deseret Drive, St George, UT 84790

Product Name

Repeater

Model Name

460084

FCC ID

PWO084

Output Power

Uplink: 27 dBm, Downlink: 37 dBm

Date of Test

May 16, 2025 ~ July 4, 2025

Location of Test

☒ Permanent Testing Lab ☐ On Site Testing

(Address: 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Republic of Korea)

Test Standard Used

CFR 47 Part 2, Part 90

Test Results

PASS

Manufacturer**innertron**

301, Harmony-ro, Yeonsu-gu, Incheon City 22014 Korea

REVISION HISTORY

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

Revision No.	Date of Issue	Description
0	July 07, 2025	Initial Release
1	July 14, 2025	Revised the Above 1 GHz diagram for the radiated test in Section 3.5.

Notice

Content

Engineering Statement:

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.

The results shown in this test report only apply to the sample(s), as received, provided by the applicant, unless otherwise stated.

The test results have only been applied with the test methods required by the standard(s).

The laboratory is not accredited for the test results marked *.

Information provided by the applicant is marked **.

Test results provided by external providers are marked ***.

When confirmation of authenticity of this test report is required, please contact www.hct.co.kr

The test results in this test report are not associated with the ((KS Q) ISO/IEC 17025) accreditation by KOLAS (Korea Laboratory Accreditation Scheme) / A2LA (American Association for Laboratory Accreditation) that are under the ILAC (International Laboratory Accreditation Cooperation) Mutual Recognition Agreement (MRA).

CONTENTS

1. GENERAL INFORMATION	5
1.1. APPLICANT INFORMATION	5
1.2. PRODUCT INFORMATION	5
1.3. TEST INFORMATION	5
2. FACILITIES AND ACCREDITATIONS	6
2.1. FACILITIES	6
2.2. EQUIPMENT	6
3. TEST SPECIFICATIONS	7
3.1. STANDARDS	7
3.2. ADDITIONAL DESCRIPTIONS ABOUT TEST	8
3.3. MEASUREMENT UNCERTAINTY	10
3.4. STANDARDS ENVIRONMENTAL TEST CONDITIONS	10
3.5. TEST DIAGRAMS	11
4. TEST EQUIPMENTS	13
5. TEST RESULT	14
5.1. AGC THRESHOLD	14
5.2. OUT-OF-BAND REJECTION	16
5.3. OCCUPIED BANDWIDTH	19
5.4. INPUT-VERSUS-OUTPUT SIGNAL COMPARISON	40
5.5. INPUT/OUTPUT POWER AND AMPLIFIER/BOOSTER GAIN	55
5.6. NOISE FIGURE	59
5.7. OUT-OF-BAND/OUT-OF-BLOCK EMISSIONS AND SPURIOUS EMISSIONS	63
5.8. RADIATED SPURIOUS EMISSIONS	99
5.9. FREQUENCY STABILITY	102
6. Annex A_EUT AND TEST SETUP PHOTO	109

1. GENERAL INFORMATION

1.1. APPLICANT INFORMATION

Company Name	Wilson Electronics, LLC
Company Address	3301 E Deseret Drive, St George, UT 84790

1.2. PRODUCT INFORMATION

EUT Type	Repeater		
EUT Serial Number	25IT01000001		
Power Supply	110-240 VAC, 50/60 Hz		
Frequency Range	Band Name	Uplink (MHz)	Downlink (MHz)
	FirstNet	788 ~ 798	758 ~ 768
	Public Safety Narrowband	799 ~ 805	769 ~ 775
	NPSPAC	806 ~ 809	851 ~ 854
	B/ILT; SMR	809 ~ 816	854 ~ 861
Tx Output Power	Uplink: 27 dBm, Downlink: 37 dBm		
Antenna Peak Gain	Uplink: 9.0 dBi, Downlink: 1.5 dBi		

1.3. TEST INFORMATION

FCC Rule Parts	CFR 47 Part 90
Measurement Standards	KDB 935210 D05 v01r04, KDB 971168 D01 v03r01, ANSI C63.26-2015
Test Location	74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Republic of Korea

2. FACILITIES AND ACCREDITATIONS

2.1. FACILITIES

The SAC(Semi-Anechoic Chamber) and conducted measurement facility used to collect the radiated data are located at the 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA. The site is constructed in conformance with the requirements of ANSI C63.4. (Version :2014) and CISPR Publication22. Detailed description of test facility was submitted to the Commission and accepted dated March 11, 2024 (CAB identifier: KR0032).

2.2. EQUIPMENT

Radiated emissions are measured with one or more of the following types of linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements.

Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.

All receiving equipment conforms to CISPR Publication 16-1, “Radio Interference Measuring Apparatus and Measurement Methods.”

3. TEST SPECIFICATIONS

3.1. STANDARDS

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with FCC CFR 47 Part 2, Part 90.

Description	Reference	Results
AGC threshold	KDB 935210 D05 v01r04 3.2 KDB 935210 D05 v01r04 4.2	Compliant
Out-of-band rejection	KDB 935210 D05 v01r04 3.3 KDB 935210 D05 v01r04 4.3	Compliant
Occupied Bandwidth	§ 2.1049 § 90.209, § 90.219(e)(4)(ii)	Compliant
Input-versus-output signal comparison	§ 90.210, § 90.219(e)(4)(iii)	Compliant
Input/output power and amplifier/booster gain	§ 2.1046, § 90.219(e)(1)	Compliant
Noise figure	§ 90.219(e)(2)	Compliant
Out-of-band/out-of-block emissions and spurious emissions	§ 2.1051, § 90.219(e)(3), § 90.543(c), (e)(1), (f)	Compliant
Spurious emissions radiated	§ 2.1053	Compliant
Frequency Stability	§ 90.213	Compliant

3.2. 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.
- The test was generally based on the method of KDB 935210 D05 v01r04 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	Uplink (MHz)	Downlink (MHz)	Tested Signal
FirstNet	788 ~ 798	758 ~ 768	LTE 10 MHz
Public Safety Narrowband	799 ~ 805	769 ~ 775	CW, P25 Phase 1 (12.5 kHz)
NPSPAC	806 ~ 809	851 ~ 854	
B/ILT; SMR	809 ~ 816	854 ~ 861	

- Simultaneous transmission band condition

700 MHz band	800 MHz band
FirstNet, Public Safety Narrowband	NPSPAC, B/ILT; SMR

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	0.873	800	0.891
650	0.872	850	0.877
700	0.855	900	0.947
750	0.895	950	1.005

: Output Path

Correction factor table			
Frequency (MHz)	Factor (dB)	Frequency (MHz)	Factor (dB)
2	29.800	2 000	32.469
10	29.497	2 100	32.463
30	29.808	2 200	32.532
50	31.279	2 300	32.542
100	30.008	2 400	32.699
200	30.403	2 500	32.713
300	30.641	2 600	32.872
400	30.762	2 700	32.914
500	30.970	2 800	32.942
600	31.105	2 900	33.033
700	31.163	3 000	33.048
800	31.279	4 000	33.704
900	31.383	5 000	34.081
1 000	31.491	6 000	33.279
1 100	31.602	7 000	33.543
1 200	31.711	8 000	34.023
1 300	31.770	9 000	34.324
1 400	31.763	10 000	35.259
1 500	31.919	-	-
1 600	32.047	-	-
1 700	32.068	-	-
1 800	32.130	-	-
1 900	32.341	-	-

3.3. MEASUREMENT UNCERTAINTY

Parameter	Expanded Uncertainty
Radiated Disturbance	9 kHz ~ 30 MHz
	4.36 dB
	30 MHz ~ 1 GHz
	5.68 dB
	1 GHz ~ 18 GHz
	5.75 dB
	18 GHz ~ 40 GHz
	5.82 dB

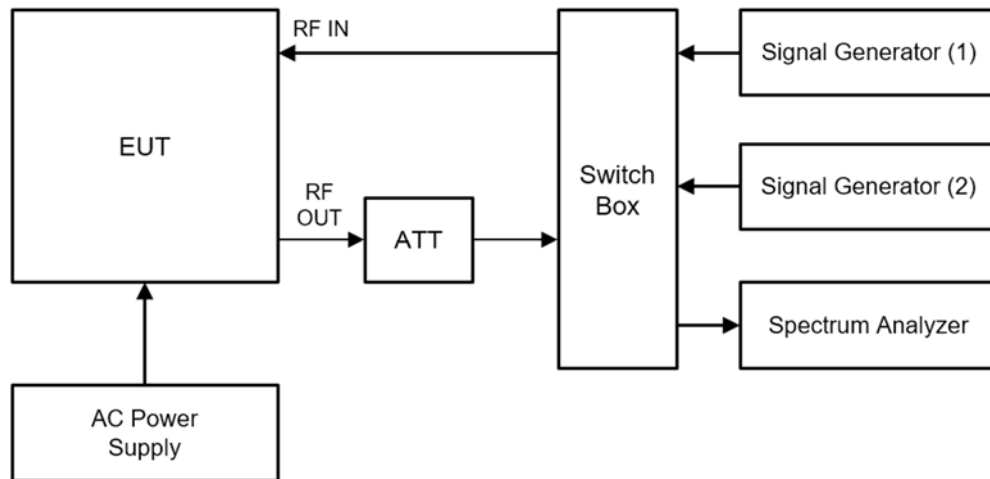
Coverage factor $k=2$, Confidence levels of 95 %

3.4. STANDARDS ENVIRONMENTAL TEST CONDITIONS

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

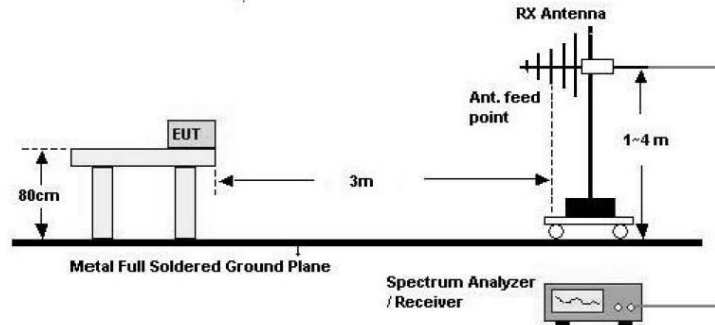
3.5. TEST DIAGRAMS

Conducted Test

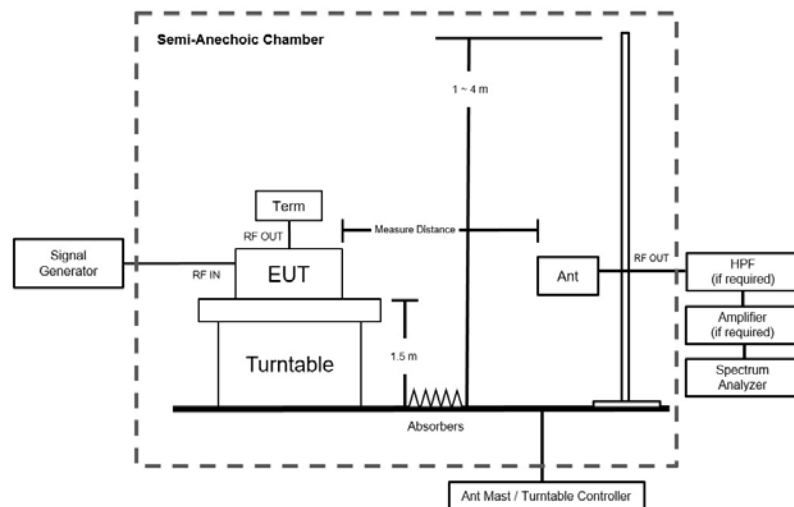


Radiated Test

30 MHz ~ 1 GHz

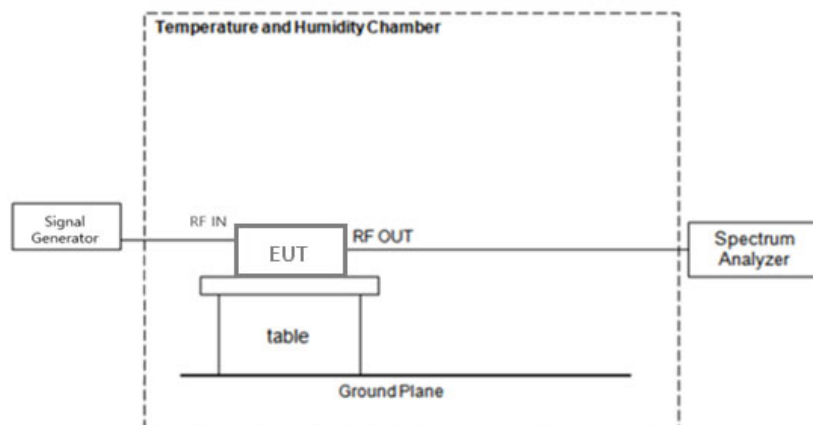


Above 1 GHz



Note: Measure distance for Above 1 GHz is 3 m.

Frequency Stability



4. TEST EQUIPMENTS

Equipment	Model	Manufacturer	Serial No.	Due to Calibration	Calibration Interval
MXA Signal Analyzer	N9020A	Agilent	MY51110063	03/24/2026	Annual
# MXG Vector Signal Generator	N5182A	Agilent	MY47070230	03/19/2026	Annual
# 30 dB Attenuator	WA93-30-33	Weinschel Associates	0113	11/15/2025	Annual
AC Power Supply	PCR2000MA	KIKUSUI	ZL002530	01/13/2026	Annual
Switch	S46-SV11	KEITHLEY	1088025	N/A	N/A
# 50Ω Termination	908A	H.P.	N/A	N/A	N/A
Temperature and Humidity Chamber	NY-THR18750	NANGYEAL	NY-200912201A	12/23/2025	Annual
Amp & Filter Bank Switch Controller	FBSM-01B	TNM system	TM20090002	N/A	N/A
Controller(Antenna Mast & Turn Table)	CO3000	Innco systems	CO3000/1251/48920320/P	N/A	N/A
Antenna Position Tower	MA4640/800-XP-EP	Innco systems	N/A	N/A	N/A
Turn Table	1060	Innco systems	N/A	N/A	N/A
Turn Table	Turn Table	Ets	N/A	N/A	N/A
Loop Antenna	FMZB 1513	Rohde & Schwarz	1513-333	03/07/2026	Biennial
Hybrid Antenna	VULB 9168	Schwarzbeck	9168-0895	08/28/2026	Biennial
Horn Antenna	BBHA 9120D	Schwarzbeck	9120D-937	02/07/2027	Biennial
Horn Antenna	BBHA9170	Schwarzbeck	BBHA9170124	09/20/2026	Biennial
RF Switching System	FBSR-04C	TNM system	S4L4	03/12/2026	Annual
Low Noise Amplifier	TK-PA1840H	TESTEK	170011-L	10/11/2025	Annual
High Pass Filter	WHKX10-900-1000-15000-40SS	WAINWRIGHT INSTRUMENTS	16	07/24/2025	Annual

This equipment has been used to each port or each band, but we only listed one equipment for simplicity.

Note:

1. Equipment listed above that calibrated during the testing period was set for test after the calibration.
2. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.

5. TEST RESULT

5.1. AGC THRESHOLD

Test Requirement:

KDB 935210 D05 v01r04

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 v01r04.

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.

Output power measurement in subclause 5.2.4.4.1 of ANSI C63.26

- a) Set span to $2 \times$ to $3 \times$ the OBW.
- b) Set RBW = 1% to 5% of the OBW.
- c) Set VBW $\geq 3 \times$ RBW.
- d) Set number of measurement points in sweep $\geq 2 \times$ 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.

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.

Measurements were in accordance with the test methods section 4.2 of KDB 935210 D05 v01r04.

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.

Measurement were in accordance with the test methods in subclause 7.2.3.1 of ANSI C63.26.

- Connect a signal generator to the input of the EUT.
- Connect a spectrum analyzer or power meter to the output of the EUT using appropriate attenuation.
- The signal generator must be set for CW operation.
- While monitoring the output of the EUT, increase the input level until a 1 dB increase in the input signal no longer causes a 1 dB increase in the output signal.
- This is the AGC threshold level of the EUT.

Test Results:

Test Band	Link	Signal	Center Frequency (MHz)	AGC Threshold Level (dBm)	Output Level (dBm)
FirstNet	Uplink	LTE 10 MHz	793.00	-53	27.35
	Downlink		763.00	-52	37.49
Public Safety Narrowband	Uplink	CW	802.00	-52	27.01
	Downlink		772.50	-52	37.74
NPSPAC	Uplink		807.50	-53	26.91
	Downlink		852.50	-53	37.34
B/ILT; SMR	Uplink		812.50	-53	27.10
	Downlink		857.50	-53	37.26

5.2. OUT-OF-BAND REJECTION

Test Requirement:

KDB 935210 D05 v01r04

Out-of-band rejection required.

Test Procedures:

Measurements were in accordance with the test methods section 3.3 of KDB 935210 D05 v01r04.

A signal booster shall reject amplification of other signals outside of its passband. Adjust the internal gain control of the EUT (if so equipped) 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 = $\text{SPAN}/(\text{RBW}/2)$.
- 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 $\geq 3 \times \text{RBW}$.
- 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.

