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TEST REPORT

FCC Test for ADXV-R-339P
Certification

APPLICANT
ADRF KOREA, Inc.

REPORT NO.
HCT-RF-2008-FC059-R2

DATE OF ISSUE
9 September 2020

Tested by
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TEST REPORT

FCC Test for ADXV-R-339P

REPORT NO.
HCT-RF-2008-FC059-R2

DATE OF ISSUE
September 09, 2020

Additional Model
-

Applicant	**ADRF KOREA, Inc.** 5-5, Mojeon-Ri, Backsa-Myun, Icheon-Citi, Kyunggi-Do, Korea
Eut Type Model Name	DAS ADXV-R-339P
FCC ID	N52-ADXV-R-339P
Output Power	33 dBm
Date of Test	July 17, 2020 ~ September 9, 2020
FCC Rule Parts:	Part 2, Part 22, Part 24, Part 90, Part 101

The result shown in this test report refer only to the sample(s) tested unless otherwise stated.
This test results were applied only to the test methods required by the standard.

REVISION HISTORY

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

Revision No.	Date of Issue	Description
0	August 27, 2020	Initial Release
1	September 8, 2020	Revised the 'Antenna Peak Gain'.
1	September 9, 2020	Retest the noise figure on section 5.5.

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.

CONTENTS

1. GENERAL INFORMATION

1.1. APPLICANT INFORMATION

Company Name	ADRF KOREA, Inc.
Company Address	5-5, Mojeon-Ri, Backsa-Myun, Icheon-Citi, Kyunggi-Do, Korea

1.2. PRODUCT INFORMATION

EUT Type	DAS
EUT Serial Number	ADXVR339P202001
Power Supply	110-120V AC / 210-240 AC , DC 36V ~ DC 76V
Frequency Range	(see table below)
Tx Output Power	33 dBm
Antenna Peak Gain	3 dBi

Frequency Range:

Band Frequency (MHz)	Part
928 ~ 929	101
929 ~ 930	90
930 ~ 931	24
931 ~ 932	22
932 ~ 935	101
935 ~ 940	90
940 ~ 941	24

1.3. TEST INFORMATION

FCC Rule Parts	Part 2, Part 22, Part 24, Part 90, Part 101
Measurement Standards	KDB 935210 D02 v04r02, KDB 935210 D05 v01r04, 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. 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 Publication 22.

Detailed description of test facility was submitted to the Commission and accepted dated April 02, 2018 (Registration Number: 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 Part 2, Part 22, Part 24, Part 90, Part 101.

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
Input-versus-output signal comparison	§ 2.1049, § 22.531, § 24.131, § 90.219(e)(4)(ii)	Compliant
Input/output power and amplifier/booster gain	§ 2.1046, § 22.535(f), § 24.132(c), § 90.219(e)(1), § 101.113(a)	Compliant
Noise figure	KDB 935210 D02 v04r02 V(j)(5) § 90.219(d)(6)(ii)	Compliant
Out-of-band/out-of-block emissions and spurious emissions	§ 2.1051, § 22.359, § 24.133(a), § 90.210(g), (j), § 90.219(e)(3), § 101.111(a)(5), (6)	Compliant
Spurious emissions radiated	§ 2.1053	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.

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 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 Frequency (MHz)	Tested signals
928 ~ 929 MHz	APCO 25(P25) Phase 1: C4FM (12.5 kHz) Phase 2: CQPSK (6.25 kHz)
930 ~ 931 MHz	
931 ~ 932 MHz	
932 ~ 935 MHz	
940 ~ 941 MHz	
929 ~ 930 MHz	CW
935 ~ 940 MHz	

The frequency stability measurement has been omitted in accordance with section 3.7 of KDB 935210 D05 v01r04.
: It can be confirmed through input-versus-output signal comparison 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	0.692	2 100	1.078
650	0.745	2 200	1.131
700	0.782	2 300	1.428
750	0.728	2 400	1.237
800	0.725	2 500	1.410
850	0.702	2 600	1.376
900	0.717	2 700	1.062
950	0.702	2 800	1.114
1 000	0.643		
1 100	0.697		
1 200	0.878		
1 300	0.974		
1 400	0.917		
1 500	1.061		
1 600	1.044		
1 700	0.911		
1 800	0.794		
1 900	0.966		
2 000	0.985		

: Output Path

Correction factor table			
Frequency (MHz)	Factor (dB)	Frequency (MHz)	Factor (dB)
2	29.386	2 200	30.777
10	29.486	2 400	30.873
30	29.533	2 600	30.941
50	29.432	2 800	30.818
100	29.508	3 000	31.227
200	29.625	4 000	31.525
300	29.936	5 000	31.619
400	30.073	6 000	31.804
500	30.137	7 000	32.023
600	30.205	8 000	32.374
700	30.282	9 000	32.647
800	30.284	10 000	34.562
900	30.236	11 000	33.648
1 000	30.269	12 000	33.602
1 200	30.477	13 000	33.219
1 400	30.546	14 000	34.451
1 600	30.693	15 000	34.300
1 800	30.532	16 000	34.581
2 000	30.713	17 000	34.189

3.3. MEASUREMENTUNCERTAINTY

Description	Reference	Results
AGC threshold	-	±0.87 dB
Out-of-band rejection	-	±0.58 MHz
Input-versus-output signal comparison	OBW ≤ 25 kHz	±0.16 MHz
		±0.58 MHz
Input/output power and amplifier/booster gain	-	±0.87 dB
Noise Figure		±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

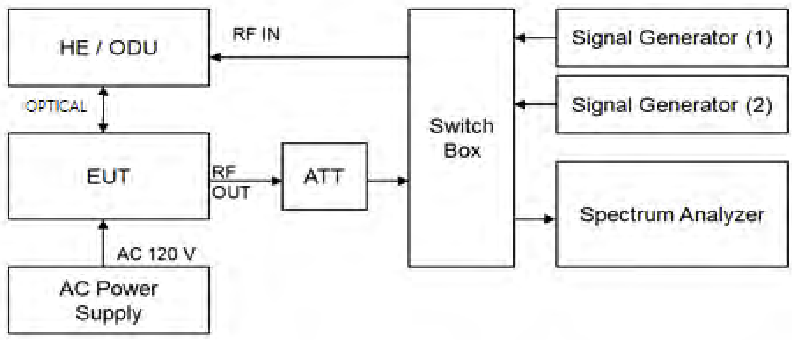
** Coverage factor k = 2, Confidence levels of 95 %*

3.4. STANDARDS ENVIRONMENTAL TEST CONDITIONS

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

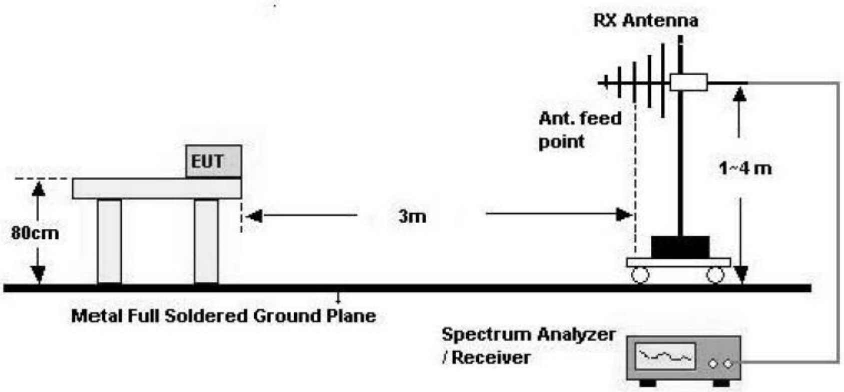
3.5. TEST DIAGRAMS

Conducted Test

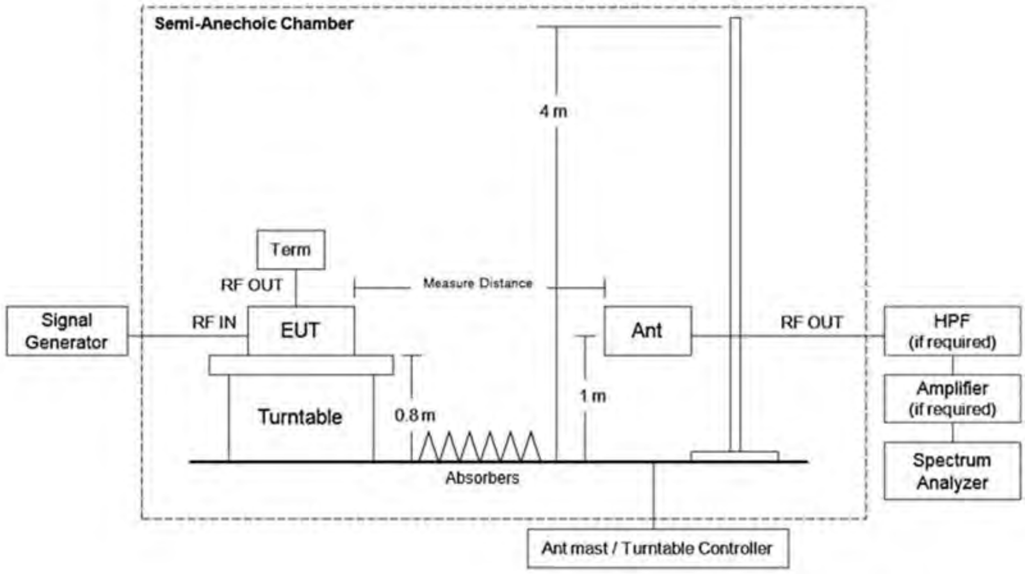


Radiated Test

30 MHz ~ 1 GHz



Above 1 GHz



※ 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	05/11/2020	Annual	MY50200093
Agilent	N9030B / PXA Signal Analyzer	06/04/2020	Annual	MY55480167
Agilent	N5182A / MXG Vector Signal Generator	12/23/2019	Annual	MY46240523
Agilent	N5182A / MXG Vector Signal Generator	01/17/2020	Annual	MY47070406
Weinschel Associates	WA93-30-33 / 30 dB Attenuator	04/09/2020	Annual	0202
KEITHLEY	S46 / Switch	N/A	N/A	1088024
Deayoung ENT	DFSS60 / AC Power Supply	04/07/2020	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
TNM system	FBSM-01B / Amp & Filter Bank Switch Controller	N/A	N/A	N/A
Rohde & Schwarz	Loop Antenna	05/12/2020	Biennial	1513-175
Schwarzbeck	VULB 9168 / Hybrid Antenna	08/02/2019	Biennial	01039
Schwarzbeck	BBHA 9120D / Horn Antenna	06/28/2019	Biennial	1300
Rohde & Schwarz	FSP(9 kHz ~ 40 GHz) / Spectrum Analyzer	06/08/2020	Annual	100843
TNM system	FBSM-05B / LNA1(1~18GHz)	01/21/2020	Annual	25540
Wainwright Instruments	WHKX10-900-1000-15000-40SS/ High Pass Filter	06/24/2020	Annual	5
CERNEX	CBL18265035 / Power Amplifier	12/26/2019	Annual	22966

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 / Section 4.2 of KDB 935210 D05 v01r04.

3.2 Measuring AGC threshold level

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.

4.2 Measuring AGC threshold

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.

Table 1 —Test signals for PLMRS devices

Emission Designator	Modulation	Occupied Bandwidth	Channel Bandwidth	Audio Frequency
16K0F3E	FM	16 kHz	25 kHz	1 kHz
11K3F3E	FM	11.3 kHz	12.5 kHz	1 kHz
4K00F1E	FM	4 kHz	6.25 kHz	1 kHz
N/A	CW	N/A	N/A	N/A

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:

Frequency (MHz)	Link	Signal	Center Frequency (MHz)	AGC Threshold Level (dBm)	Output Level (dBm)
928 ~ 929	Downlink	P25 Phase 1	928.50	-15	33.07
		P25 Phase 2	928.50	-15	33.13
930 ~ 931		P25 Phase 1	930.50	-15	33.34
		P25 Phase 2	930.50	-15	32.92
931 ~ 932		P25 Phase 1	931.50	-15	33.04
		P25 Phase 2	931.50	-15	33.04
932 ~ 935		P25 Phase 1	933.50	-15	32.80
		P25 Phase 2	933.50	-15	33.22
940 ~ 941		P25 Phase 1	940.50	-15	32.70
		P25 Phase 2	940.50	-15	32.76
929 ~ 930		CW	929.50	-15	33.19
935 ~ 940		CW	937.50	-15	32.53

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 / section 4.3 of KDB 935210 D05 v01r04.

3.3 Out-of-band rejection

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.

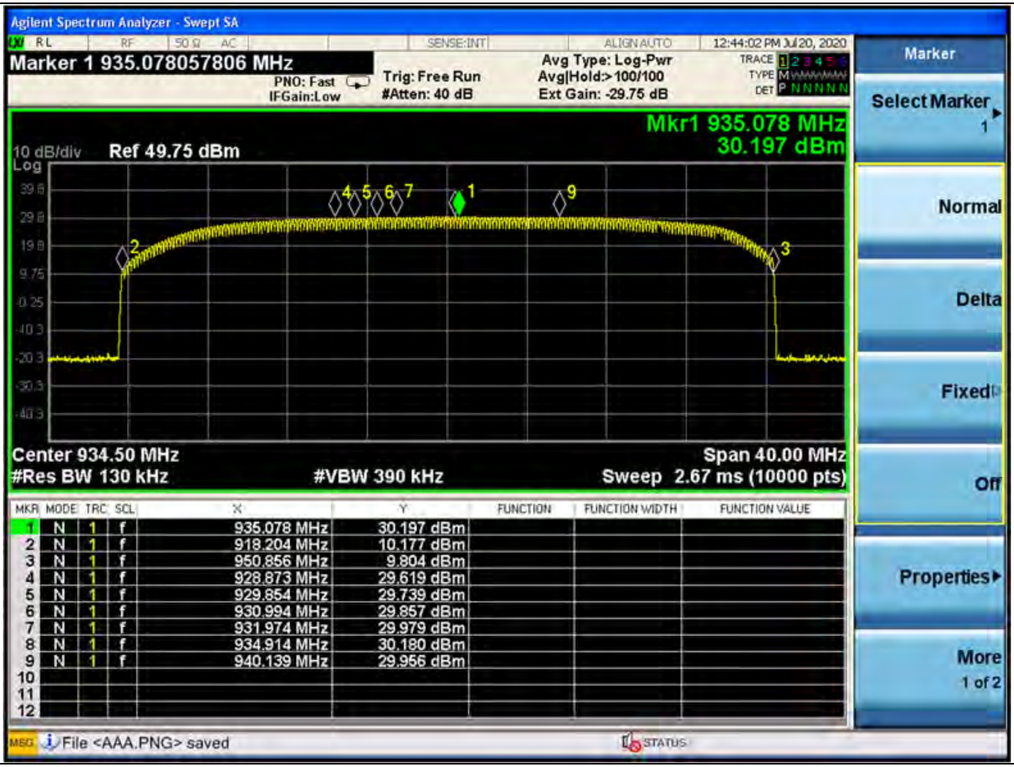
a) Connect a signal generator to the input of the EUT.
b) Configure a swept CW signal with the following parameters:
   1) Frequency range = ±250 % of the passband, for each applicable CMRS band.
   2) Level = a sufficient level to affirm that the out-of-band rejection is > 20 dB above the noise floor and will not engage the AGC during the entire sweep.
   3) Dwell time = approximately 10 ms.
   4) Number of points = 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.

4.3 Out-of-band rejection

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 × 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:

900 MHz / Downlink


MKR	MODE	TRC	SCL	X	Y
1	N	1	f	935.078 MHz	30.197 dBm
2	N	1	f	918.204 MHz	10.177 dBm
3	N	1	f	950.856 MHz	9.804 dBm
4	N	1	f	928.873 MHz	29.619 dBm
5	N	1	f	929.854 MHz	29.739 dBm
6	N	1	f	930.994 MHz	29.857 dBm
7	N	1	f	931.974 MHz	29.979 dBm
8	N	1	f	934.914 MHz	30.180 dBm
9	N	1	f	940.139 MHz	29.956 dBm

5.3. INPUT-VERSUS-OUTPUT SIGNAL COMPARISON

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.

§ 22.531 Channels for paging operation.

The following channels are allocated for assignment to base transmitters that provide paging service, either individually or collectively under a paging geographic area authorization. Unless otherwise indicated, all channels have a bandwidth of 20 kHz and are designated by their center frequencies in MegaHertz.

§ 24.131 Authorized bandwidth.

The authorized bandwidth of narrowband PCS channels will be 10 kHz for 12.5 kHz channels and 45 kHz for 50 kHz channels. For aggregated adjacent channels, a maximum authorized bandwidth of 5 kHz less than the total aggregated channel width is permitted.

§ 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 / Section 4.4 of KDB 935210 D05 v01r04.

3.4 Input-versus-output signal comparison

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.

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. 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.

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

4.4 Input-versus-output signal comparison

Compliance with the emission mask of the EUT output shall be measured for the public safety service signal types as specified in 4.1.

Refer to the applicable regulatory requirements (e.g., Section 90.210) for emission mask specifications.

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 (see Table 1).
c) Configure the signal level to be just below the AGC threshold (see results from 4.2).
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 × to 5 × 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 f0 per 4.3.
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.

Test Results:

Tabular data of Output Occupied Bandwidth

Frequency (MHz)	Link	Signal	Center Frequency (MHz)	99 % OBW (kHz)	26 dB OBW (kHz)
928 ~ 929	Downlink	P25 Phase 1	928.50	8.2091	11.598
		P25 Phase 2	928.50	4.8368	5.440
930 ~ 931		P25 Phase 1	930.50	8.6350	11.956
		P25 Phase 2	930.50	4.8382	5.465
931 ~ 932		P25 Phase 1	931.50	8.5262	11.953
		P25 Phase 2	931.50	4.8438	5.504
932 ~ 935		P25 Phase 1	933.50	8.4039	12.122
		P25 Phase 2	933.50	4.8442	5.555
940 ~ 941		P25 Phase 1	940.50	8.4644	12.163
		P25 Phase 2	940.50	4.8649	5.471
929 ~ 930		P25 Phase 1	929.50	8.2200	11.34
		P25 Phase 2	929.50	4.8475	5.48
935 ~ 940		P25 Phase 1	937.50	8.4089	11.82
		P25 Phase 2	937.50	4.8357	5.43

Tabular data of Input Occupied Bandwidth

Frequency (MHz)	Link	Signal	Center Frequency (MHz)	99 % OBW (kHz)	26 dB OBW (kHz)
928 ~ 929	Downlink	P25 Phase 1	928.50	8.2405	11.884
		P25 Phase 2	928.50	4.8483	5.467
930 ~ 931		P25 Phase 1	930.50	8.6505	11.953
		P25 Phase 2	930.50	4.8606	5.482
931 ~ 932		P25 Phase 1	931.50	8.3970	12.005
		P25 Phase 2	931.50	4.8654	5.510
932 ~ 935		P25 Phase 1	933.50	8.5052	12.259
		P25 Phase 2	933.50	4.8718	5.495
940 ~ 941		P25 Phase 1	940.50	8.3114	12.223
		P25 Phase 2	940.50	4.8539	5.506
929 ~ 930		P25 Phase 1	929.50	8.1600	11.61
		P25 Phase 2	929.50	4.8461	5.47
935 ~ 940		P25 Phase 1	937.50	8.3989	11.86
		P25 Phase 2	937.50	4.8638	5.49

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

Frequency (MHz)	Link	Signal	Center Frequency (MHz)	99 % OBW (kHz)	26 dB OBW (kHz)
928 ~ 929	Downlink	P25 Phase 1	928.50	8.3519	11.873
		P25 Phase 2	928.50	4.8508	5.462
930 ~ 931		P25 Phase 1	930.50	8.5757	11.562
		P25 Phase 2	930.50	4.8773	5.503
931 ~ 932		P25 Phase 1	931.50	8.3615	11.937
		P25 Phase 2	931.50	4.8754	5.459
932 ~ 935		P25 Phase 1	933.50	8.5028	12.070
		P25 Phase 2	933.50	4.8820	5.504
940 ~ 941		P25 Phase 1	940.50	8.5132	11.933
		P25 Phase 2	940.50	4.8786	5.459
929 ~ 930		P25 Phase 1	929.50	8.1602	11.52
		P25 Phase 2	929.50	4.8609	5.46
935 ~ 940		P25 Phase 1	937.50	8.2397	11.07
		P25 Phase 2	937.50	4.8376	5.48

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

Frequency (MHz)	Link	Signal	Center Frequency (MHz)	99 % OBW (kHz)	26 dB OBW (kHz)
928 ~ 929	Downlink	P25 Phase 1	928.50	8.2704	12.092
		P25 Phase 2	928.50	4.8473	5.491
930 ~ 931		P25 Phase 1	930.50	8.6022	11.752
		P25 Phase 2	930.50	4.8523	5.481
931 ~ 932		P25 Phase 1	931.50	8.4939	12.430
		P25 Phase 2	931.50	4.8781	5.516
932 ~ 935		P25 Phase 1	933.50	8.5431	12.030
		P25 Phase 2	933.50	4.8948	5.523
940 ~ 941		P25 Phase 1	940.50	8.3974	11.800
		P25 Phase 2	940.50	4.8397	5.472
929 ~ 930		P25 Phase 1	929.50	8.3882	11.91
		P25 Phase 2	929.50	4.8313	5.46
935 ~ 940		P25 Phase 1	937.50	8.2174	11.32
		P25 Phase 2	937.50	4.8384	5.47