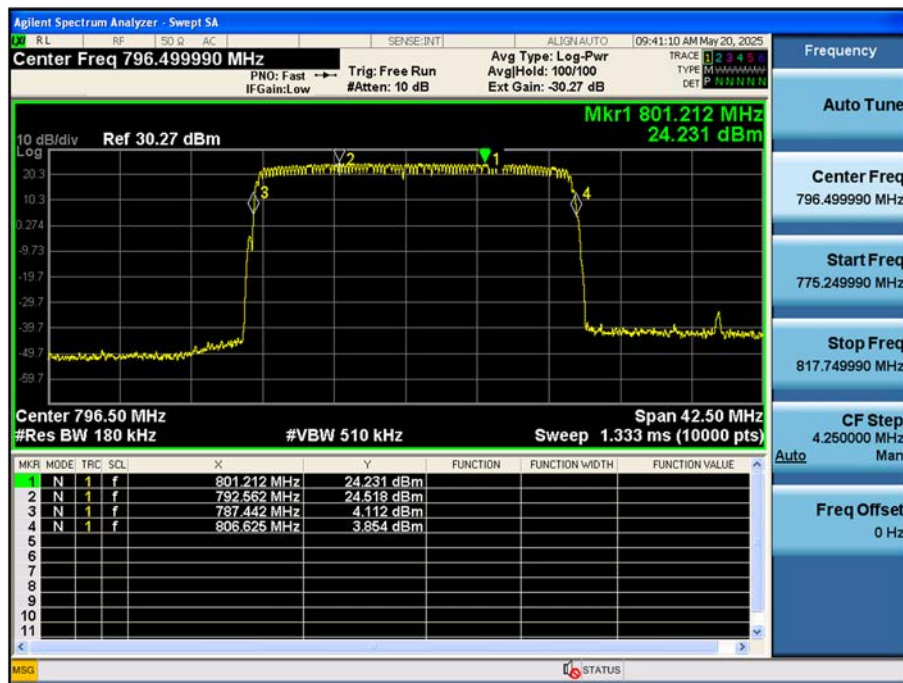
Measurements were in accordance with the test methods section 4.3 of KDB 935210 D05 v01r04.

A signal booster shall reject amplification of other signals outside of its passband. 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 = $3 \times \text{RBW}$.
- 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 f_0 , 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.

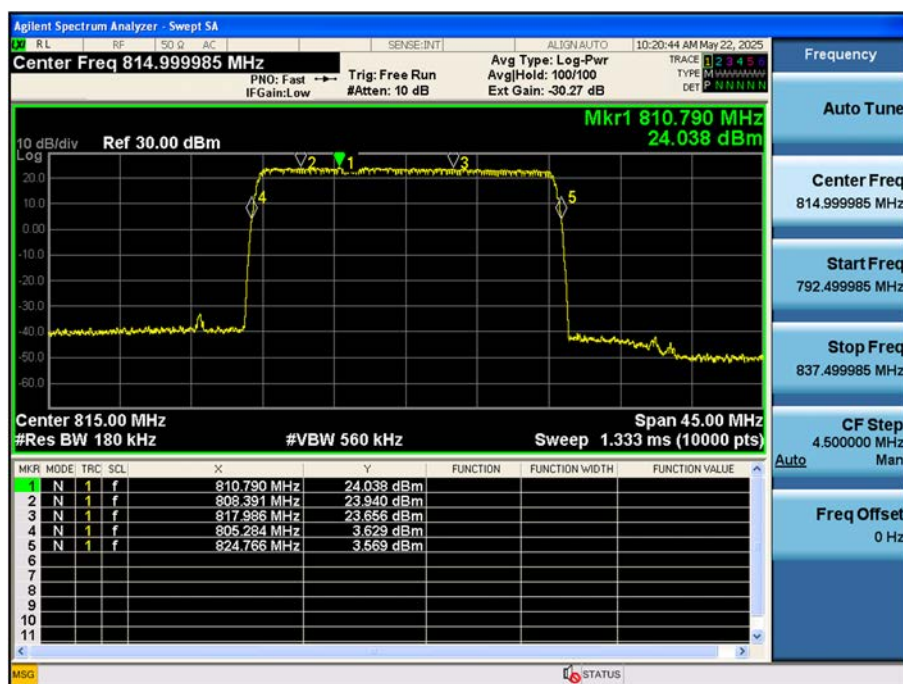
Test Results:

700 MHz (FirstNet, Public Safety Narrowband) / Uplink



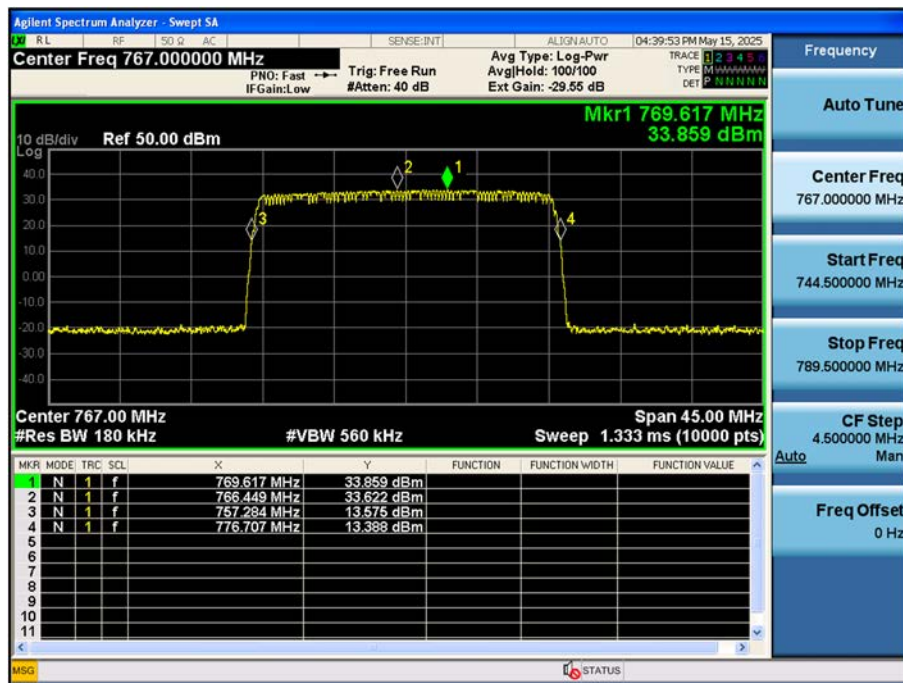
Note: The EUT is amplified from 788 to 806 MHz, but this report includes results only for the 788 ~ 798 MHz and 799 ~ 805 MHz bands.

800 MHz (NPSPAC, B/ILT; SMR) / Uplink



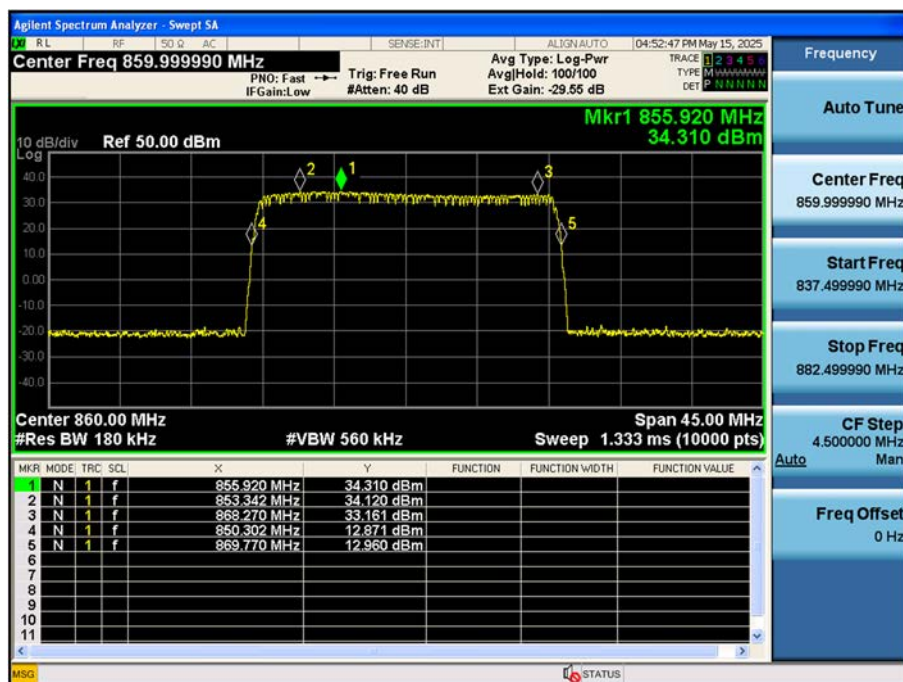
Note: The EUT is amplified from 806 to 824 MHz, but this report includes results only for the 806 ~ 809 MHz and 809 ~ 816 MHz bands.

700 MHz (FirstNet, Public Safety Narrowband) / Downlink



Note: The EUT is amplified from 758 to 776 MHz, but this report includes results only for the 758 ~ 768 MHz and 769 ~ 775 MHz bands.

800 MHz (NPSPAC, B/ILT; SMR) / Downlink



Note: The EUT is amplified from 851 to 869 MHz, but this report includes results only for the 851 ~ 854 MHz and 854 ~ 861 MHz bands.

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.

§ 90.209 Bandwidth limitations.

Table 1 to § 90.209(b)(5) - Standard Channel Spacing/Bandwidth

Frequency band (MHz)	Channel spacing (kHz)	Authorized bandwidth (kHz)
Below 25		
25-50	20	20
72-76	20	20
150-174	7.5	¹ 20/11.25/6
216-220	6.25	20/11.25/6
220-222	5	4
406-512	6.25	20/11.25/6
806-809/851-854 [#]	12.5	20
809-817/854-862	12.5	20/11.25
817-824/862-869	25	20
896-901/935-940	12.5	13.6
902-928		
929-930	25	20
1427-1432	12.5	12.5
2450-2483.5		
Above 2500		

§ 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 v01r04.

A 26 dB bandwidth measurement shall be performed on the input signal and the output signal; alternatively, the 99 % OBW can be measured and used. See KDB Publication 971168 [R8] for more information on measuring OBW.

- Connect a signal generator to the input of the EUT.
- Configure the signal generator to transmit the AWGN signal.
- 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 $\geq 3 \times \text{RBW}$.
- 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 $[10 \log (\text{OBW} / \text{RBW})]$ below the reference level. Steps f) and g) may require iteration to enable adjustments within the specified tolerances.
- h) The noise floor of the spectrum analyzer at the selected RBW shall be at least 36 dB below the reference level.
- i) Set spectrum analyzer detection function to positive peak.
- j) Set the trace mode to max hold.
- k) 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.
- l) 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.
- m) Repeat steps e) to l) with the input signal connected directly to the spectrum analyzer (i.e., input signal measurement).
- n) 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.
- o) 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. 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 $1.5 \times \text{OBW}$ 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 $\geq 3 \times \text{RBW}$.
- 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 Input Occupied Bandwidth

Test Band	Link	Signal	Center Frequency (MHz)	99 % OBW (MHz)	26 dB OBW (MHz)
FirstNet	Uplink	LTE 10 MHz	793.00	8.9836	9.8400
	Downlink		763.00	8.9843	9.9660
Test Band	Link	Signal	Center Frequency (MHz)	99 % OBW (kHz)	26 dB OBW (kHz)
Public Safety Narrowband	Uplink	P25 Phase 1	802.00	8.3258	11.497
	Downlink		772.50	8.2916	11.439
NPSPAC	Uplink		807.50	8.2975	10.388
	Downlink		852.50	8.2284	10.463
B/ILT; SMR	Uplink		812.50	8.3099	10.880
	Downlink		857.50	8.2359	11.728

Tabular data of Output Occupied Bandwidth

Test Band	Link	Signal	Center Frequency (MHz)	99 % OBW (MHz)	26 dB OBW (MHz)
FirstNet	Uplink	LTE 10 MHz	793.00	8.9519	9.7840
	Downlink		763.00	8.9693	9.9020
Test Band	Link	Signal	Center Frequency (MHz)	99 % OBW (kHz)	26 dB OBW (kHz)
Public Safety Narrowband	Uplink	P25 Phase 1	802.00	8.2256	11.251
	Downlink		772.50	8.2584	11.289
NPSPAC	Uplink		807.50	8.1886	10.742
	Downlink		852.50	8.3230	10.923
B/ILT; SMR	Uplink		812.50	8.2977	10.908
	Downlink		857.50	8.3677	11.597

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

Test Band	Link	Signal	Center Frequency (MHz)	99 % OBW (MHz)	26 dB OBW (MHz)
FirstNet	Uplink	LTE 10 MHz	793.00	8.9725	9.8620
	Downlink		763.00	8.9548	9.8600
Test Band	Link	Signal	Center Frequency (MHz)	99 % OBW (kHz)	26 dB OBW (kHz)
Public Safety Narrowband	Uplink	P25 Phase 1	802.00	8.1923	11.317
	Downlink		772.50	8.3503	11.602
NPSPAC	Uplink		807.50	8.1746	10.919
	Downlink		852.50	8.2502	10.693
B/ILT; SMR	Uplink		812.50	8.2394	10.488
	Downlink		857.50	8.1035	11.163

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

Test Band	Link	Signal	Center Frequency (MHz)	99 % OBW (MHz)	26 dB OBW (MHz)
FirstNet	Uplink	LTE 10 MHz	793.00	8.9435	9.8280
	Downlink		763.00	8.9306	9.8840
Test Band	Link	Signal	Center Frequency (MHz)	99 % OBW (kHz)	26 dB OBW (kHz)
Public Safety Narrowband	Uplink	P25 Phase 1	802.00	8.2430	10.907
	Downlink		772.50	8.3281	11.125
NPSPAC	Uplink		807.50	8.1987	11.257
	Downlink		852.50	8.3039	10.429
B/ILT; SMR	Uplink		812.50	8.2818	10.851
	Downlink		857.50	8.2640	10.954

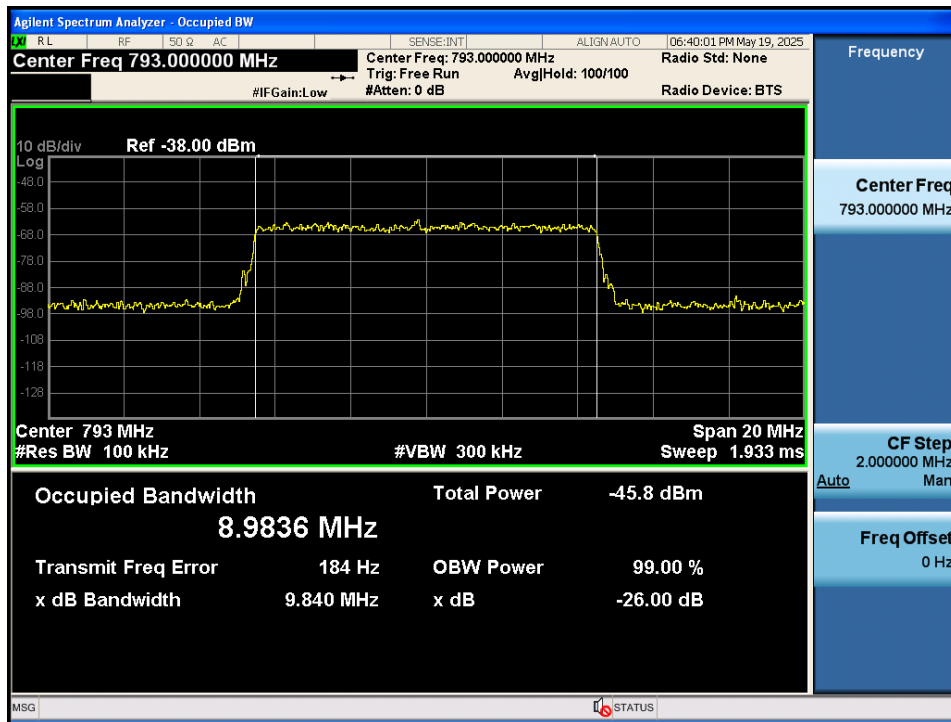
Measured Occupied Bandwidth Comparison

Test Band	Link	Signal	Variant of Input and output Occupied Bandwidth (%)	Variant of Input and 3 dB above the AGC threshold output Occupied Bandwidth (%)
FirstNet	Uplink	LTE 10 MHz	-0.57	-0.34
	Downlink		-0.64	0.24
Public Safety Narrowband	Uplink	P25 Phase 1	-2.14	-3.62
	Downlink		-1.31	-4.11
NPSPAC	Uplink		3.41	3.10
	Downlink		4.40	-2.47
B/ILT; SMR	Uplink		0.26	3.46
	Downlink		-1.12	-1.87

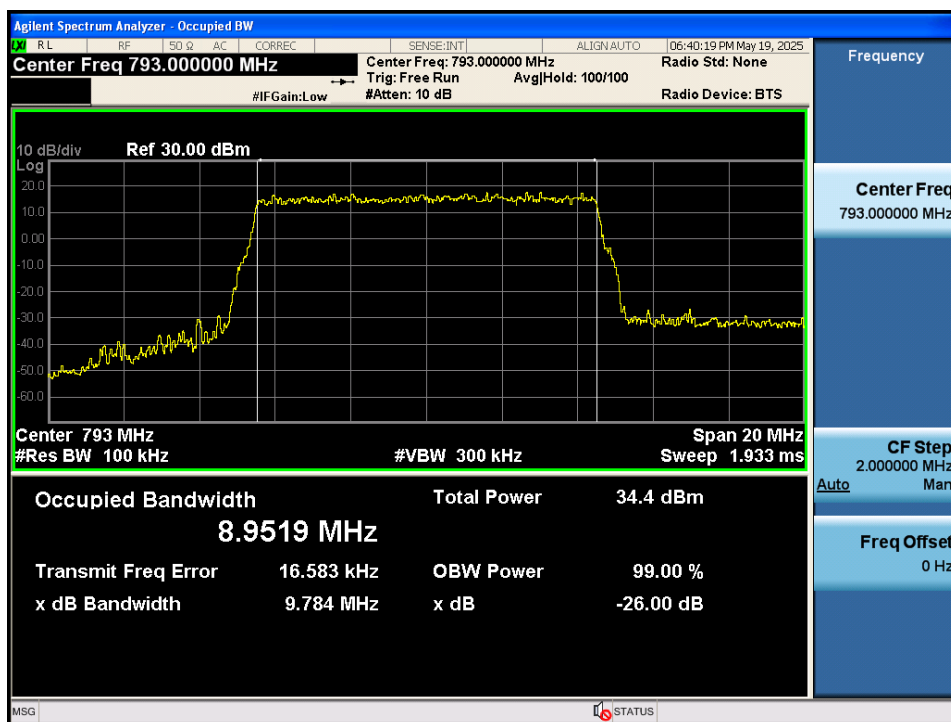
Change in input-output OBW is less than $\pm 5\%$.