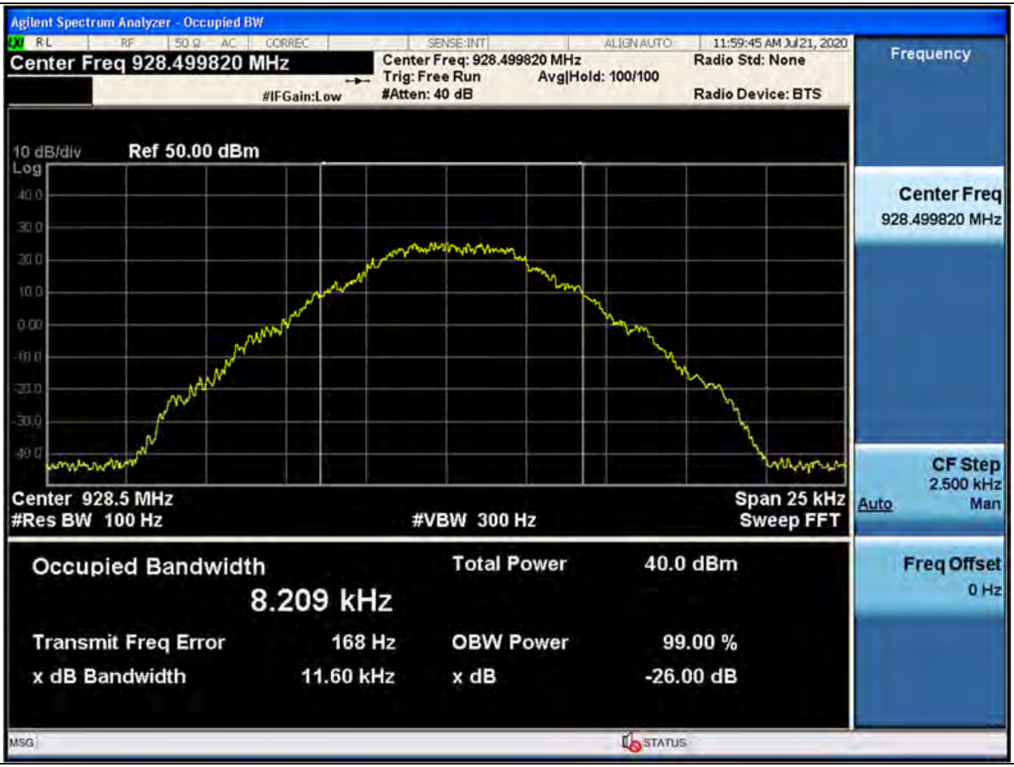
Measured Occupied Bandwidth Comparison

Frequency (MHz)	Link	Signal	Variant of Input and output Occupied Bandwidth (%)	Variant of Input and 3 dB above the AGC threshold output Occupied Bandwidth (%)
928 ~ 929	Downlink	P25 Phase 1	-2.407	-1.811
		P25 Phase 2	-0.494	-0.528
930 ~ 931		P25 Phase 1	0.025	-1.617
		P25 Phase 2	-0.310	0.401
931 ~ 932		P25 Phase 1	-0.433	-3.966
		P25 Phase 2	-0.109	-1.033
932 ~ 935		P25 Phase 1	-1.118	0.333
		P25 Phase 2	1.092	-0.344
940 ~ 941		P25 Phase 1	-0.491	1.127
		P25 Phase 2	-0.636	-0.238
929 ~ 930		P25 Phase 1	-2.308	-3.225
		P25 Phase 2	0.073	0.018
935 ~ 940		P25 Phase 1	-0.405	-2.165
		P25 Phase 2	-0.912	0.220

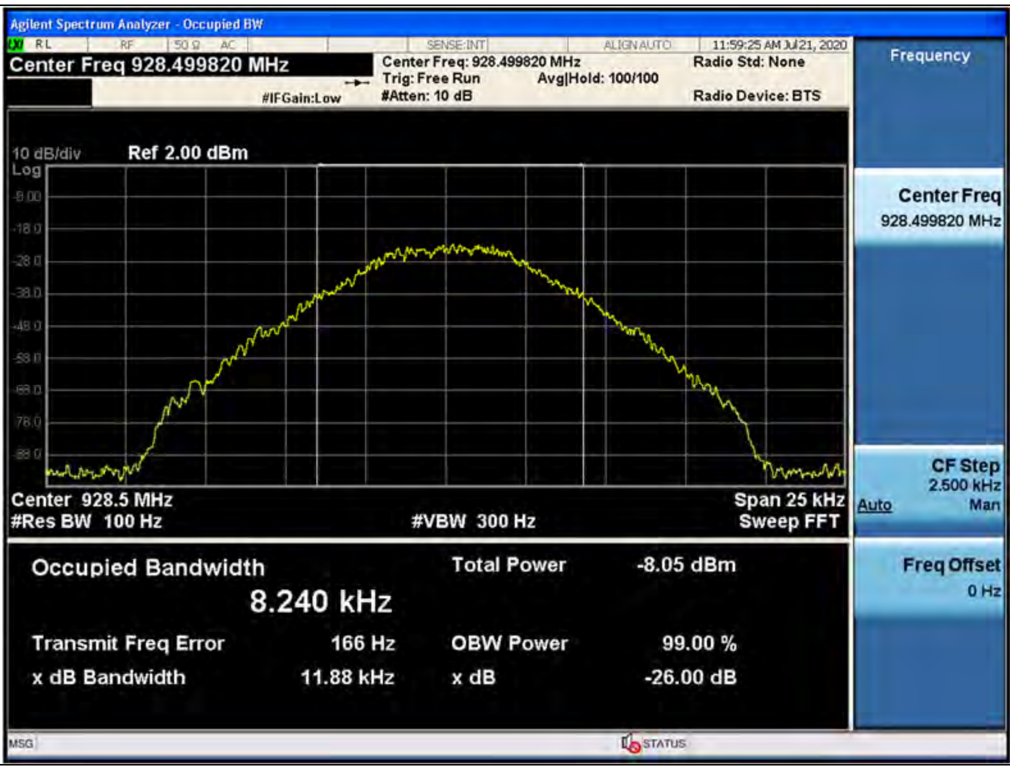
** Change in input-output OBW is less than ±5 %.*

Plot data of Occupied Bandwidth

Output / 928 ~ 929 MHz / Downlink / P25 Phase 1

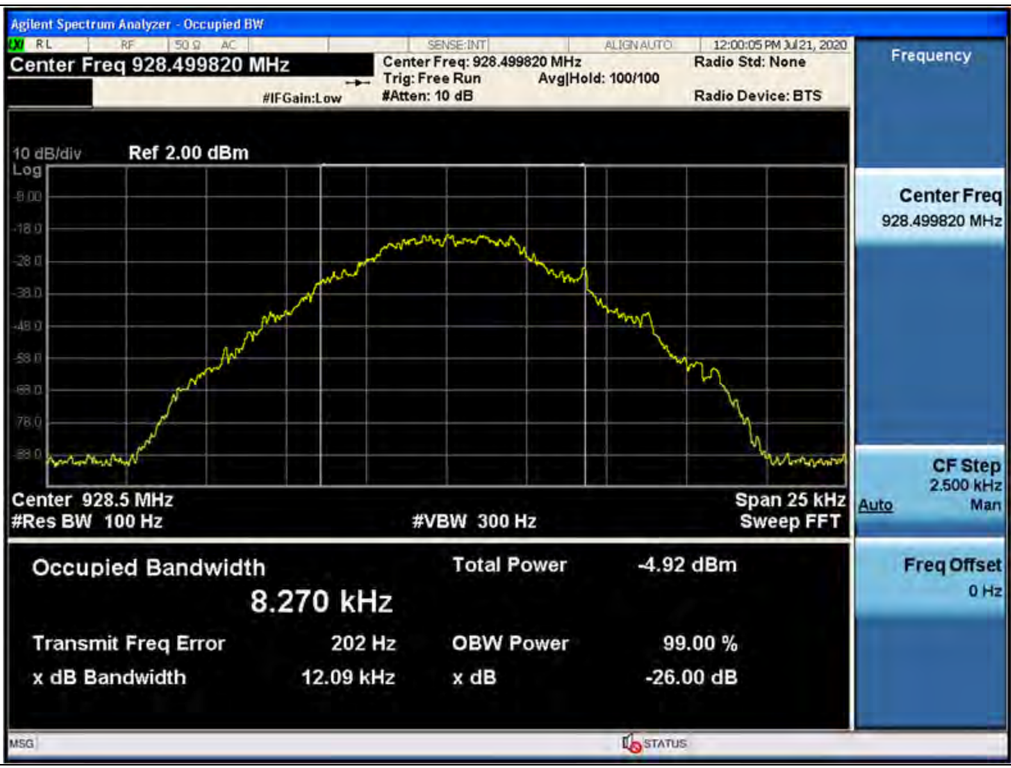


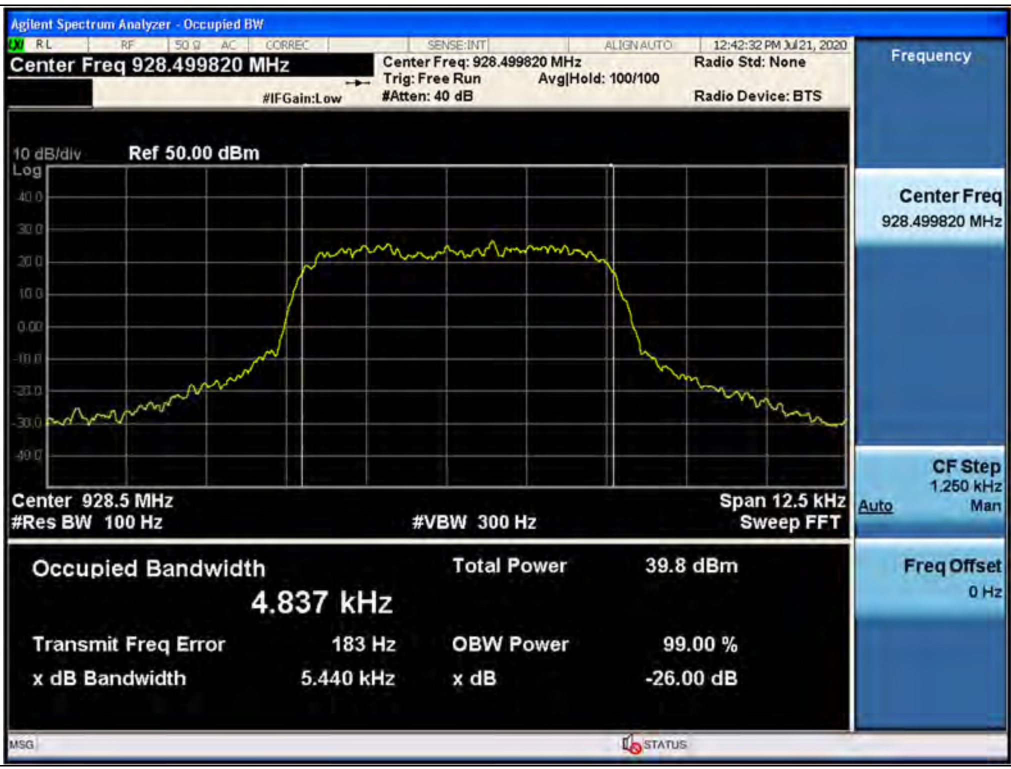
Input / 928 ~ 929 MHz / Downlink / P25 Phase 1

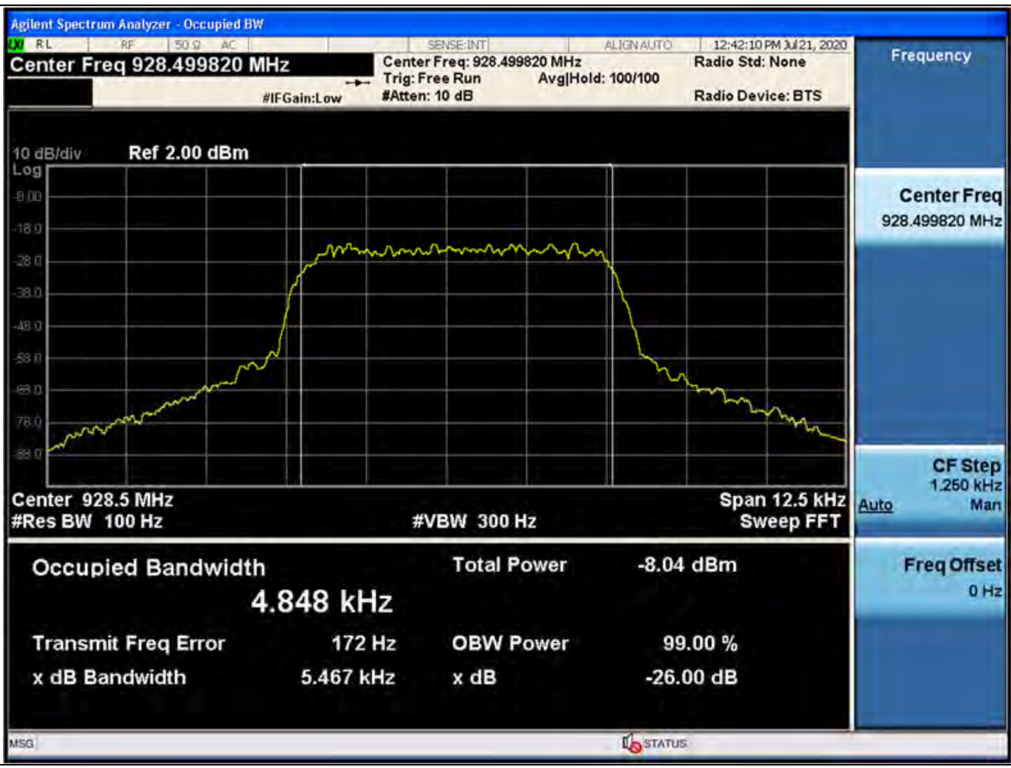


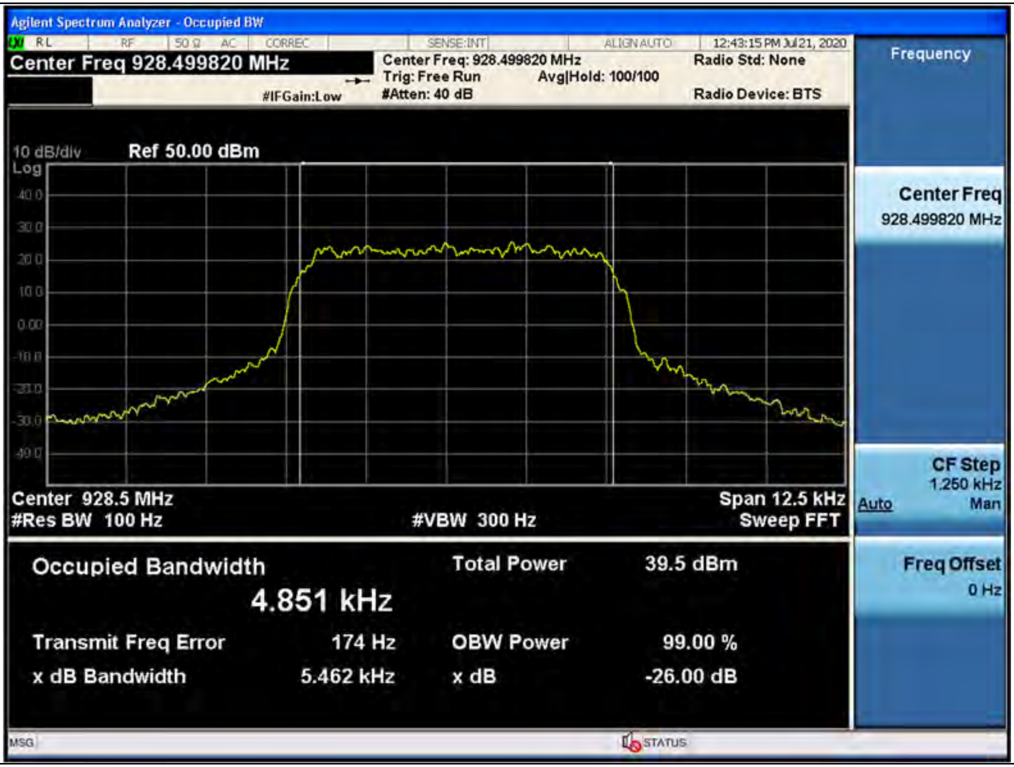
3 dB above the AGC threshold output / 928 ~ 929 MHz / Downlink / P25 Phase 1

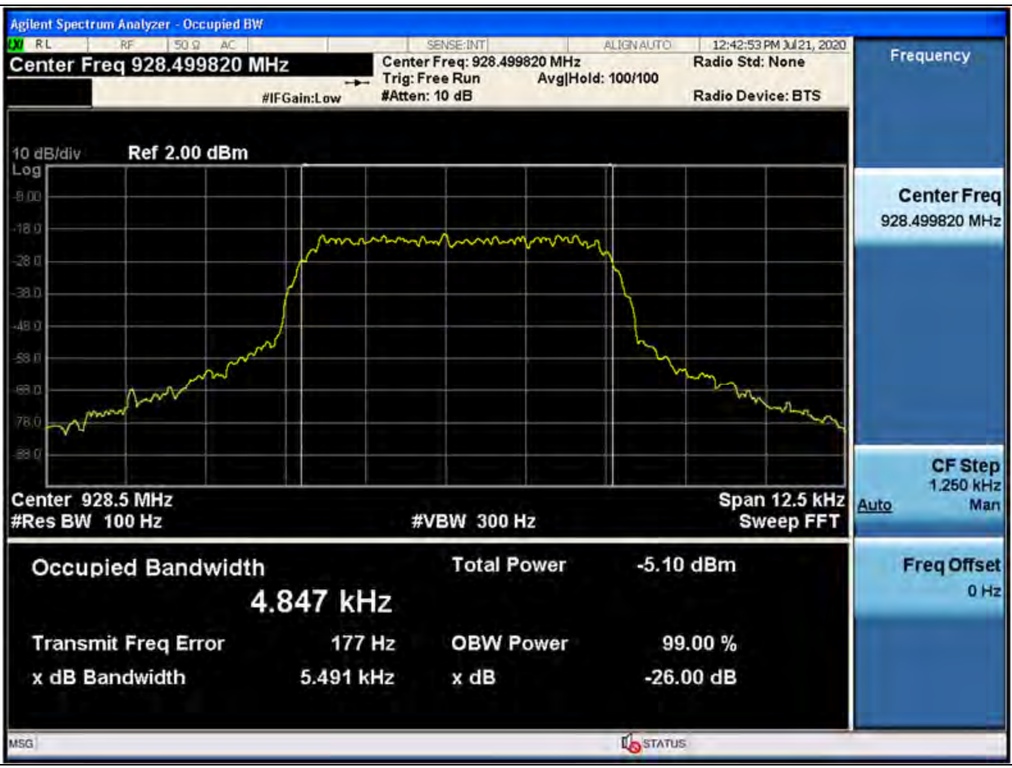
3 dB above the AGC threshold Input / 928 ~ 929 MHz / Downlink / P25 Phase 1