Plot data of Occupied Bandwidth

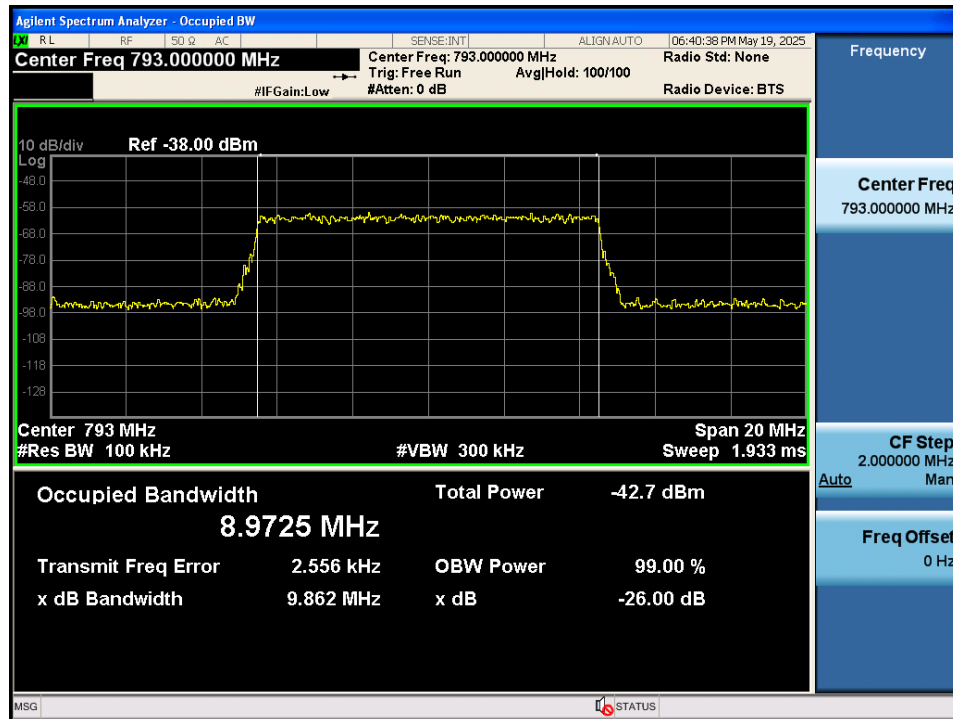
Input / FirstNet / Uplink / LTE 10 MHz



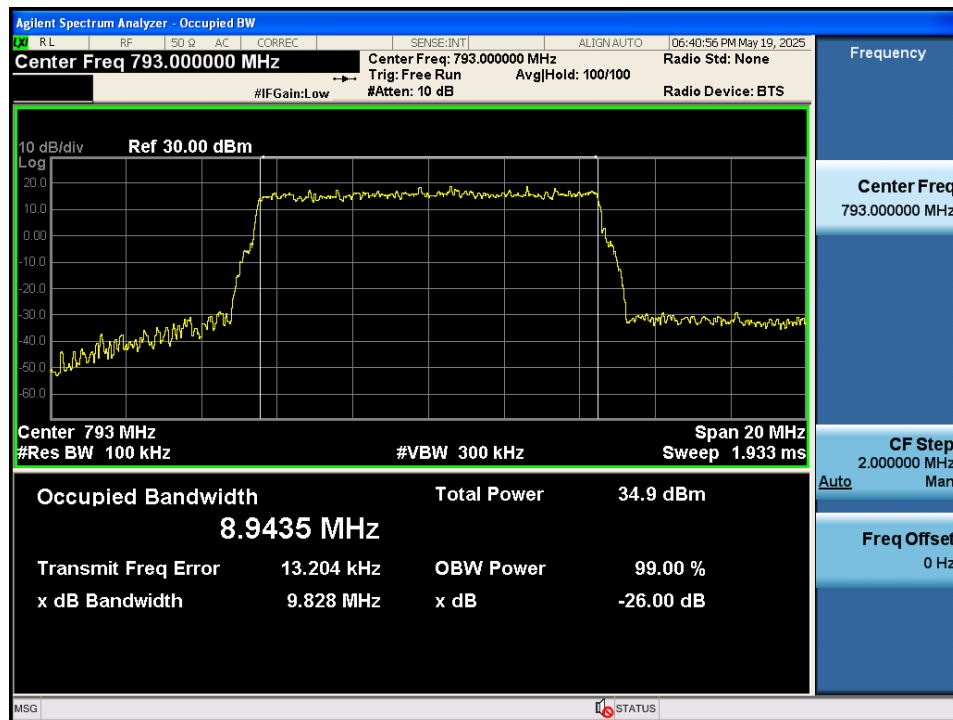
Output / FirstNet / Uplink / LTE 10 MHz



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



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



Input / Public Safety Narrowband / Uplink / P25 Phase 1



Output / Public Safety Narrowband / Uplink / P25 Phase 1



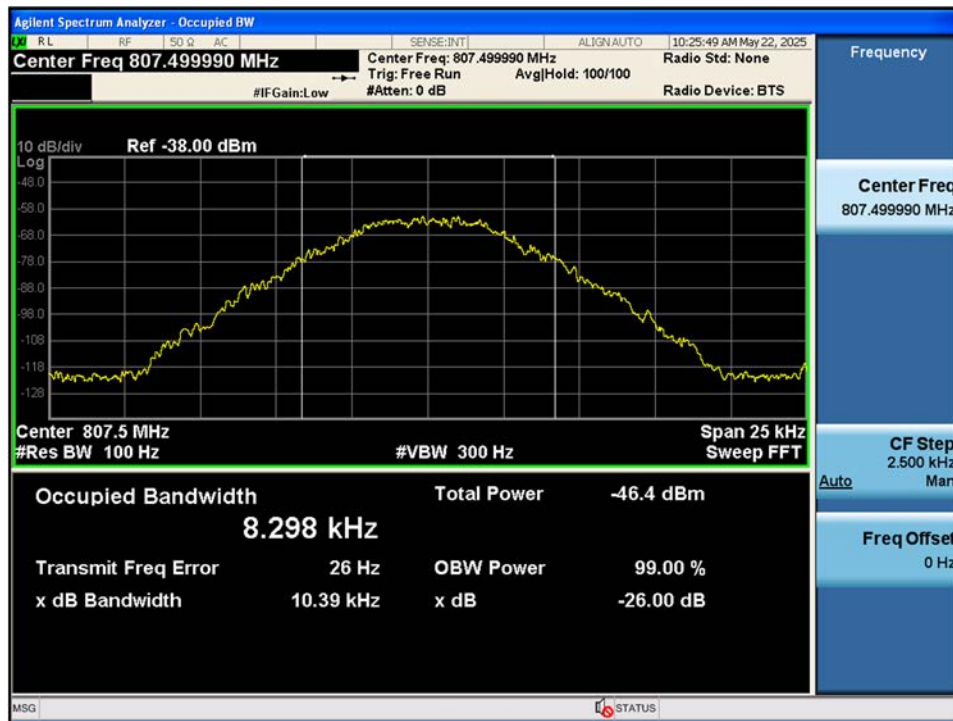
3 dB above the AGC threshold Input / Public Safety Narrowband / Uplink / P25 Phase 1



3 dB above the AGC threshold output / Public Safety Narrowband / Uplink / P25 Phase 1



Input / NPSPAC / Uplink / P25 Phase 1



Output / NPSPAC / Uplink / P25 Phase 1



3 dB above the AGC threshold Input / NPSPAC / Uplink / P25 Phase 1



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



Input / B/ILT; SMR / Uplink / P25 Phase 1



Output / B/ILT; SMR / Uplink / P25 Phase 1



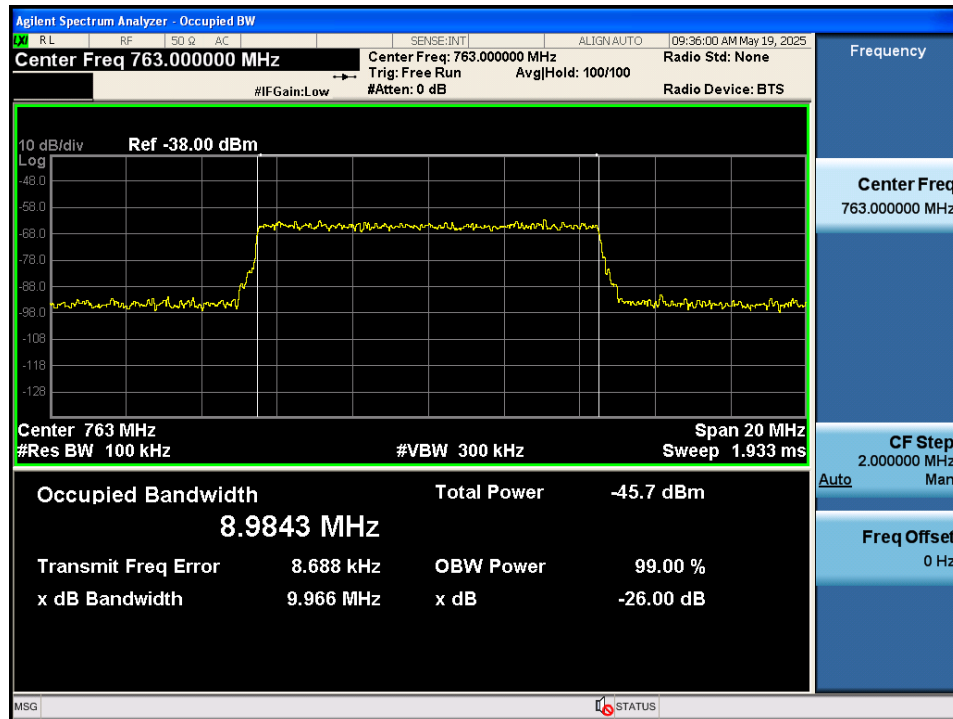
3 dB above the AGC threshold Input / B/ILT; SMR / Uplink / P25 Phase 1



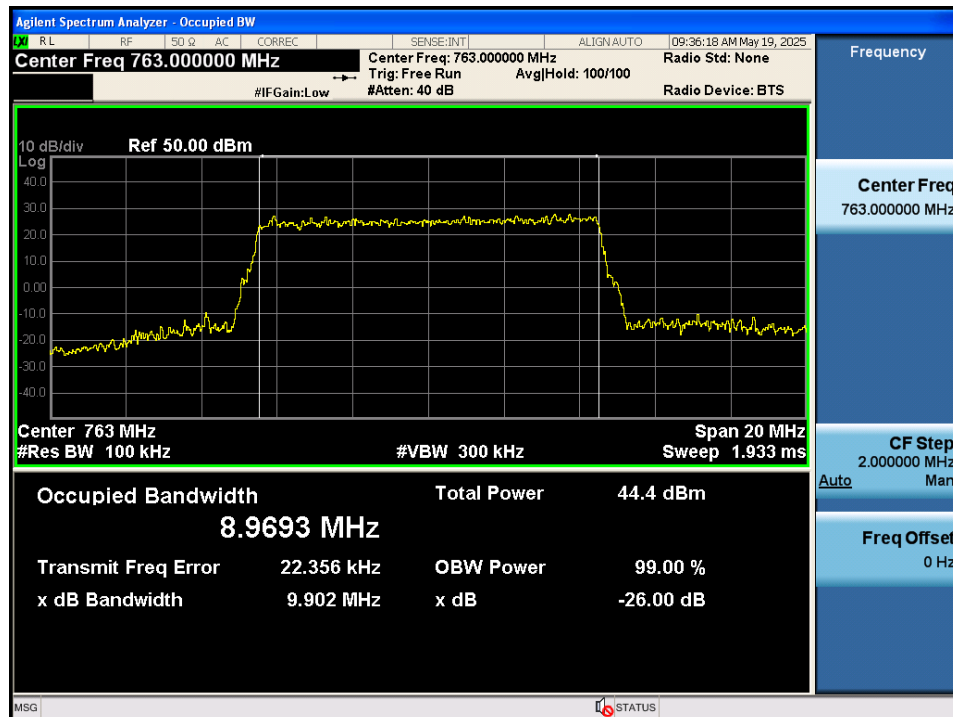
3 dB above the AGC threshold output / B/ILT; SMR / Uplink / P25 Phase 1



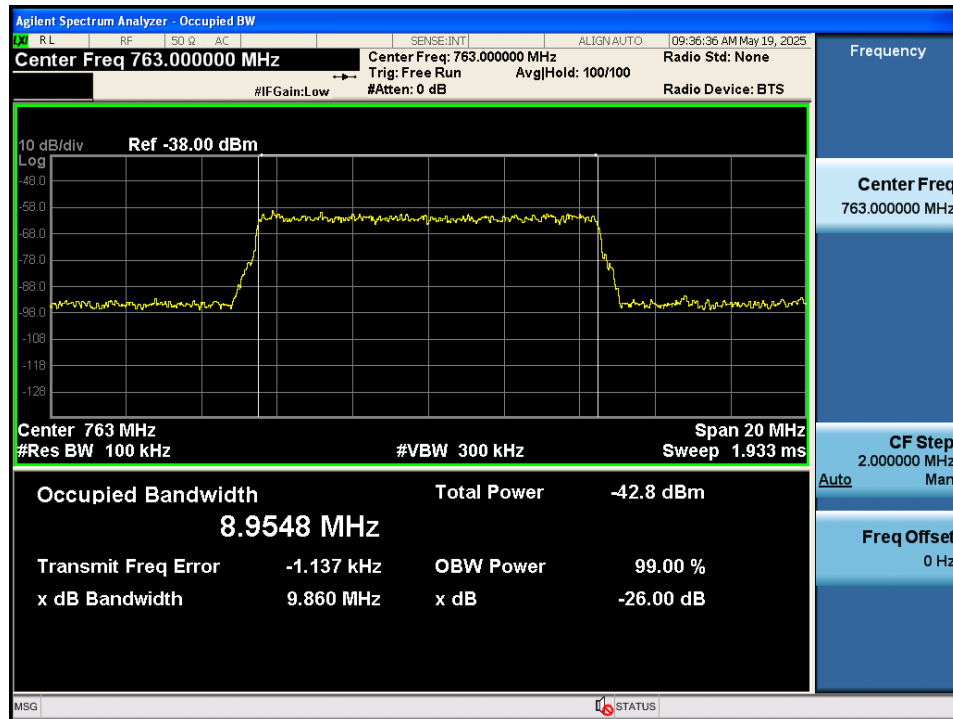
Input / FirstNet / Downlink / LTE 10 MHz



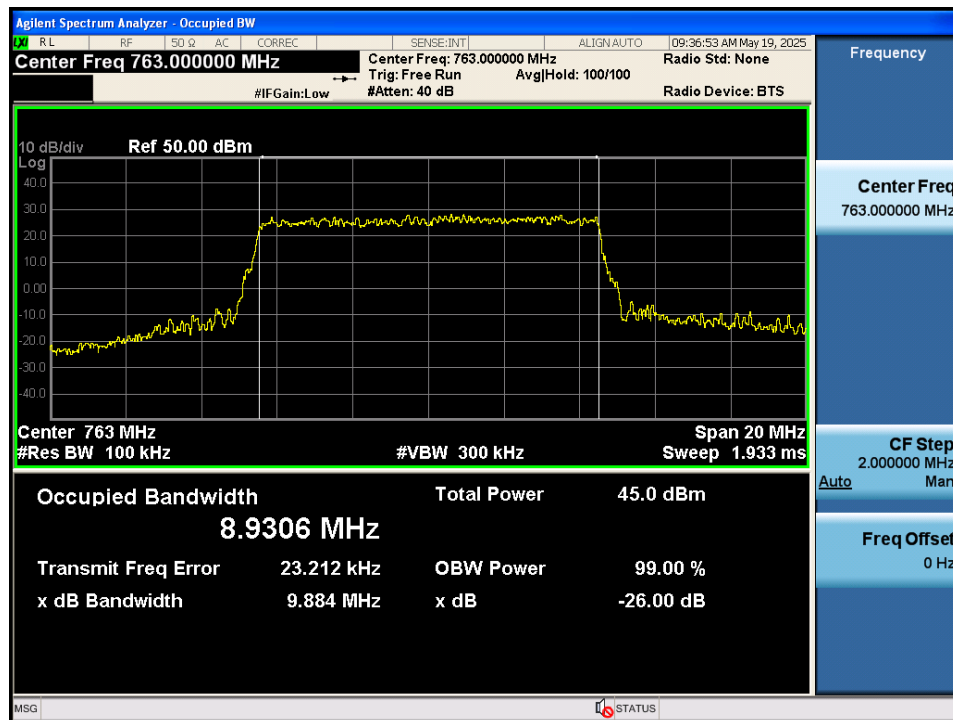
Output / FirstNet / Downlink / LTE 10 MHz



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



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



Input / Public Safety Narrowband / Downlink / P25 Phase 1



Output / Public Safety Narrowband / Downlink / P25 Phase 1



3 dB above the AGC threshold Input / Public Safety Narrowband / Downlink / P25 Phase 1



3 dB above the AGC threshold output / Public Safety Narrowband / Downlink / P25 Phase 1



Input / NPSPAC / Downlink / P25 Phase 1



Output / NPSPAC / Downlink / P25 Phase 1



3 dB above the AGC threshold Input / NPSPAC / Downlink / P25 Phase 1



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



Input / B/ILT; SMR / Downlink / P25 Phase 1



Output / B/ILT; SMR / Downlink / P25 Phase 1



3 dB above the AGC threshold Input / B/ILT; SMR / Downlink / P25 Phase 1



3 dB above the AGC threshold output / B/ILT; SMR / Downlink / P25 Phase 1



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 (f_d in kHz) of more than 5 kHz, but not more than 10 kHz: At least $83 \log(f_d/5)$ dB;
 - (2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 10 kHz, but not more than 250 percent of the authorized bandwidth: At least $29 \log(f_d/11)$ 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 f_0 to 5.625 kHz removed from f_0 : Zero dB.
 - (2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least $7.27(f_d - 2.88 \text{ kHz})$ dB.
 - (3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d 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 (f_d 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 (f_d in kHz) of more than 4 kHz, but no more than 8.5 kHz: At least $107 \log(f_d/4)$ dB;
 - (3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 8.5 kHz, but no more than 15 kHz: At least $40.5 \log(f_d/1.16)$ dB;
 - (4) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 15 kHz, but no more than 25 kHz: At least $116 \log(f_d/6.1)$ 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:

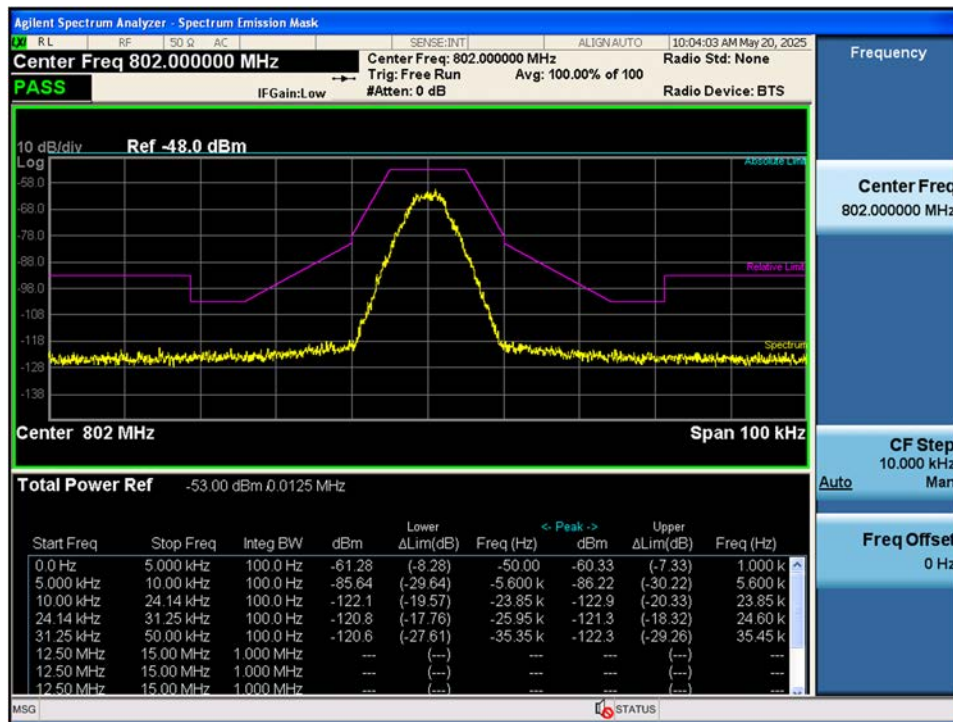
Measurements were in accordance with the test methods section 4.4 of KDB 935210 D05 v01r03.

- 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.

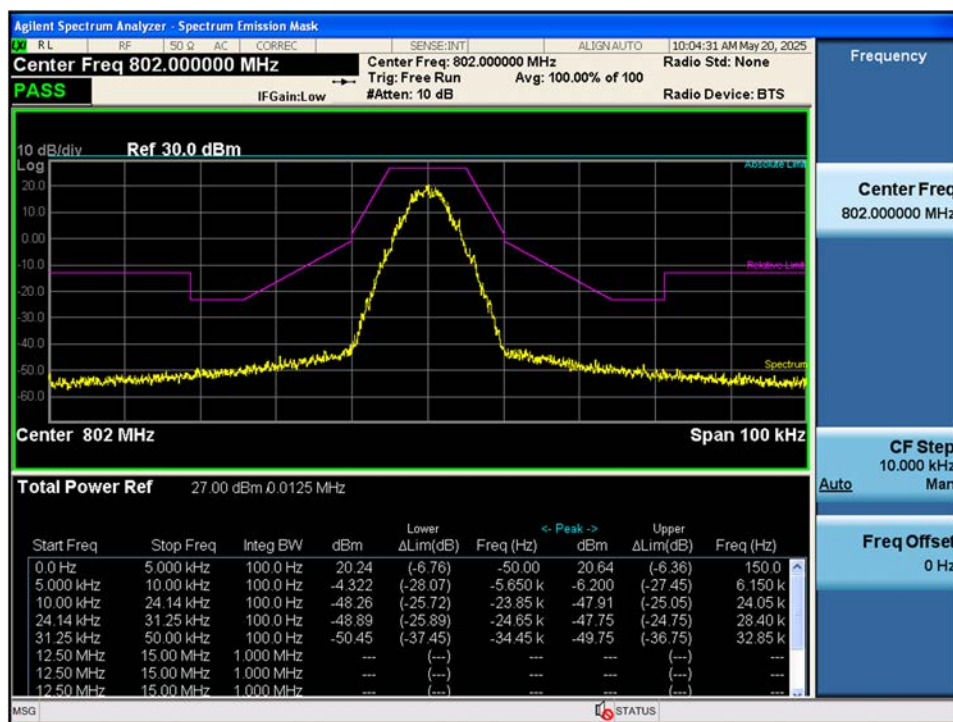
Note: Please refer to section 5.3 for the results of the FirstNet band. This section contains only emission mask results.

Plot data of Emission mask

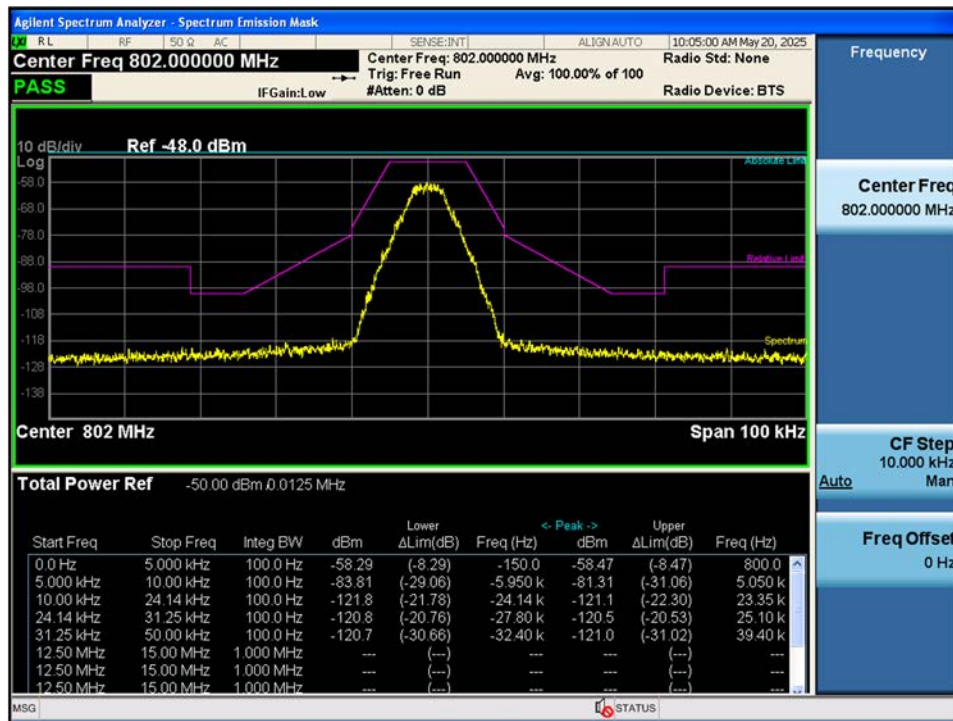
Input / Public Safety Narrowband / Uplink / Mask C



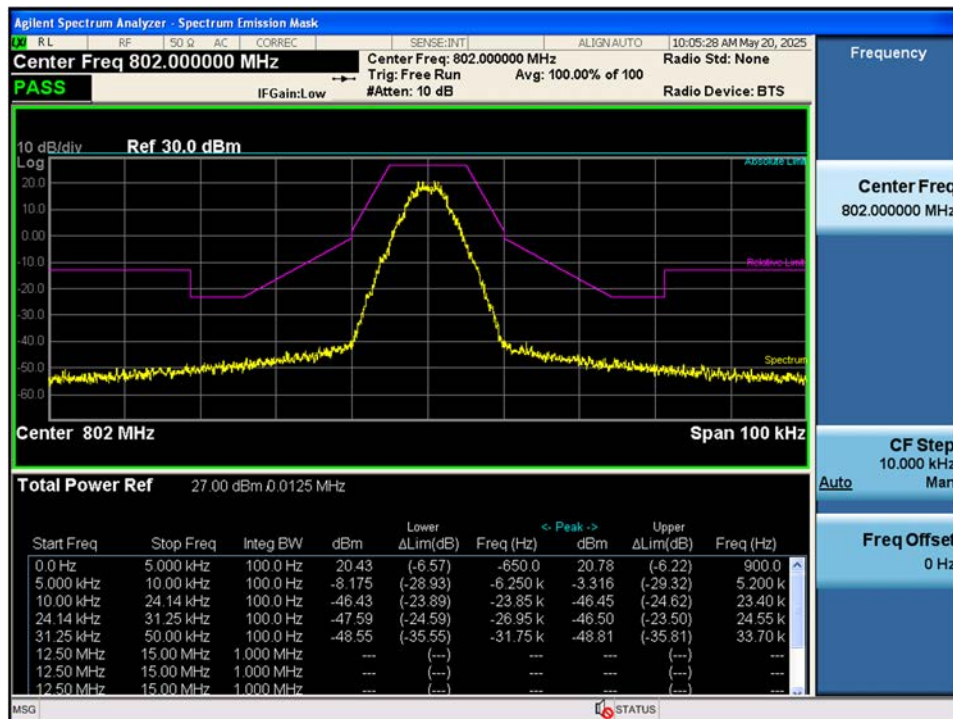
Output / Public Safety Narrowband / Uplink / Mask C



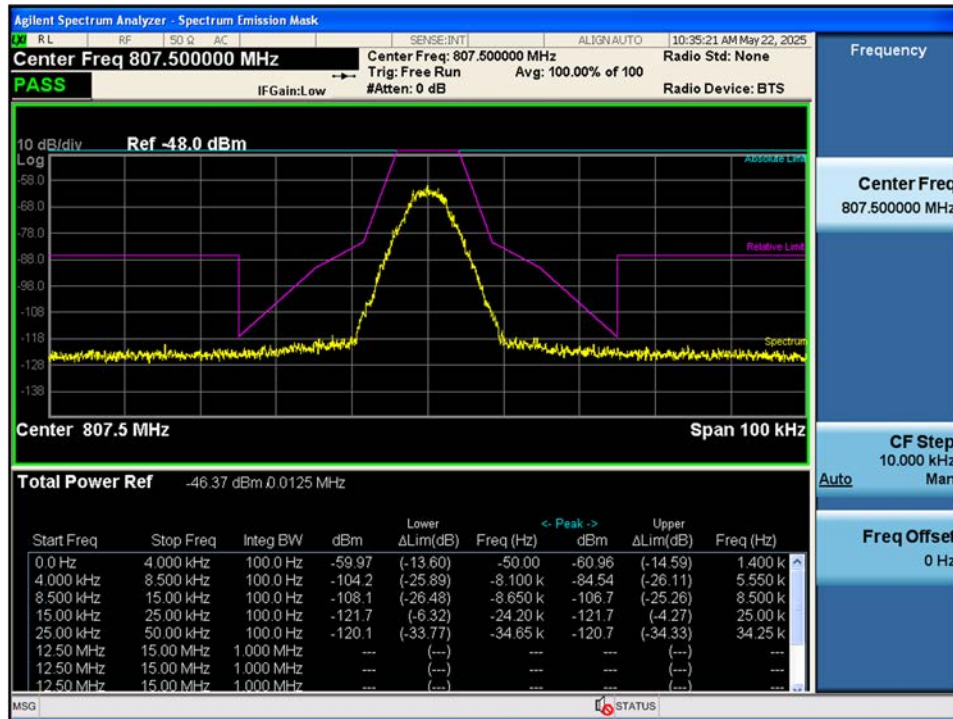
3 dB above the AGC threshold Input / Public Safety Narrowband / Uplink / Mask C



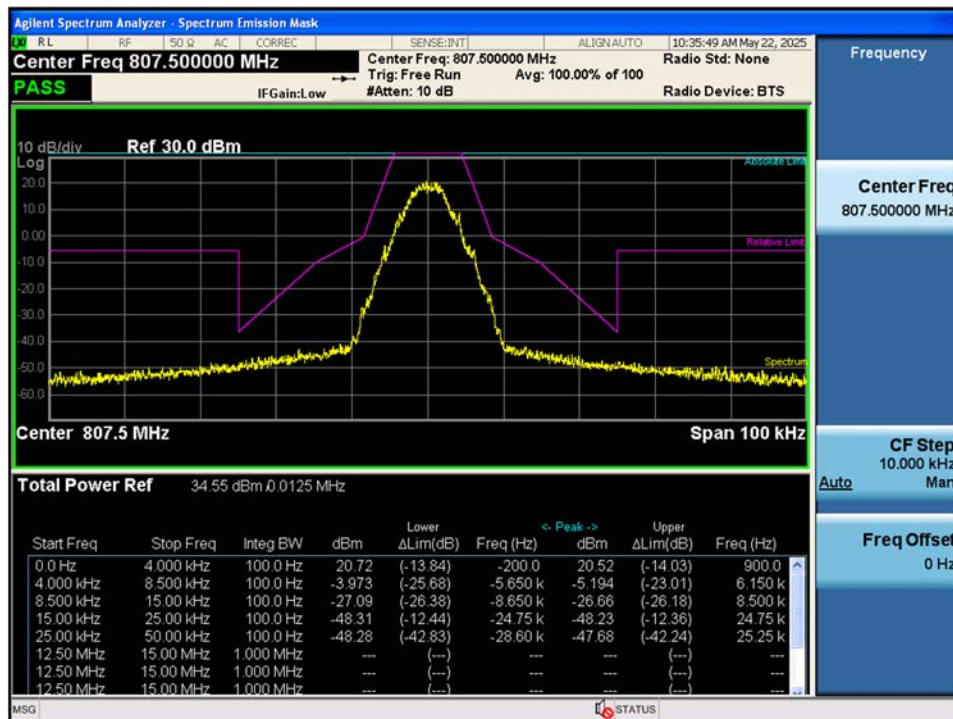
3 dB above the AGC threshold output / Public Safety Narrowband / Uplink / Mask C