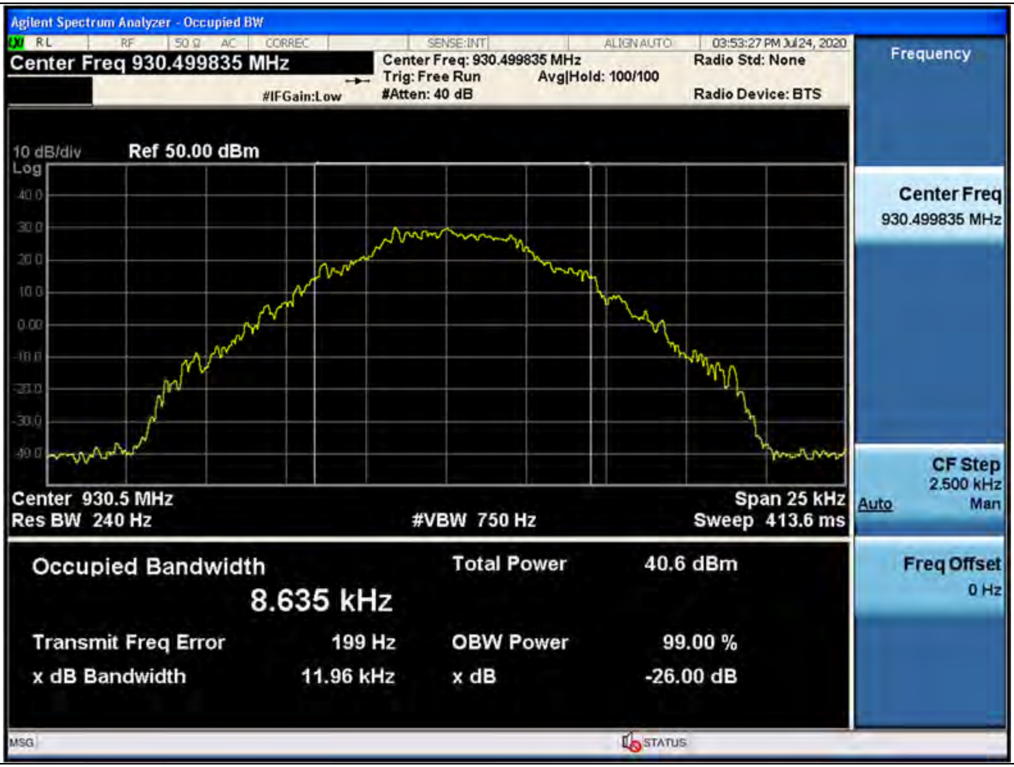


Output / 928 ~ 929 MHz / Downlink / P25 Phase 2


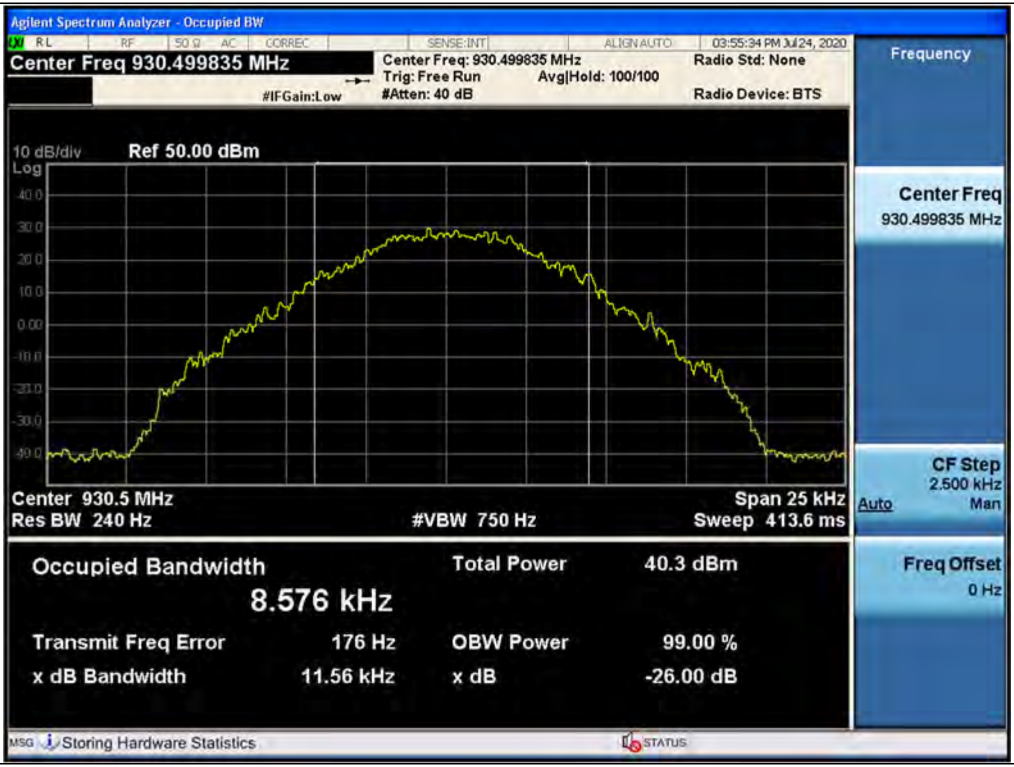
Input / 928 ~ 929 MHz / Downlink / P25 Phase 2


3 dB above the AGC threshold output / 928 ~ 929 MHz / Downlink / P25 Phase 2


3 dB above the AGC threshold Input / 928 ~ 929 MHz / Downlink / P25 Phase 2


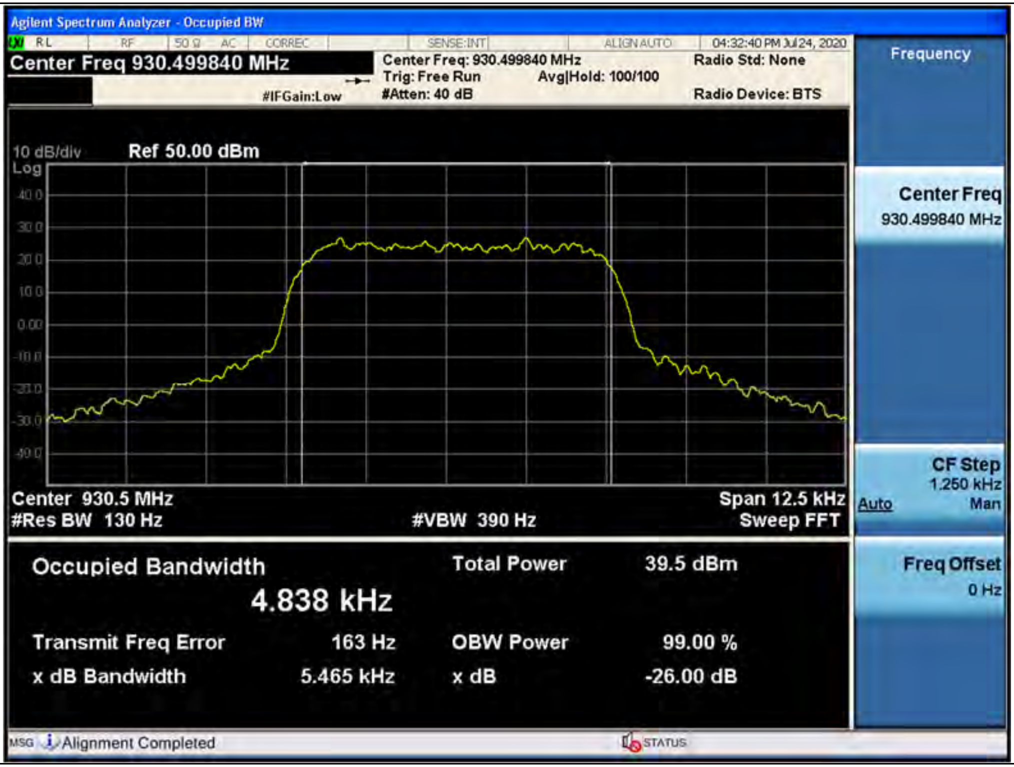
Output / 930 ~ 931 MHz / Downlink / P25 Phase 1


Input / 930 ~ 931 MHz / Downlink / P25 Phase 1

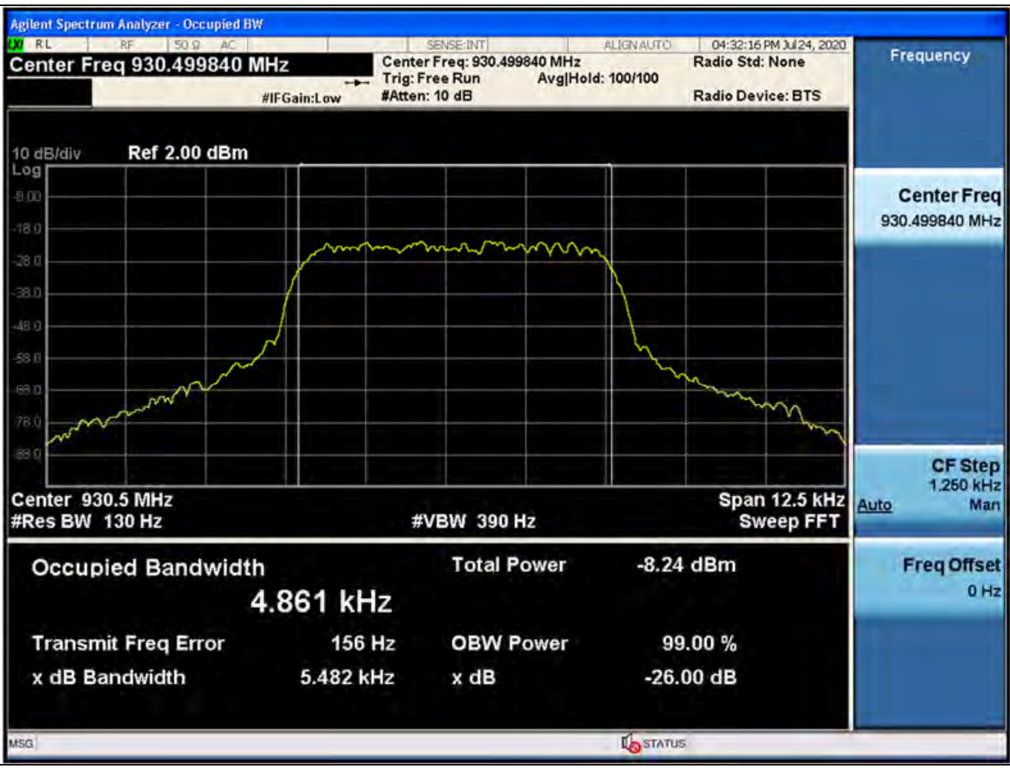

3 dB above the AGC threshold output / 930 ~ 931 MHz / Downlink / P25 Phase 1


3 dB above the AGC threshold Input / 930 ~ 931 MHz / Downlink / P25 Phase 1

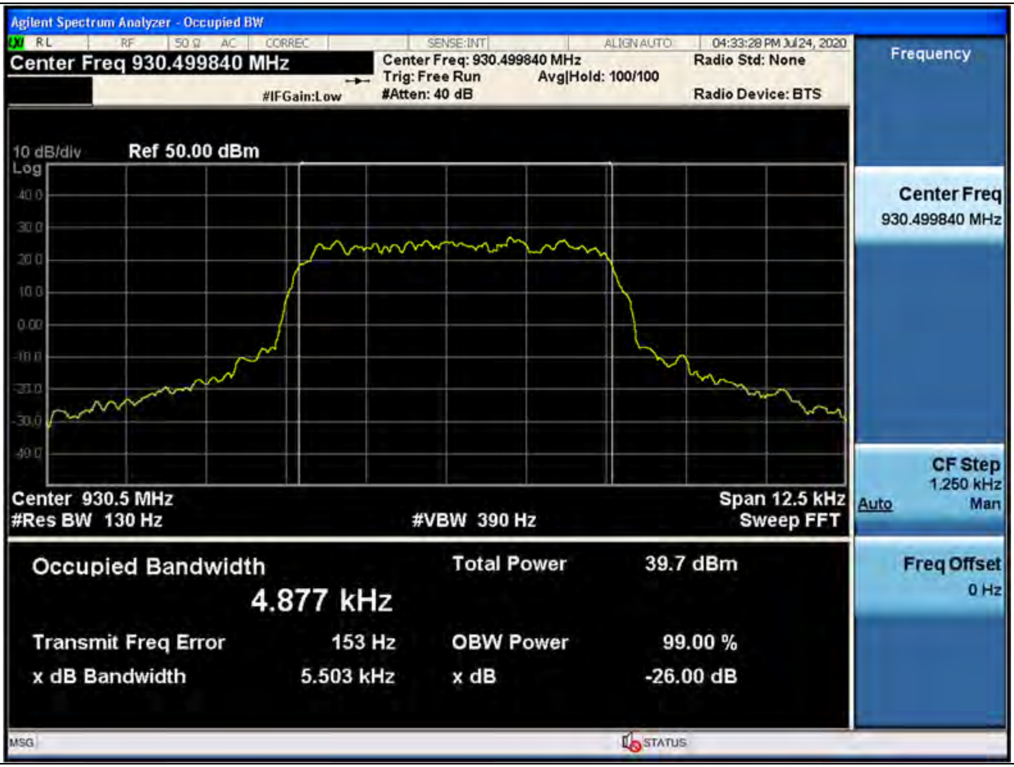

Output / 930 ~ 931 MHz / Downlink / P25 Phase 2



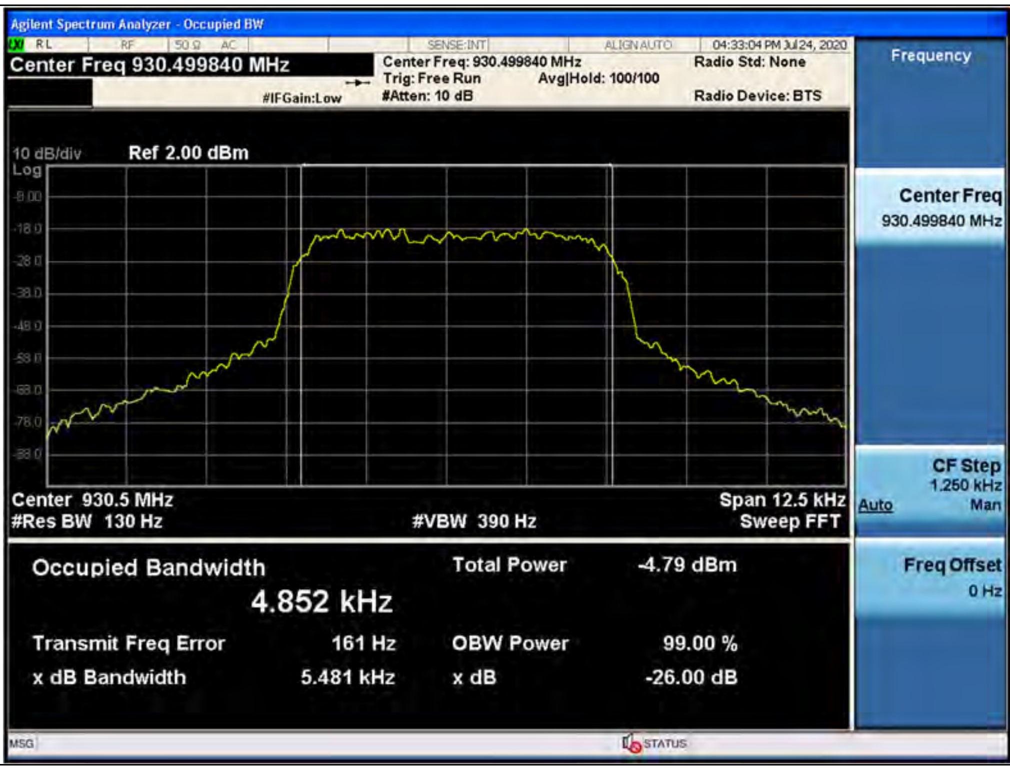
Input / 930 ~ 931 MHz / Downlink / P25 Phase 2