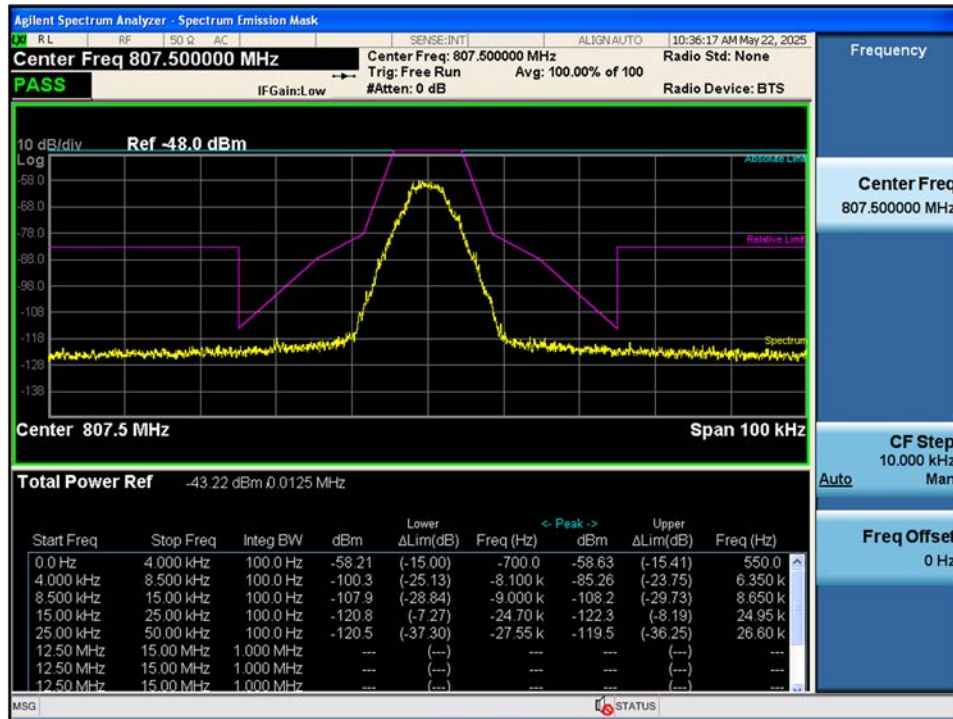
Input / NPSPAC / Uplink / Mask H



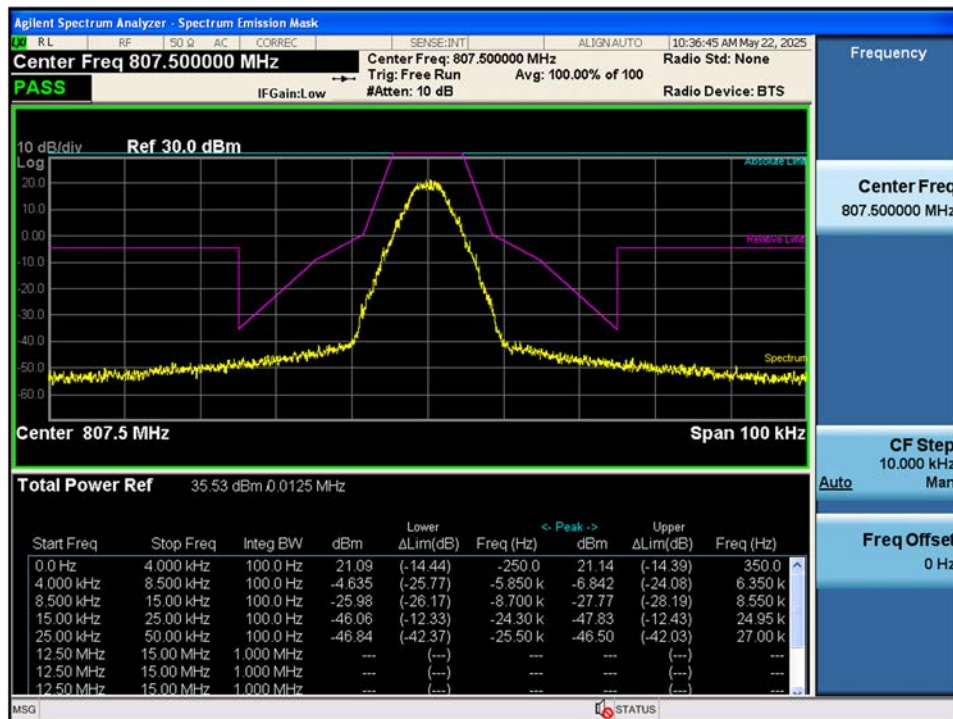
Output / NPSPAC / Uplink / Mask H



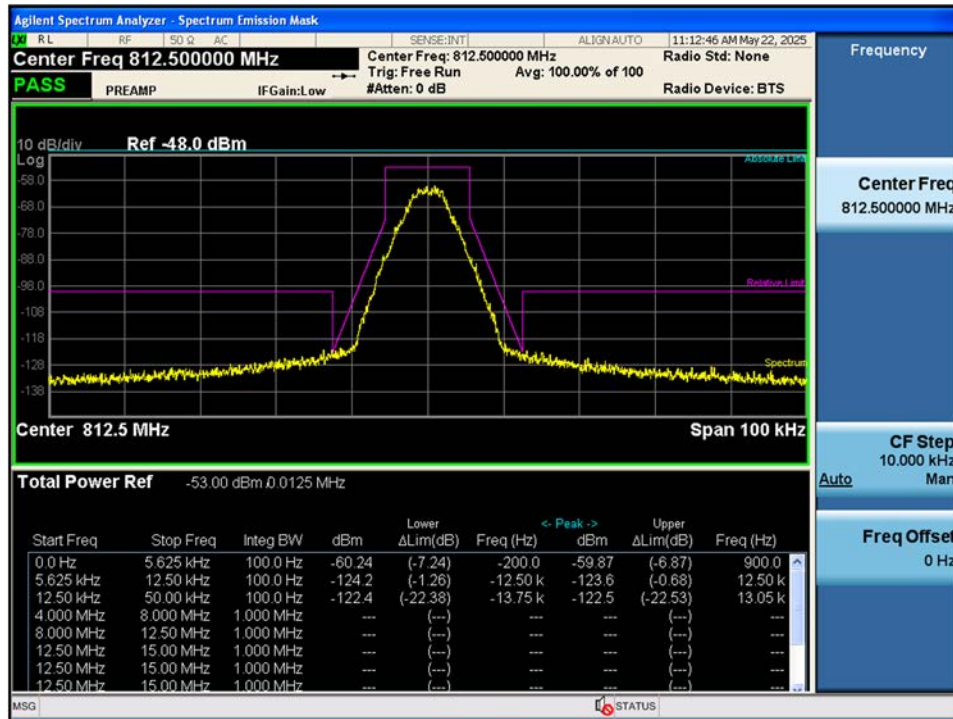
3 dB above the AGC threshold Input / NPSPAC / Uplink / Mask H



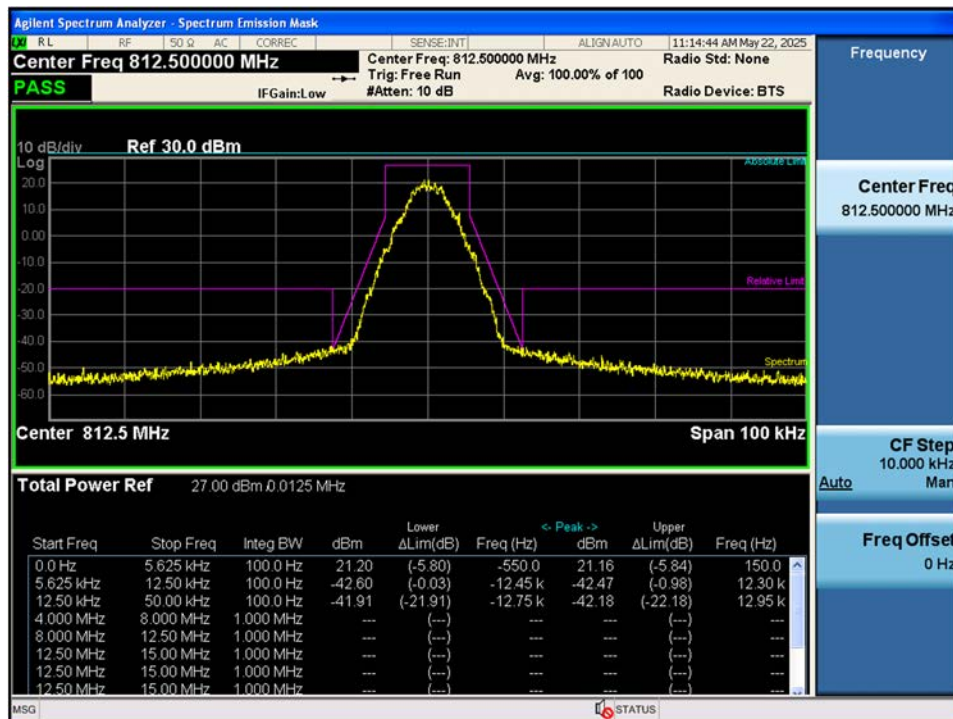
3 dB above the AGC threshold output / NPSPAC / Uplink / Mask H



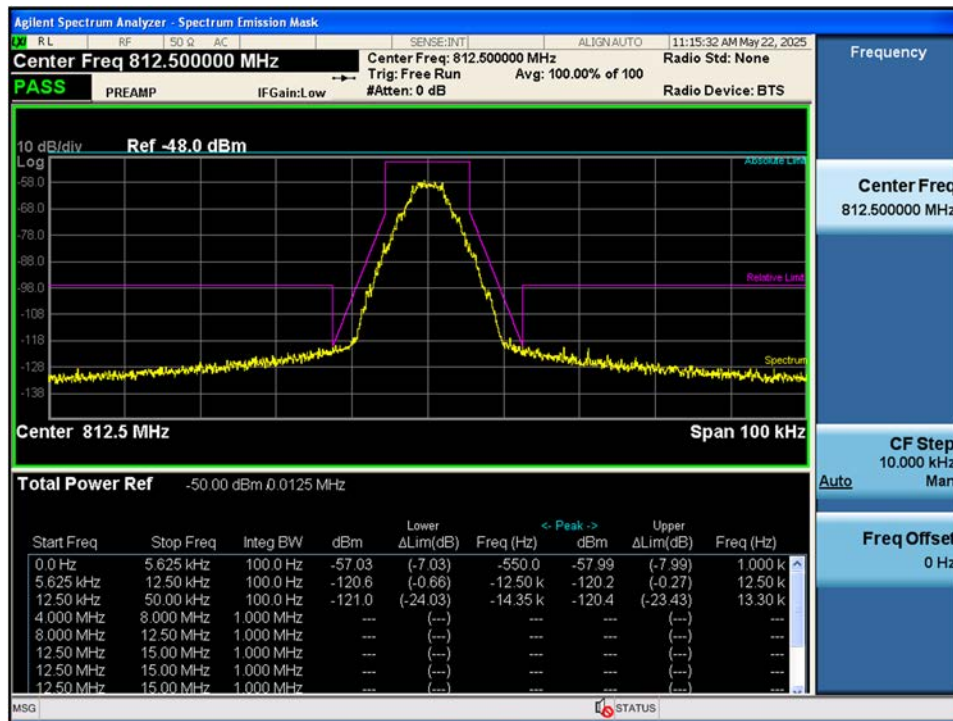
Input / B/ILT; SMR / Uplink / Mask D



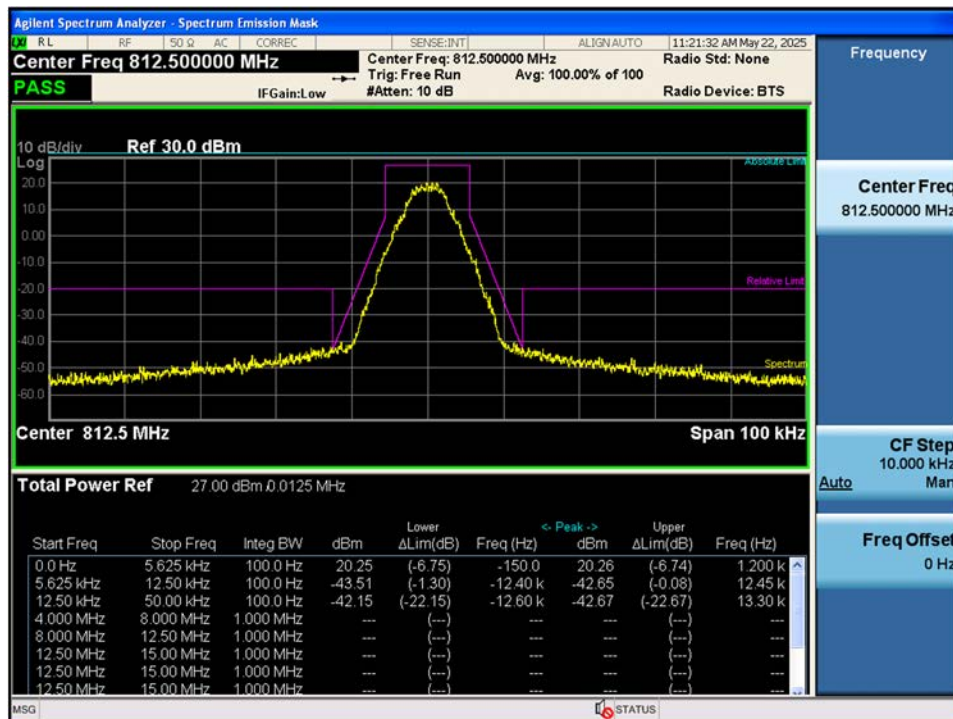
Output / B/ILT; SMR / Uplink / Mask D



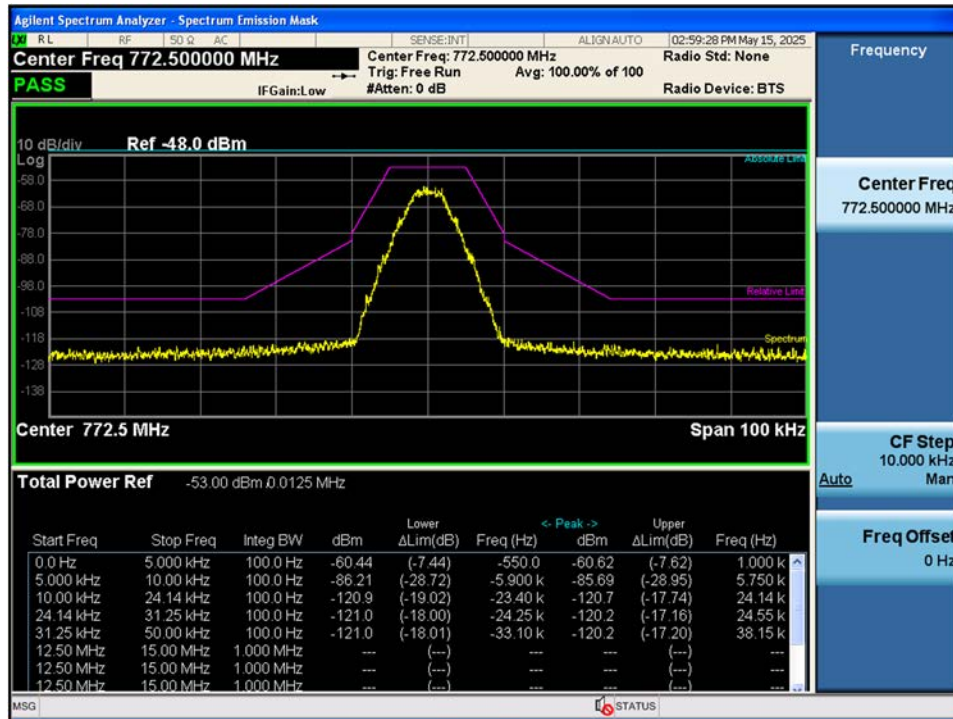
3 dB above the AGC threshold Input / B/ILT; SMR / Uplink / Mask D



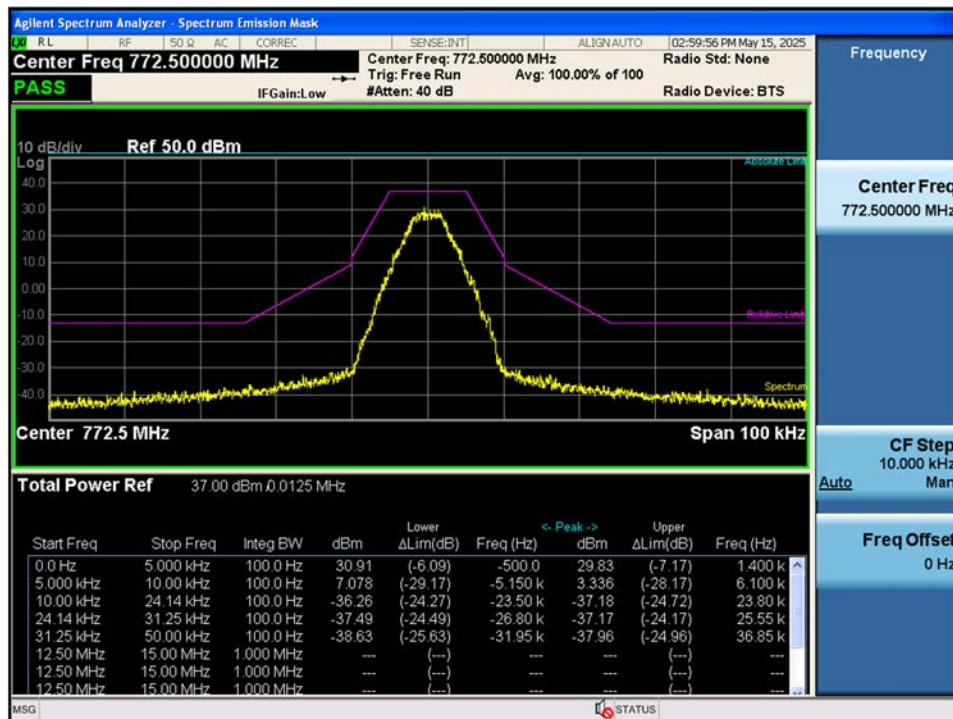
3 dB above the AGC threshold output / B/ILT; SMR / Uplink / Mask D



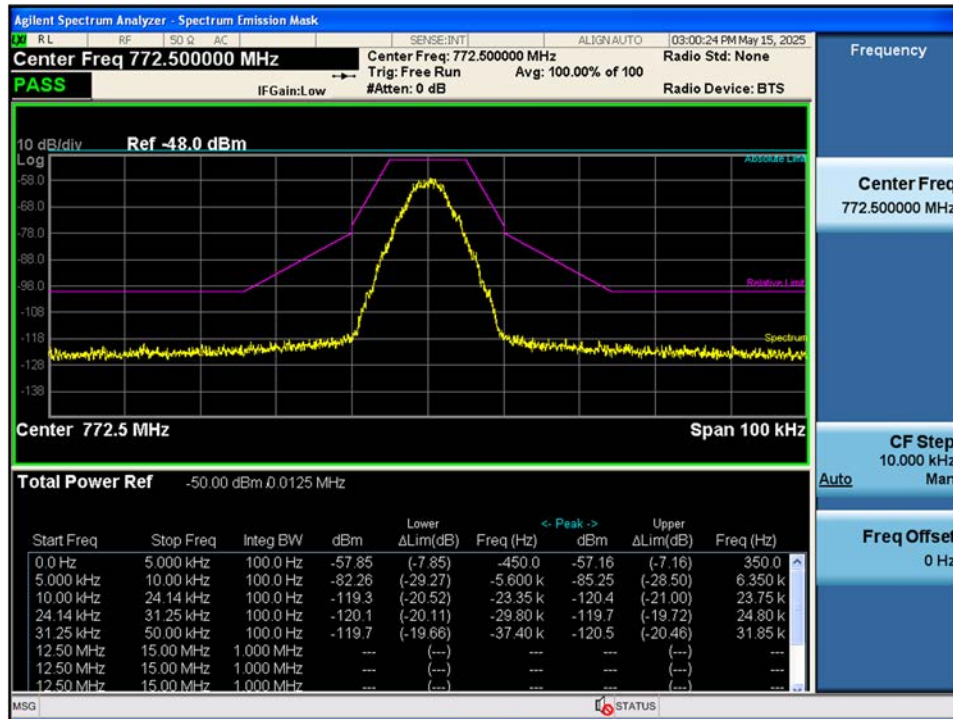
Input / Public Safety Narrowband / Downlink / Mask C



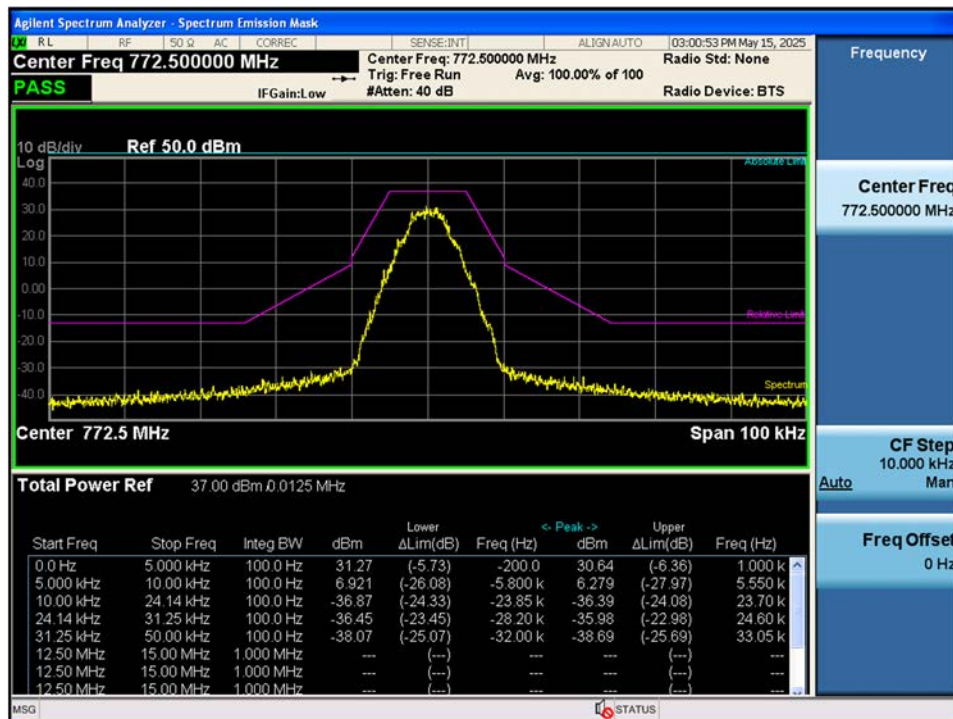
Output / Public Safety Narrowband / Downlink / Mask C



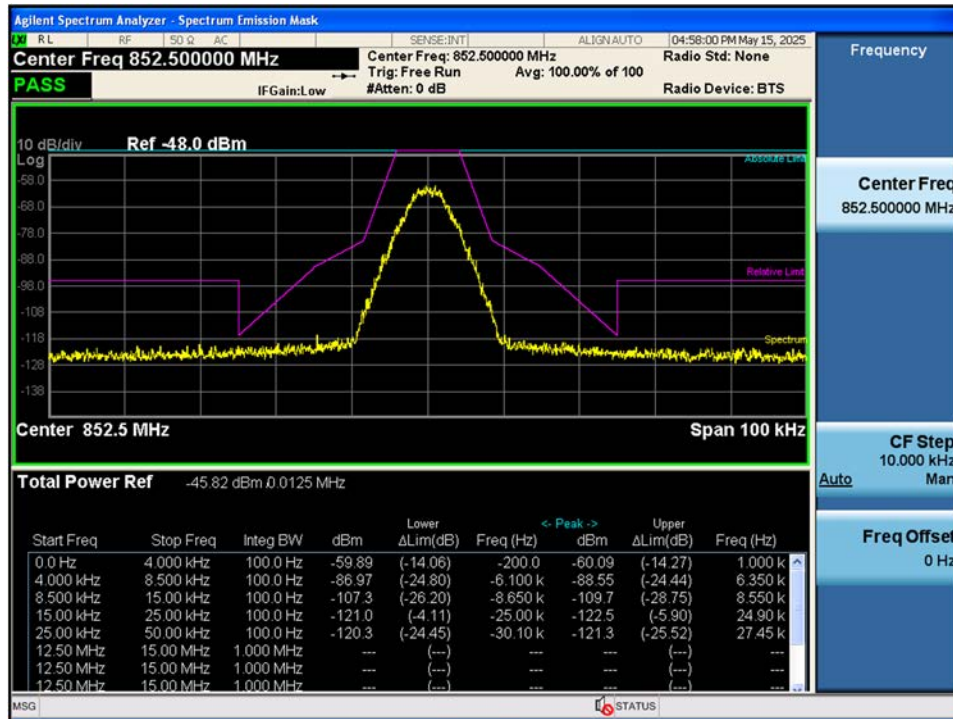
3 dB above the AGC threshold Input / Public Safety Narrowband / Downlink / Mask C



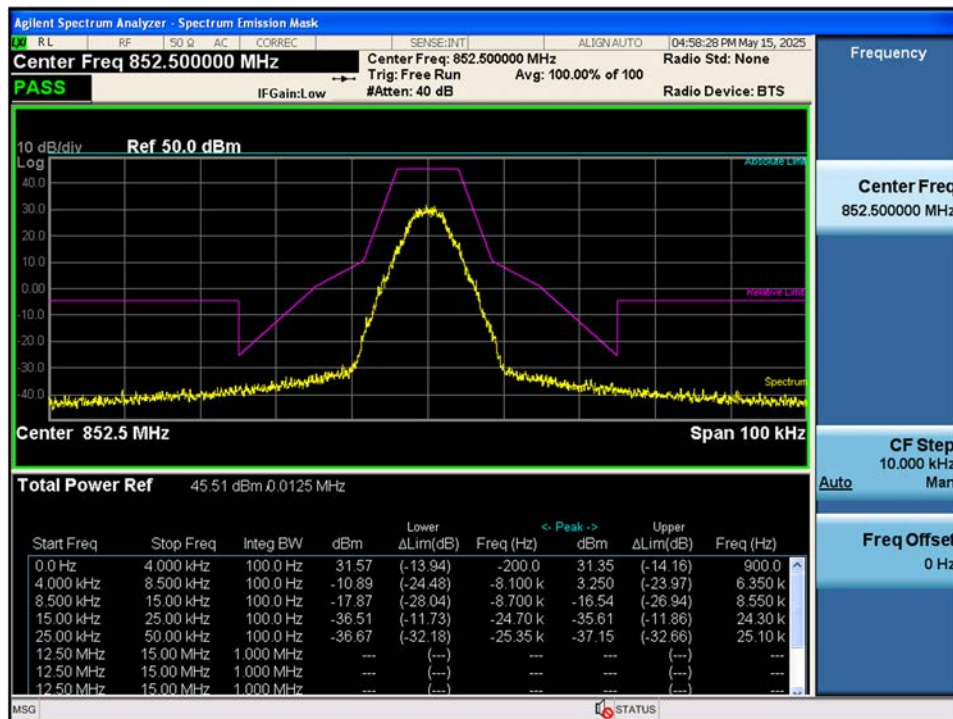
3 dB above the AGC threshold output / Public Safety Narrowband / Downlink / Mask C



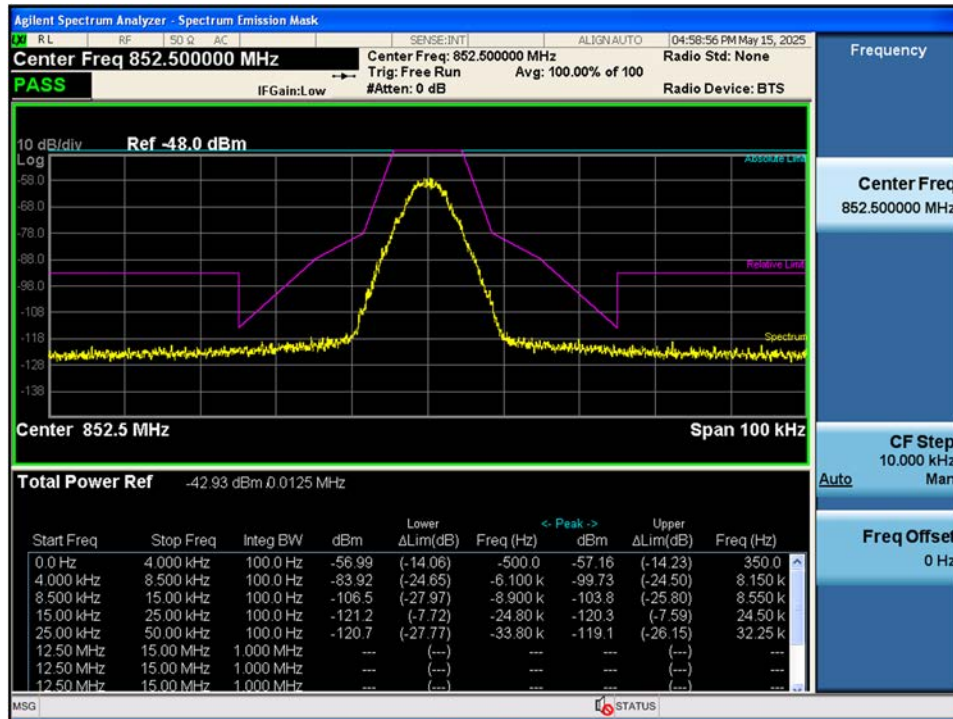
Input / NPSPAC / Downlink / Mask H



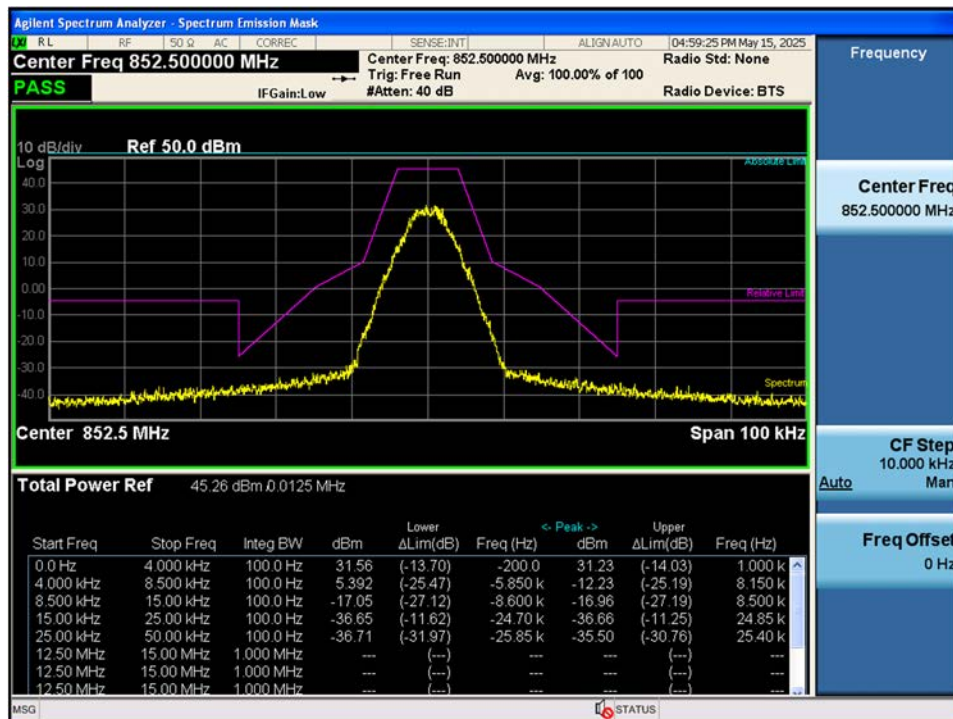
Output / NPSPAC / Downlink / Mask H



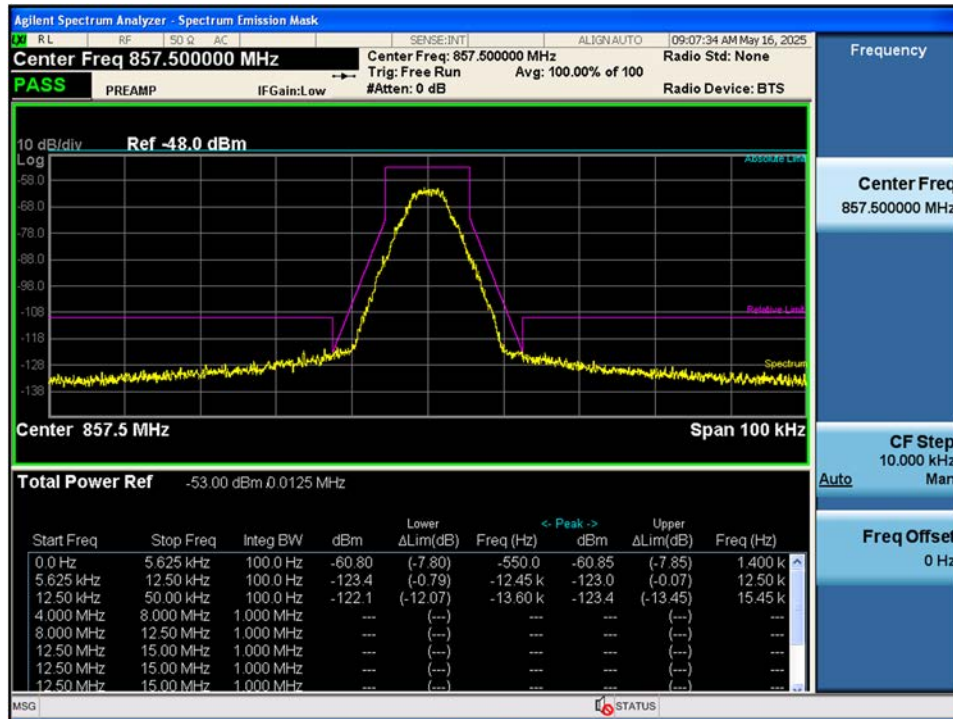
3 dB above the AGC threshold Input / NPSPAC / Downlink / Mask H