3 dB above the AGC threshold output / 930 ~ 931 MHz / Downlink / P25 Phase 2

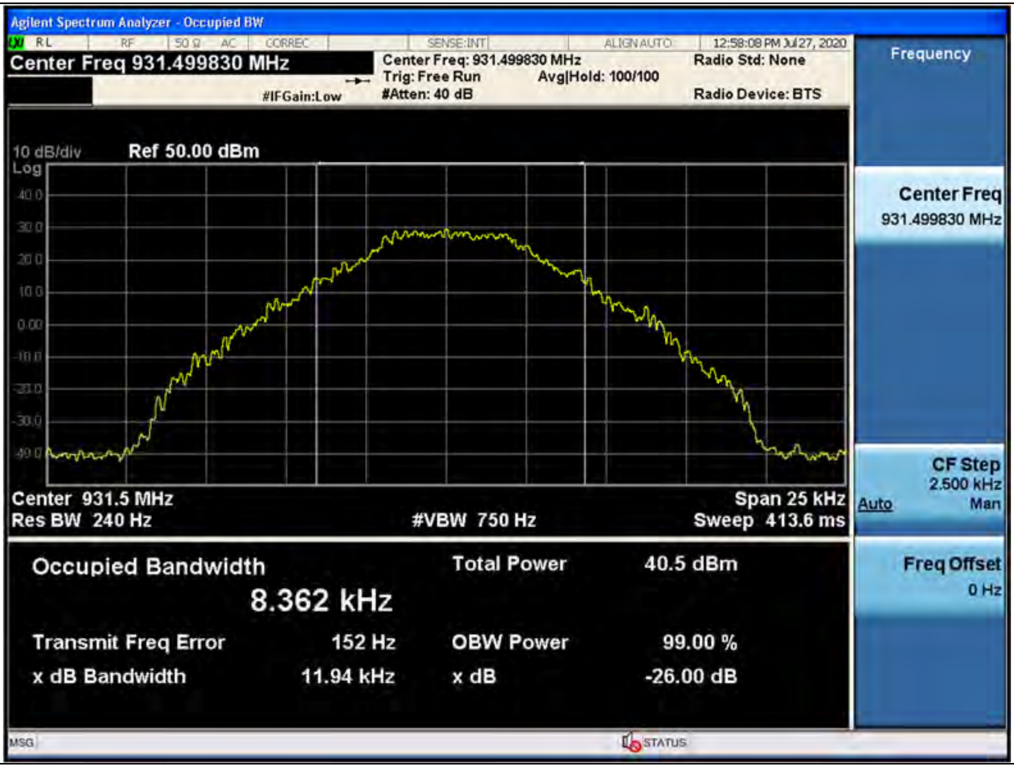


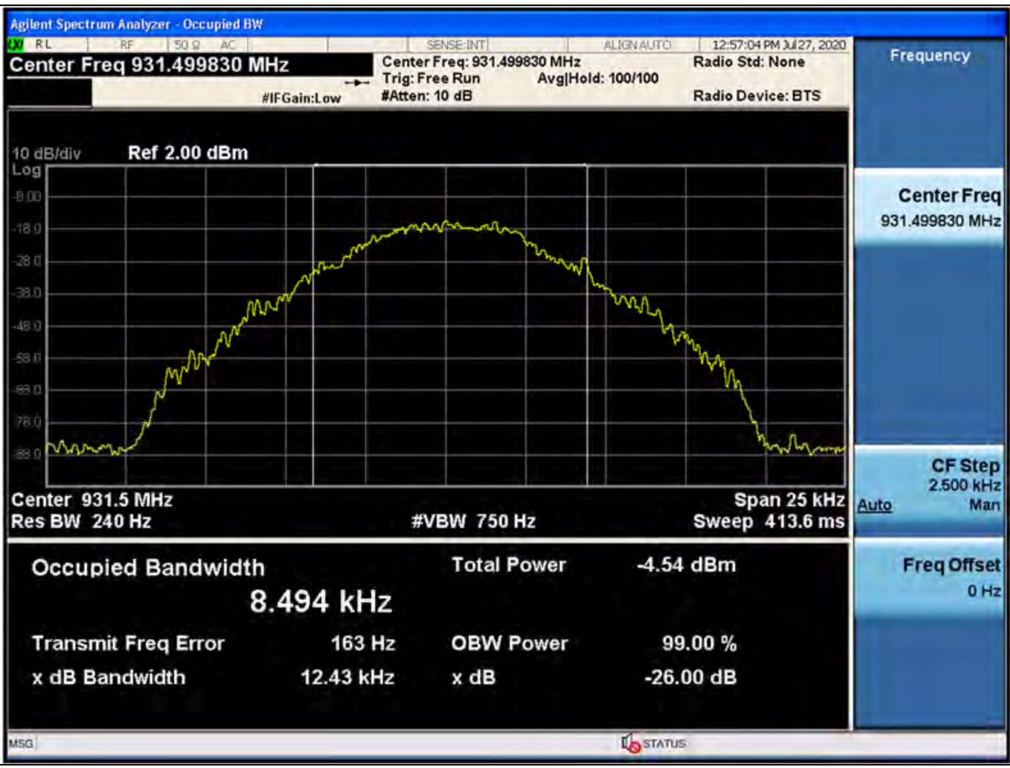
3 dB above the AGC threshold Input / 930 ~ 931 MHz / Downlink / P25 Phase 2

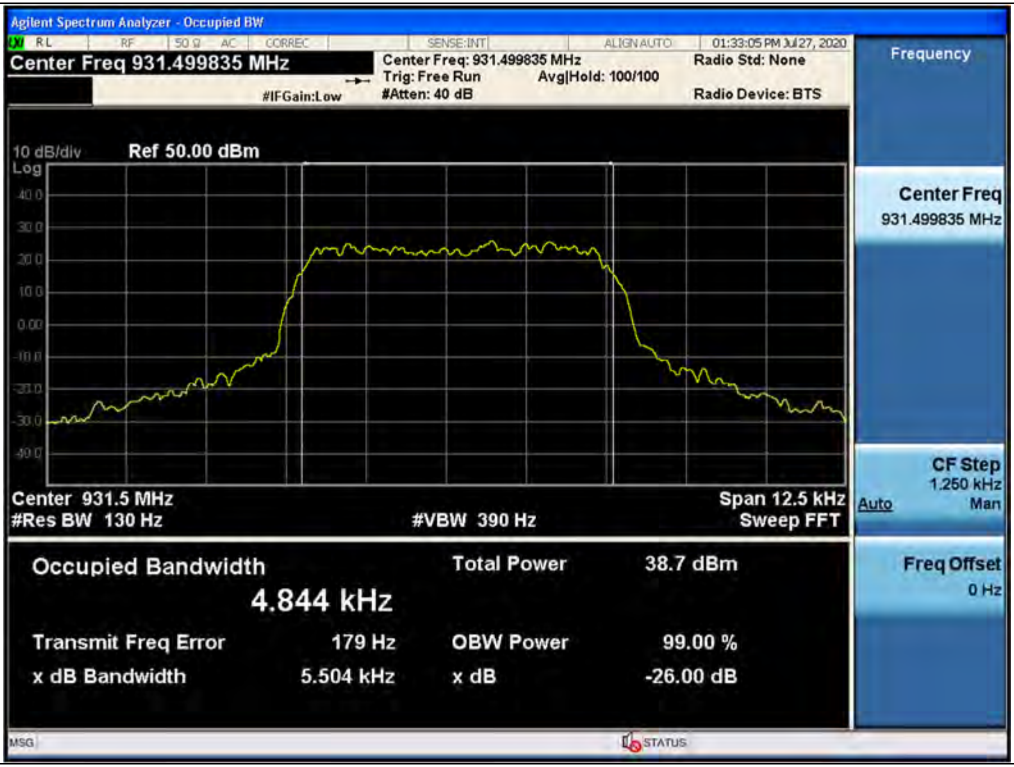


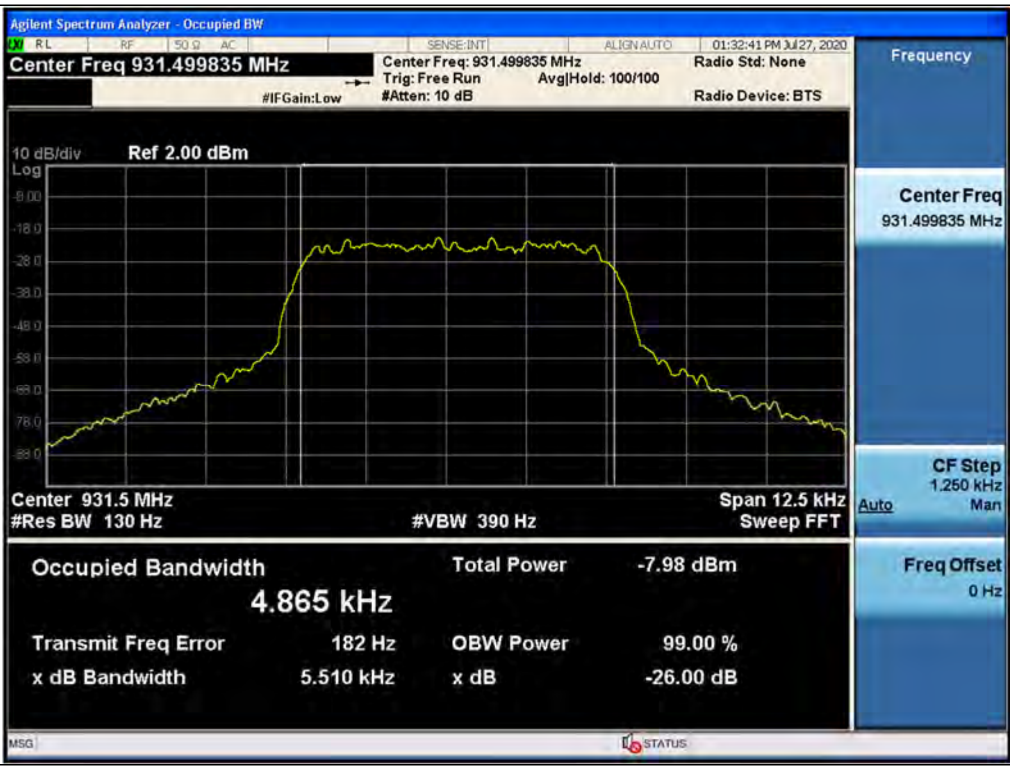
Output / 931 ~ 932 MHz / Downlink / P25 Phase 1

Input / 931 ~ 932 MHz / Downlink / P25 Phase 1

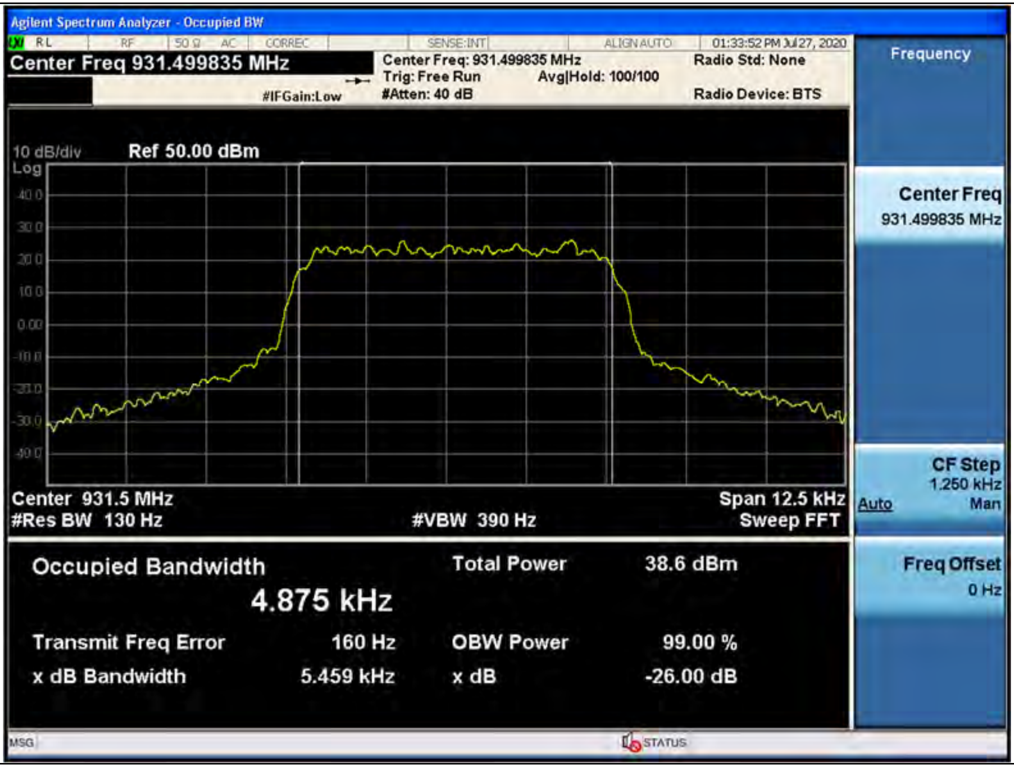
3 dB above the AGC threshold output / 931 ~ 932 MHz / Downlink / P25 Phase 1


3 dB above the AGC threshold Input / 931 ~ 932 MHz / Downlink / P25 Phase 1


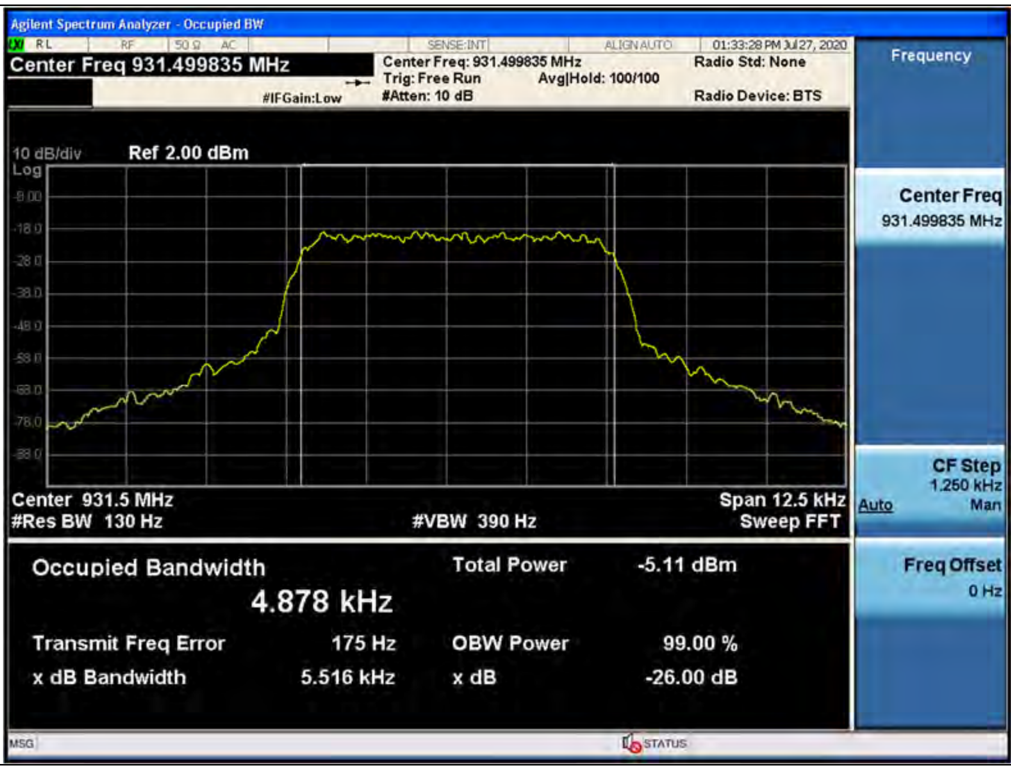
Output / 931 ~ 932 MHz / Downlink / P25 Phase 2


Input / 931 ~ 932 MHz / Downlink / P25 Phase 2


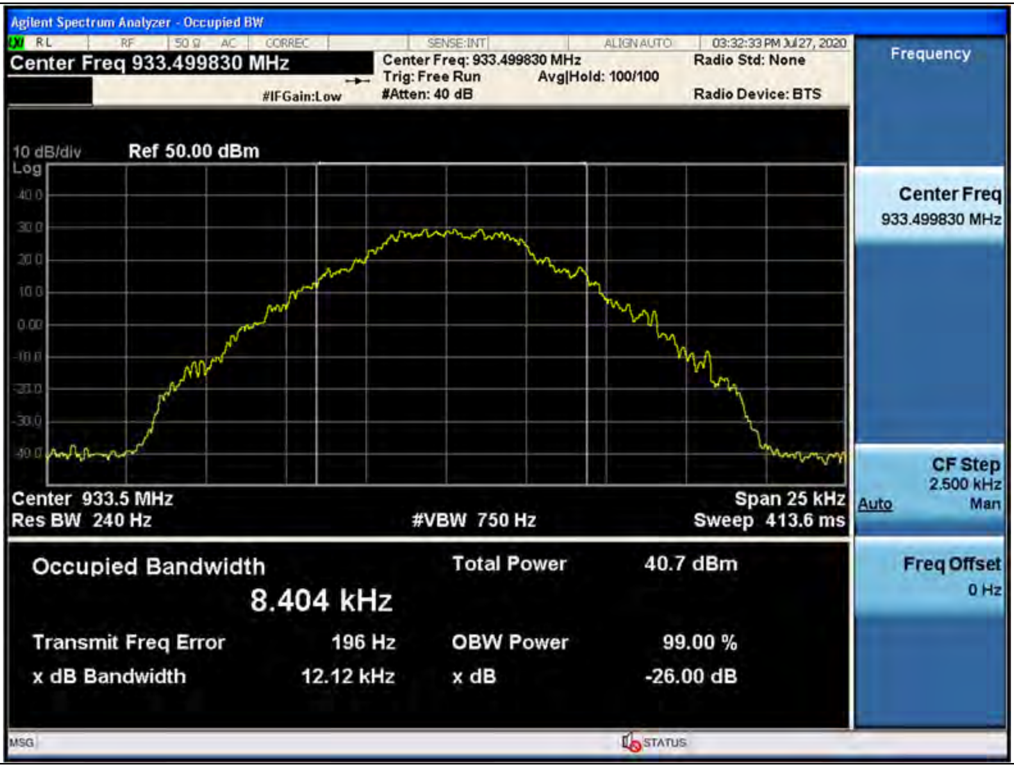
3 dB above the AGC threshold output / 931 ~ 932 MHz / Downlink / P25 Phase 2