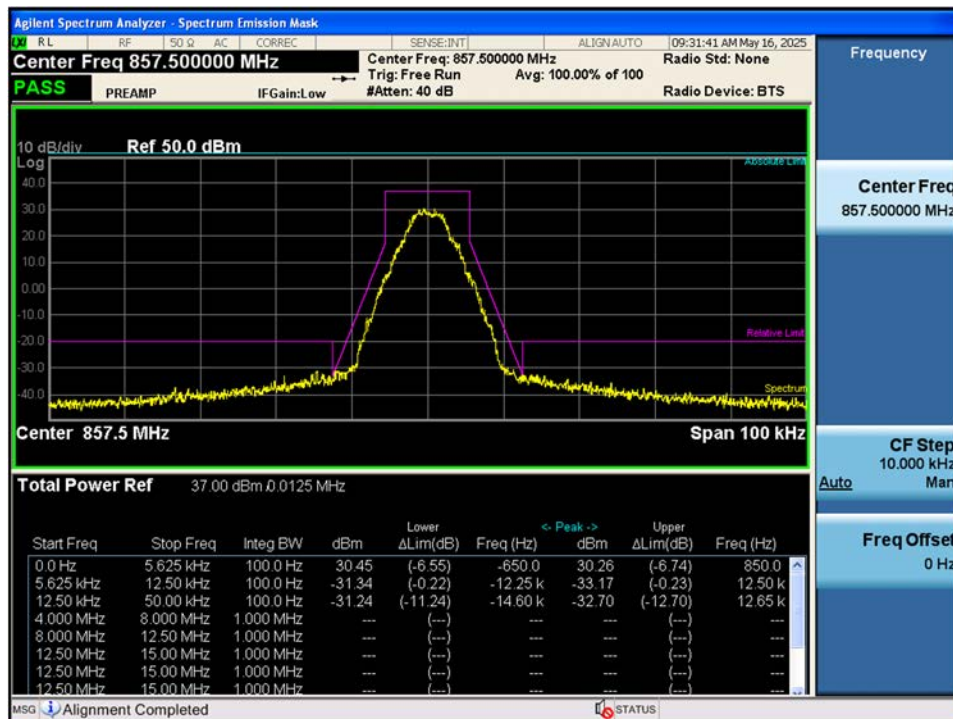
3 dB above the AGC threshold output / NPSPAC / Downlink / Mask H



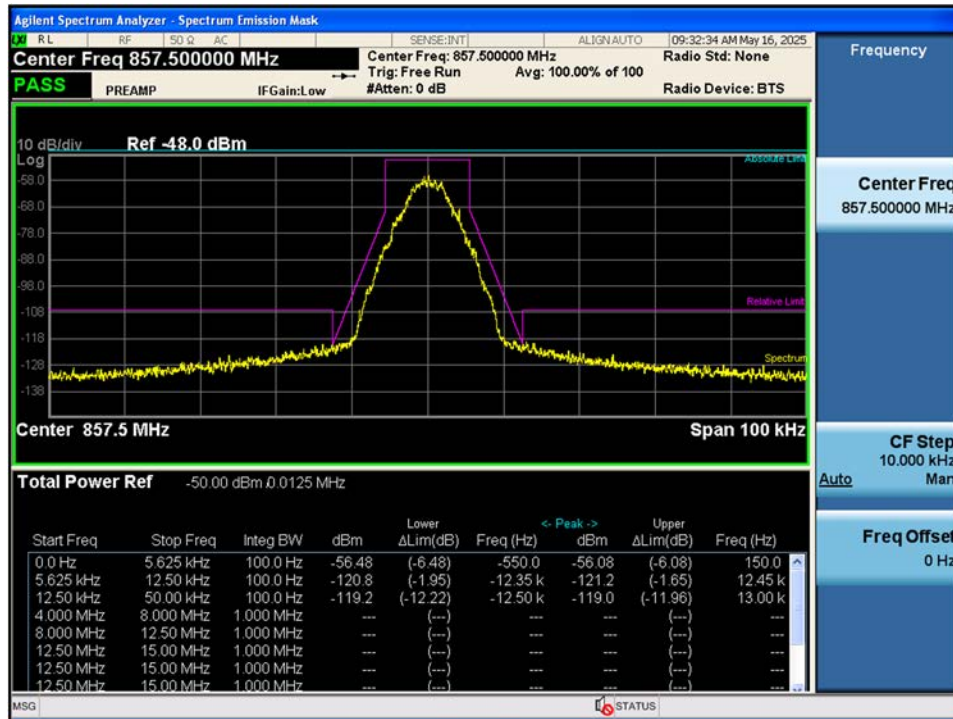
Input / B/ILT; SMR / Downlink / Mask D



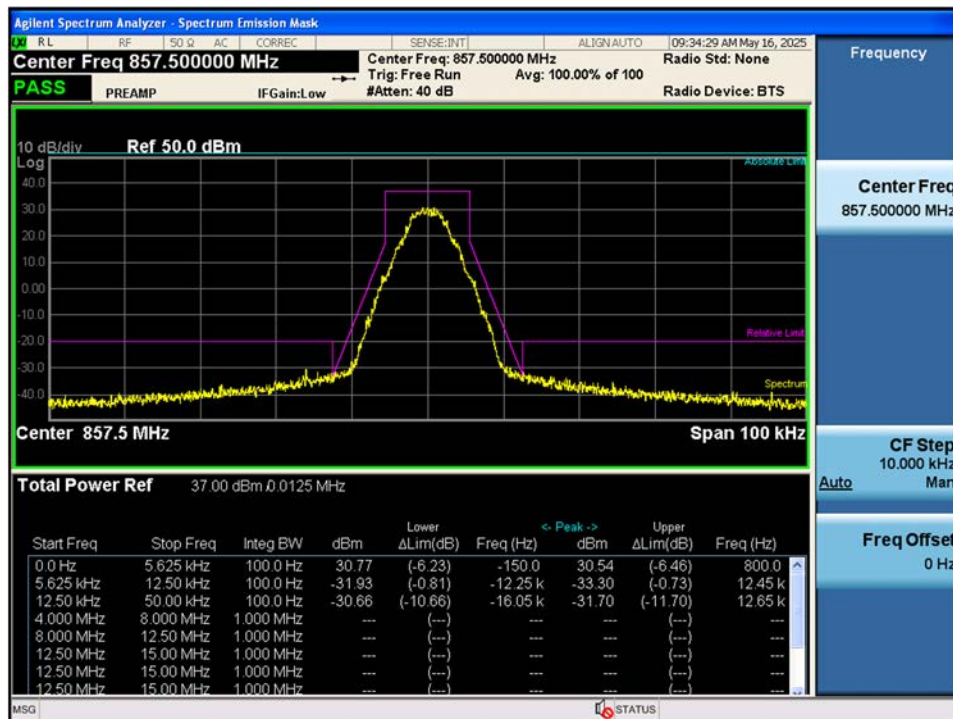
Output / B/ILT; SMR / Downlink / Mask D



3 dB above the AGC threshold Input / B/ILT; SMR / Downlink / Mask D



3 dB above the AGC threshold output / B/ILT; SMR / Downlink / Mask D



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.

Test Procedures:

Measurements were in accordance with the test methods section 3.5 of KDB 935210 D05 v01r04.

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 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 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:

$$\text{Gain (dB)} = \text{output power (dBm)} - \text{input power (dBm)}.$$

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 v01r04.

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

Apply the same guidance as in 3.5.2 to measure the maximum input and output power levels necessary for computing the mean EUT gain, but with the following modifications:

- a) Configure the signal generator for CW operation, instead of AWGN,
- b) Select the spectrum analyzer positive peak detector, instead of the power averaging (rms) detector,
- c) Activate the max hold function, instead of the trace averaging function,
- d) Use in conjunction with the guidance in 4.5.3.

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 $\geq 3 \times \text{RBW}$.
- 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:

$$\text{Gain (dB)} = \text{output power (dBm)} - \text{input power (dBm)}.$$

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

Note:

1. If f_0 that determined from out-of-band rejection test is smaller or greater than difference of test signal's center frequency and operation band block, test is performed at the lowest or the highest frequency that test signals can be passed.
2. The Uplink/Downlink ERP is calculated as follows.
 - Uplink ERP = Uplink Power + Ant. Peak Gain(dBi $\rightarrow$ dBd)
 $= 26.97 \text{ dBm} + (9.0 \text{ dBi} - 2.15 \text{ dB}) = 33.82 \text{ dBm}$
 - Downlink ERP = Downlink Power + Ant. Peak Gain(dBi $\rightarrow$ dBd)
 $= 36.93 \text{ dBm} + (1.5 \text{ dBi} - 2.15 \text{ dB}) = 36.28 \text{ dBm}$

Test Results:

Tabular data of Input / Output Power and Gain

Test Band	Link	Signal	f ₀ Frequency	Input Power	Output Power	Gain	E.R.P.	
			(MHz)	(dBm)		(dB)	(dBm)	(W)
FirstNet	Uplink	LTE 10 MHz	793.00	-53.28	26.97	80.25	33.82	2.41
	Downlink		763.00	-53.12	36.93	90.05	36.28	4.25
Public Safety Narrowband	Uplink	P25 Phase 1	801.21	-53.58	27.25	80.83	34.10	2.57
	Downlink		769.73	-52.76	36.98	89.73	38.33	6.80
NPSPAC	Uplink		808.39	-53.30	27.58	80.88	34.43	2.77
	Downlink		853.34	-52.95	37.96	90.91	39.31	8.53
B/ILT; SMR	Uplink		810.79	-53.32	27.73	81.05	34.58	2.87
	Downlink		855.92	-52.94	37.24	90.17	38.59	7.23

- Peak Antenna Gain: Uplink: 9.0 dBi(6.85 dBd), Downlink: 1.5 dBi(-0.65 dBd)

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

Test Band	Link	Signal	f ₀ Frequency	Input Power	Output Power	Gain	E.R.P.	
			(MHz)	(dBm)		(dB)	(dBm)	(W)
FirstNet	Uplink	LTE 10 MHz	793.00	-50.22	27.41	77.63	34.26	2.67
	Downlink		763.00	-50.17	37.48	87.65	36.83	4.82

- Peak Antenna Gain: Uplink: 9.0 dBi(6.85 dBd), Downlink: 1.5 dBi(-0.65 dBd)

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_o = Output Noise Power

k = Boltzmann's Constant

T_o = Standard Noise Temperature (290K)

B = Noise Bandwidth

G = Gain

' kT_oB ' 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.
- d) Set the RBW 1 MHz. and set the VBW to $\geq 3 \times$ RBW.
- e) Measure the maximum output noise power for EUT pass band.

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

$$\text{Noise Figure} = \text{Noise Output Power} - kT_oB - \text{Gain}$$

Test Results:

Test Band	Link	Input Power (dBm)	Output Power (dBm)	Gain (dB)	kT ₀ B (dBm/MHz)	Measured Value (dBm)	Noise Figure (dB)
Public Safety Narrowband	Uplink	-53.58	27.25	80.83	-114	-30.61	2.56
	Downlink	-52.76	36.98	89.73	-114	-15.94	8.33
NPSPAC	Uplink	-53.30	27.58	80.88	-114	-29.61	3.51
	Downlink	-52.95	37.96	90.91	-114	-15.36	7.73
B/ILT; SMR	Uplink	-53.32	27.73	81.05	-114	-30.03	2.92
	Downlink	-52.94	37.24	90.17	-114	-16.29	7.53

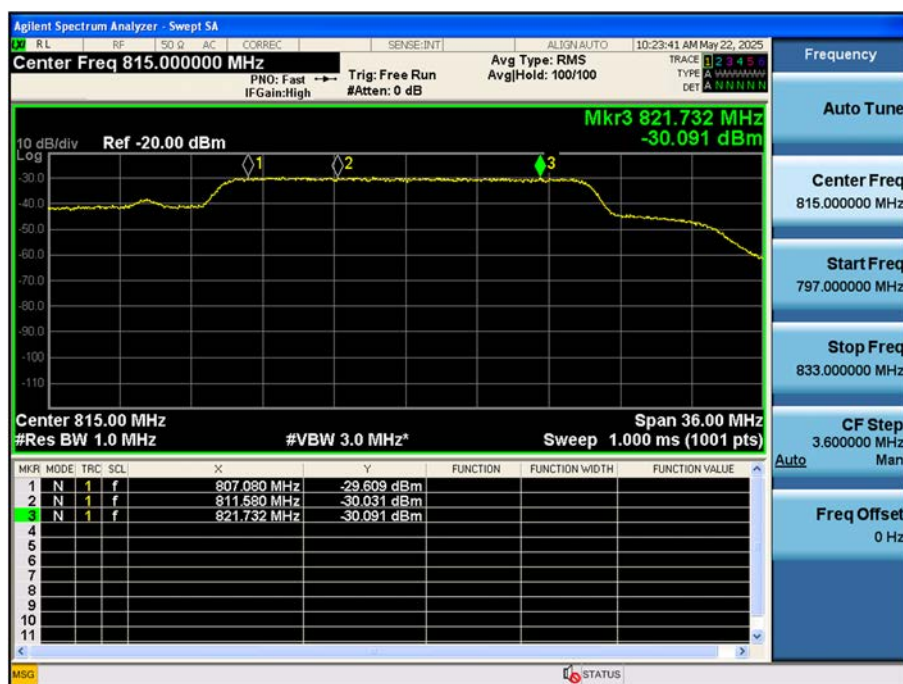
Plot data of Noise Figure

Noise Figure / Public Safety Narrowband / Uplink



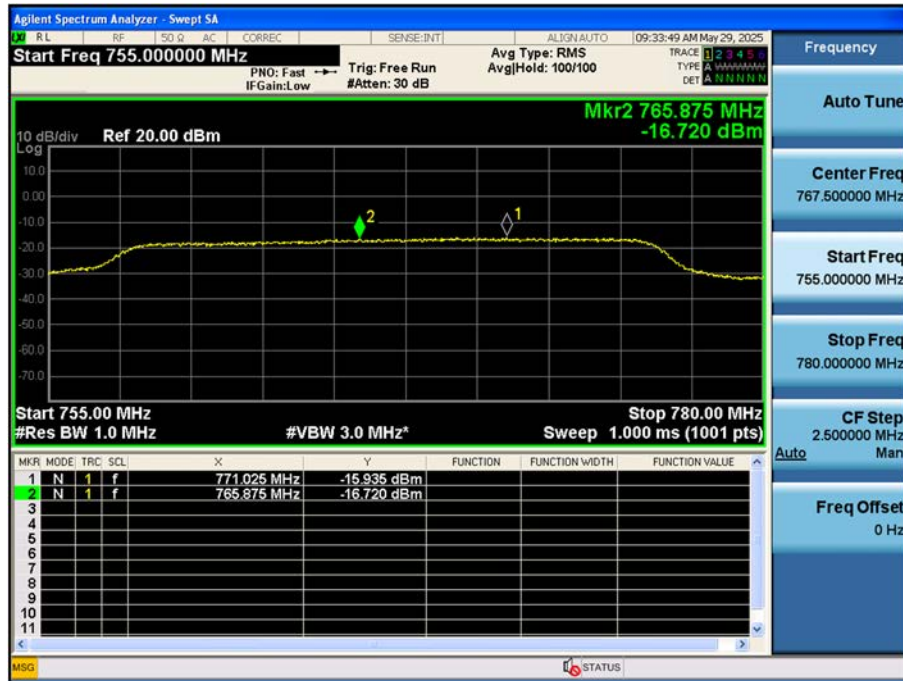
Note: The EUT is amplified from 788 to 806 MHz, but this report includes results only for the 788 ~ 798 MHz and 799 ~ 805 MHz bands.

Noise Figure / 800 MHz (NPSPAC, B/ILT; SMR) / Uplink



Note: The EUT is amplified from 806 to 824 MHz, but this report includes results only for the 806 ~ 809 MHz and 809 ~ 816 MHz bands.

Noise Figure / Public Safety Narrowband / Downlink



Note: The EUT is amplified from 758 to 776 MHz, but this report includes results only for the 758 ~ 768 MHz and 769 ~ 775 MHz bands.

Noise Figure / 800 MHz (NPSPAC, B/ILT; SMR) / Downlink



Note: The EUT is amplified from 851 to 869 MHz, but this report includes results only for the 851 ~ 854 MHz and 854 ~ 861 MHz bands.

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.

- (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 $43 + 10\log(P)$ 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.
- (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 v01r04.

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:

- a) two adjacent test signals sequentially tuned to the lower and upper frequency band/block edges;
- b) 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 = $3 \times$ 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 $\geq 3 \times$ 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 1 MHz.
The number of measurement points in each sweep must be $\geq (2 \times \text{span}/\text{RBW})$, 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 1 MHz, 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 $\geq (2 \times \text{span}/\text{RBW})$, 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 v01r04.

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 f_0 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.
- b) 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.

- c) 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.
- d) Connect a spectrum analyzer to the EUT output.
- e) Set the span to 100 kHz.
- f) Set RBW = 300 Hz with $VBW \geq 3 \times RBW$.
- g) Set the detector to power averaging (rms).
- h) Place a marker on highest intermodulation product amplitude.
- i) Capture the plot for inclusion in the test report.
- j) Repeat steps c) to h) with the composite input power level set to 3 dB above the AGC threshold.
- k) Repeat steps b) to i) for all operational bands.

4.7.3 EUT spurious emissions conducted measurements

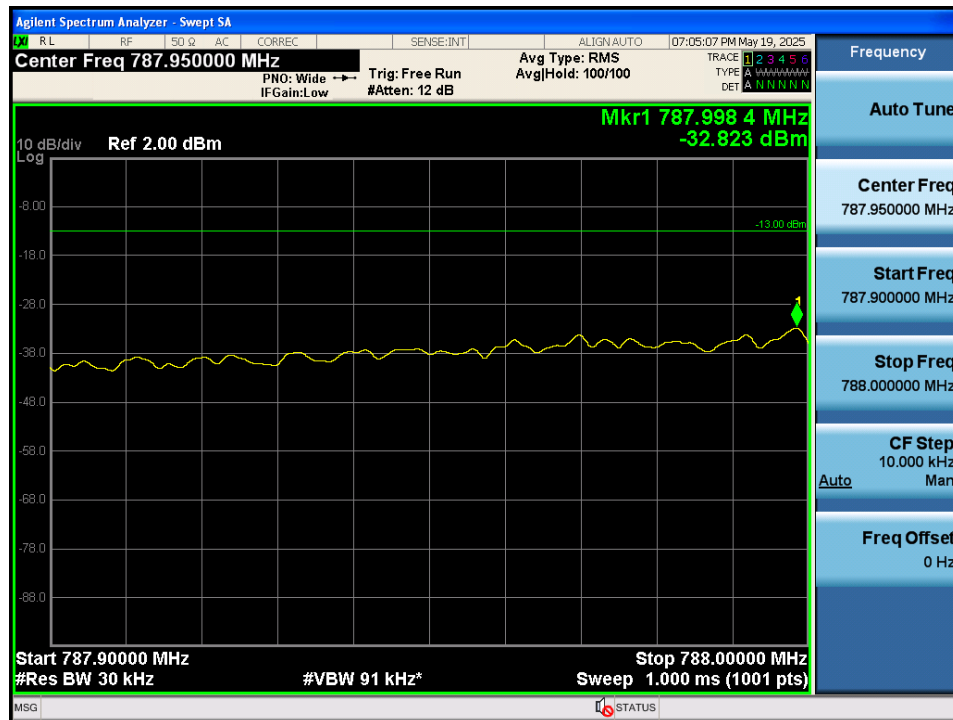
- a) Connect a signal generator to the input of the EUT.
- b) Configure the signal generator to produce a CW signal.
- c) Set the frequency of the CW signal to the center channel of the EUT passband.
- d) Set the output power level so that the resultant signal is just below the AGC threshold.
- e) Connect 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 = $3 \times RBW$.
- 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.

Note: In some bands, RBW was reduced to 0.1 %, 1 %, and 10 % of the reference bandwidth for measuring out-of-band and unwanted spurious emissions level, so the limit lines were compensated according to section 5.7.2 of ANSI C63.26-2015.

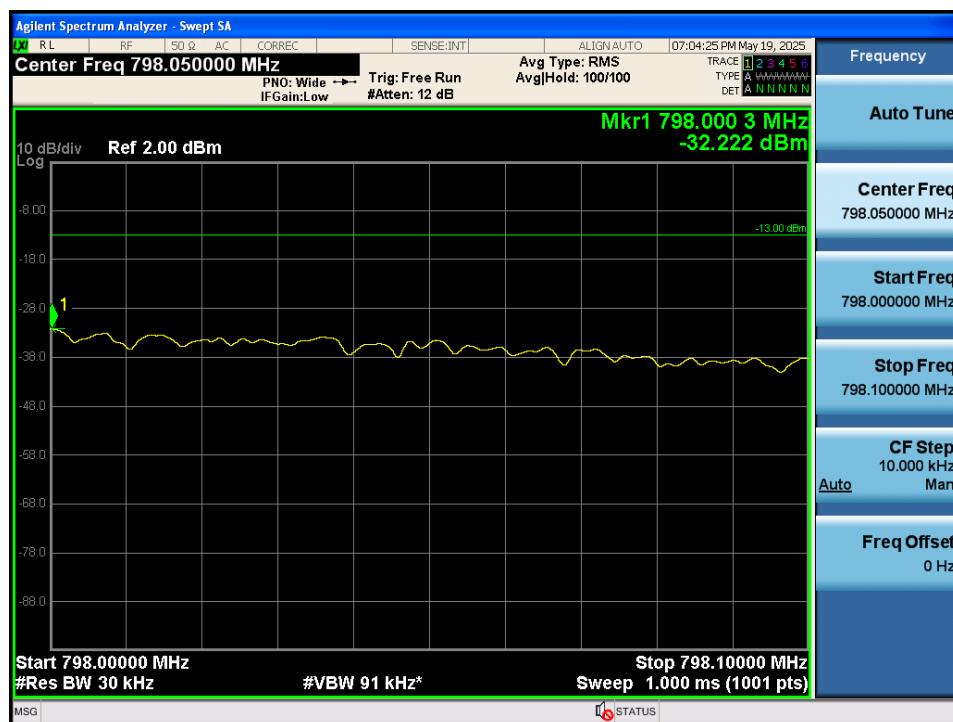
Reduced RBW	0.1 %	1 %	10 %
Limit line compensation	-30 dB	-20 dB	-10 dB

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

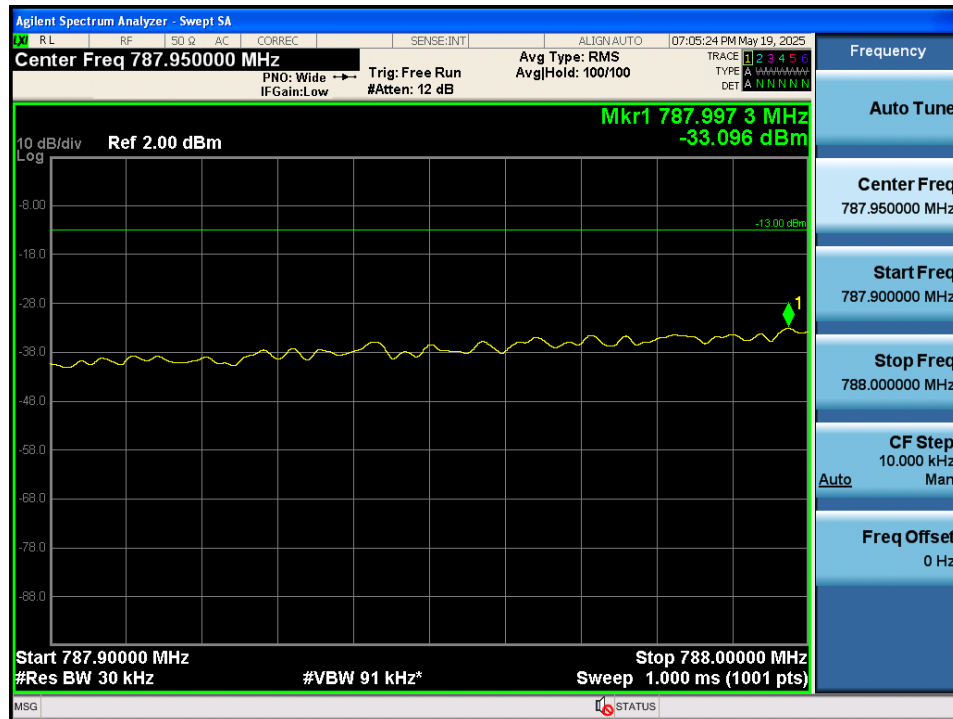
Out-of-band (single test signal) / FirstNet / Uplink / Lower



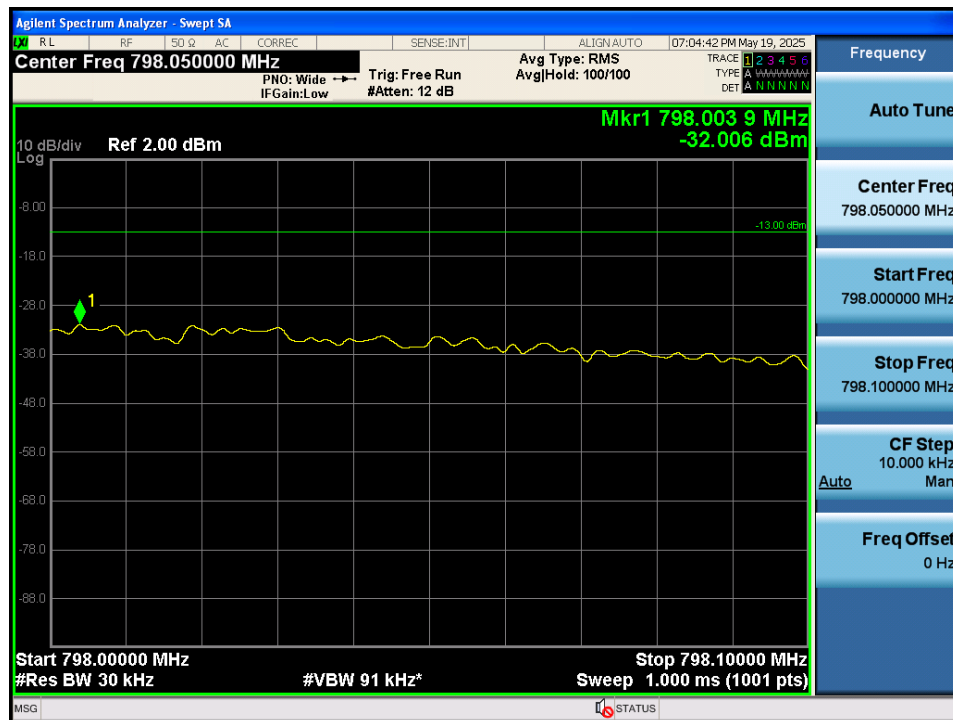
Out-of-band (single test signal) / FirstNet / Uplink / Upper



+3 dB above Out-of-band (single test signal) / FirstNet / Uplink / Lower



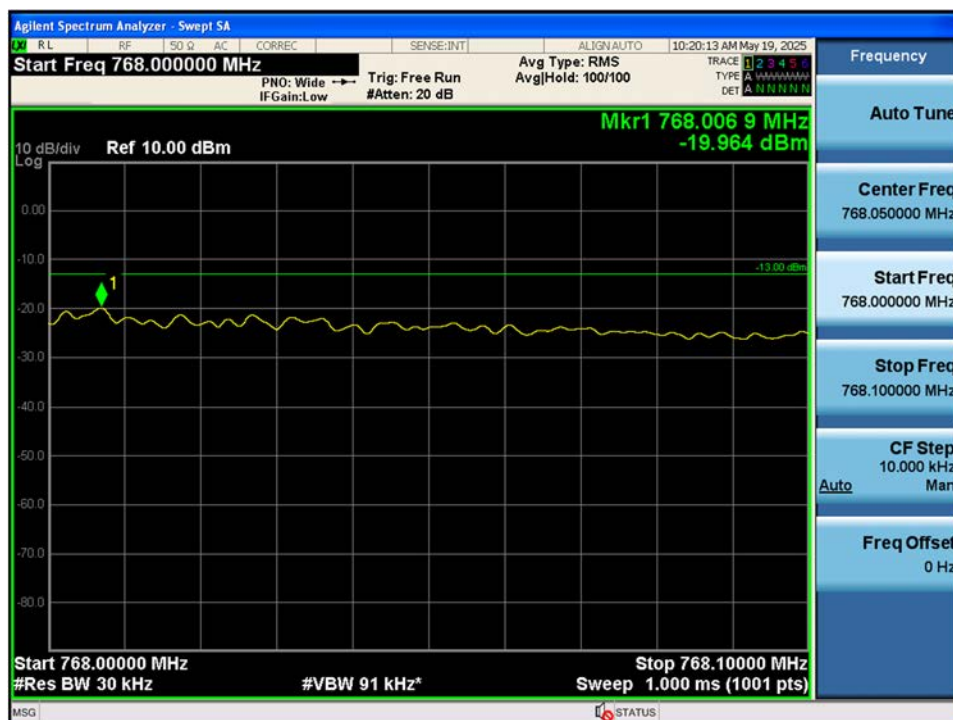
+3 dB above Out-of-band (single test signal) / FirstNet / Uplink / Upper



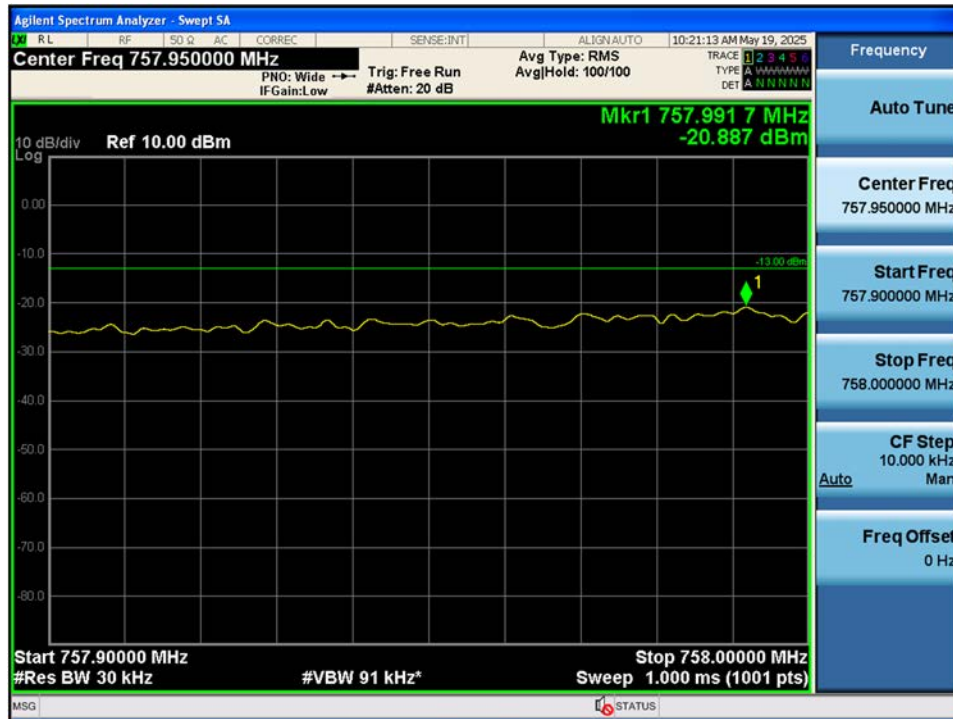
Out-of-band (single test signal) / FirstNet / Downlink / Lower



Out-of-band (single test signal) / FirstNet / Downlink / Upper



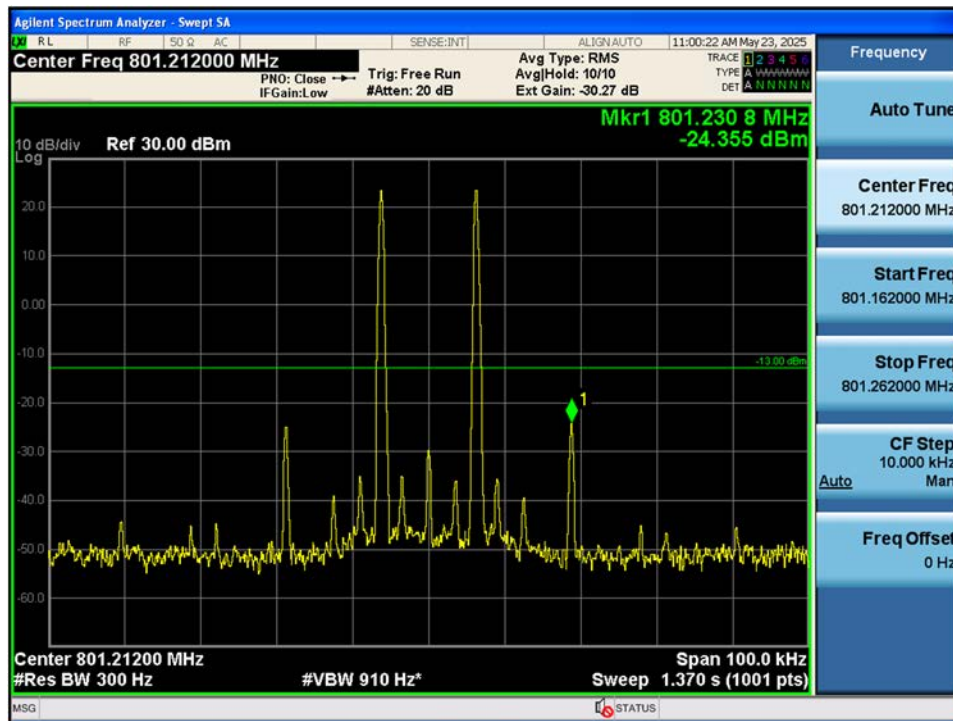
+3 dB above Out-of-band (single test signal) / FirstNet / Downlink / Lower



+3 dB above Out-of-band (single test signal) / FirstNet / Downlink / Upper



Out-of-band (two adjacent test signals) / Public Safety Narrowband / Uplink



+3 dB above Out-of-band (two adjacent test signals) / Public Safety Narrowband / Uplink