3 dB above the AGC threshold Input / 931 ~ 932 MHz / Downlink / P25 Phase 2

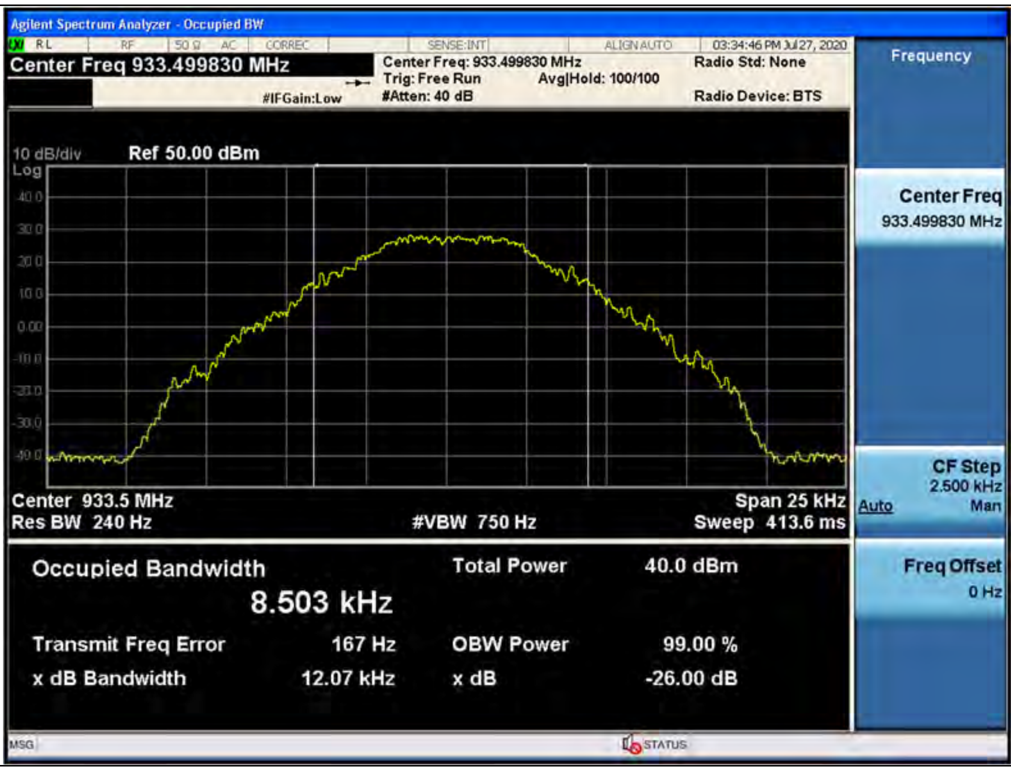


Output / 932 ~ 935 MHz / Downlink / P25 Phase 1

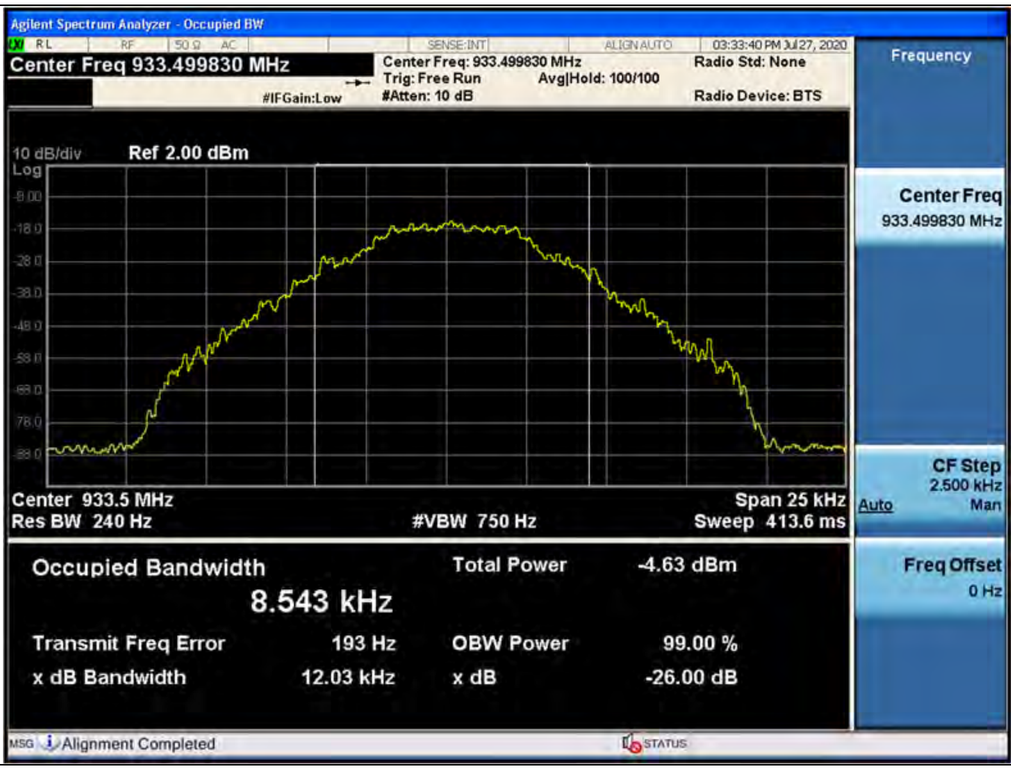


Input / 932 ~ 935 MHz / Downlink / P25 Phase 1

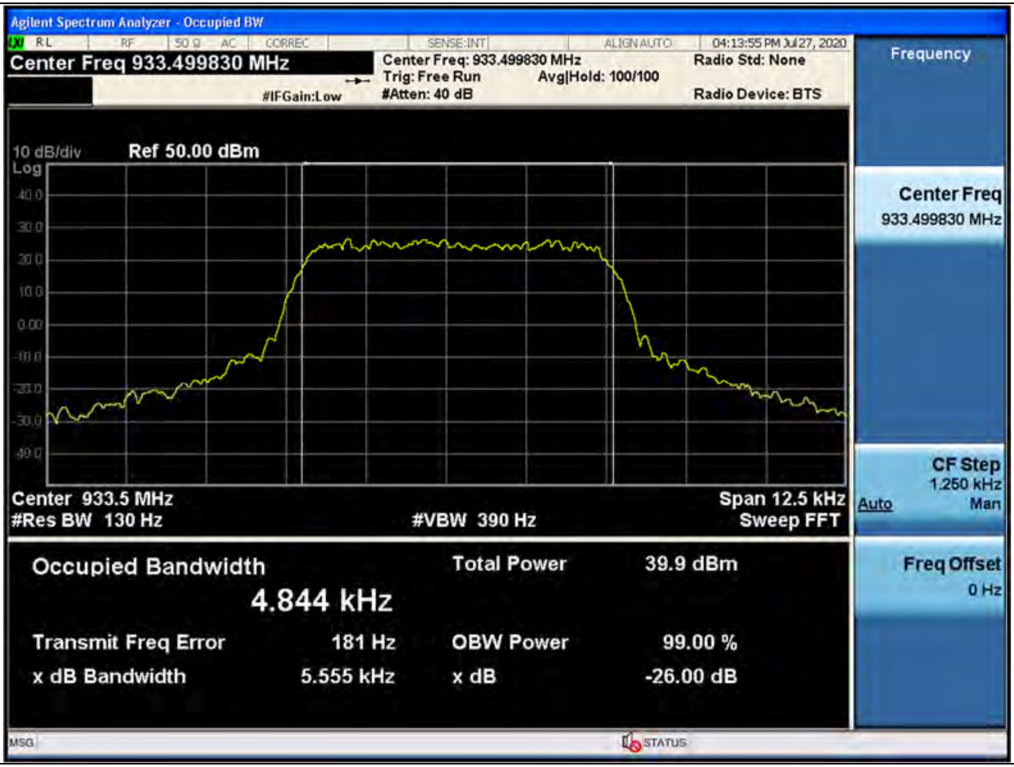
3 dB above the AGC threshold output / 932 ~ 935 MHz / Downlink / P25 Phase 1



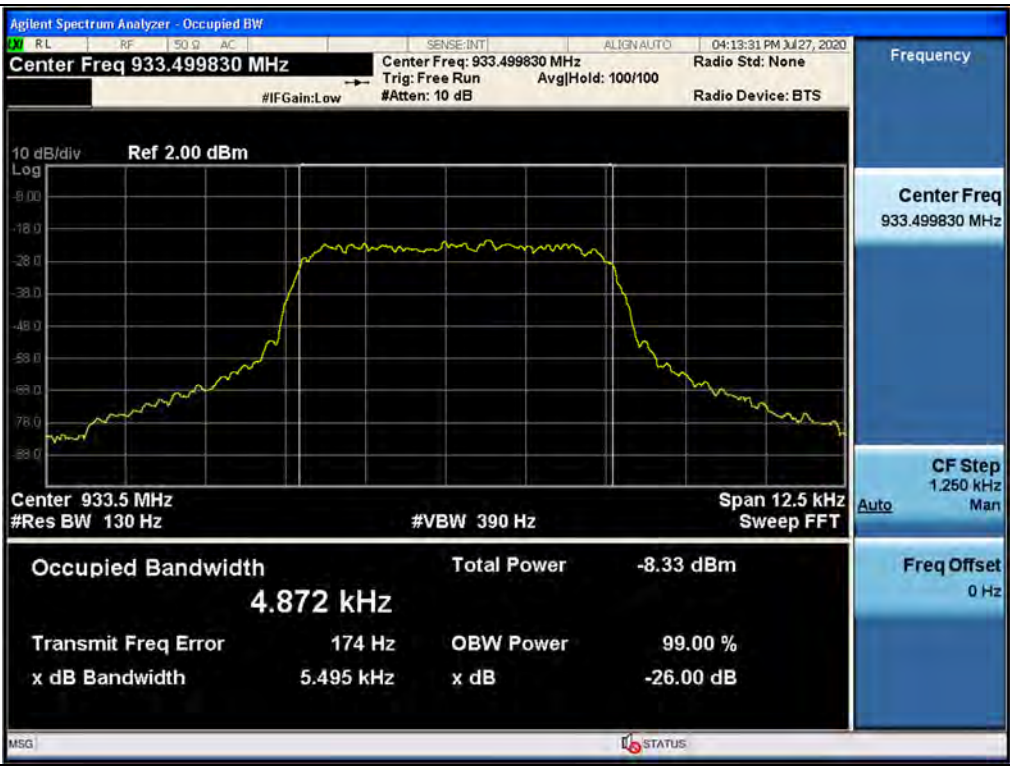
3 dB above the AGC threshold Input / 932 ~ 935 MHz / Downlink / P25 Phase 1

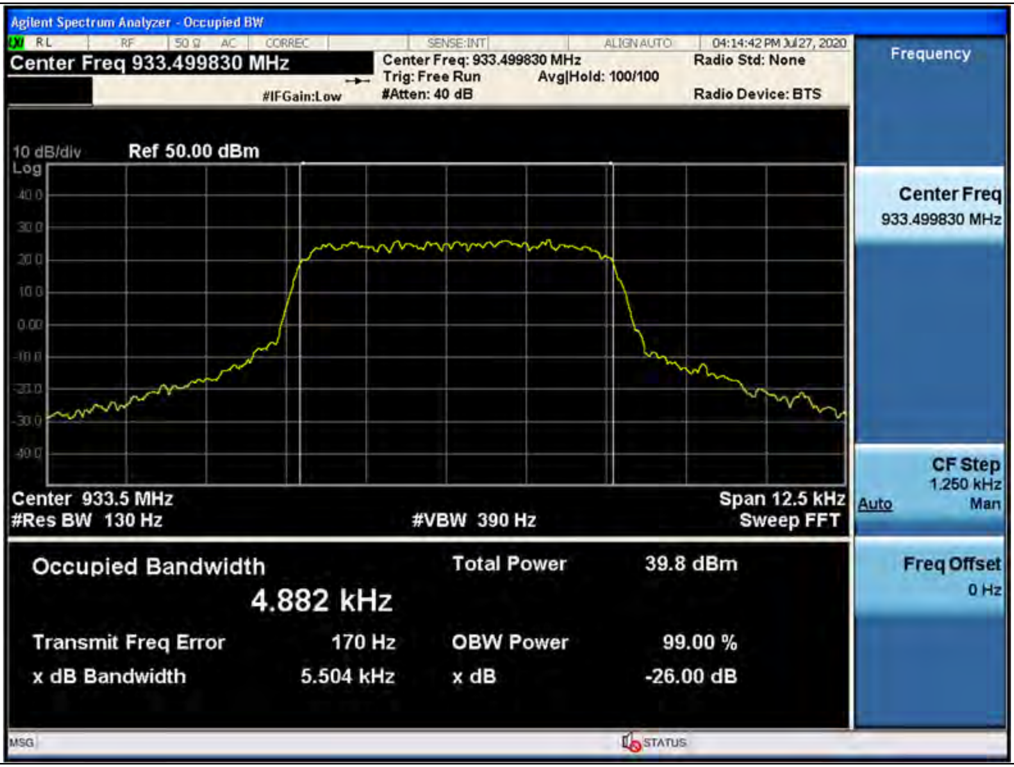


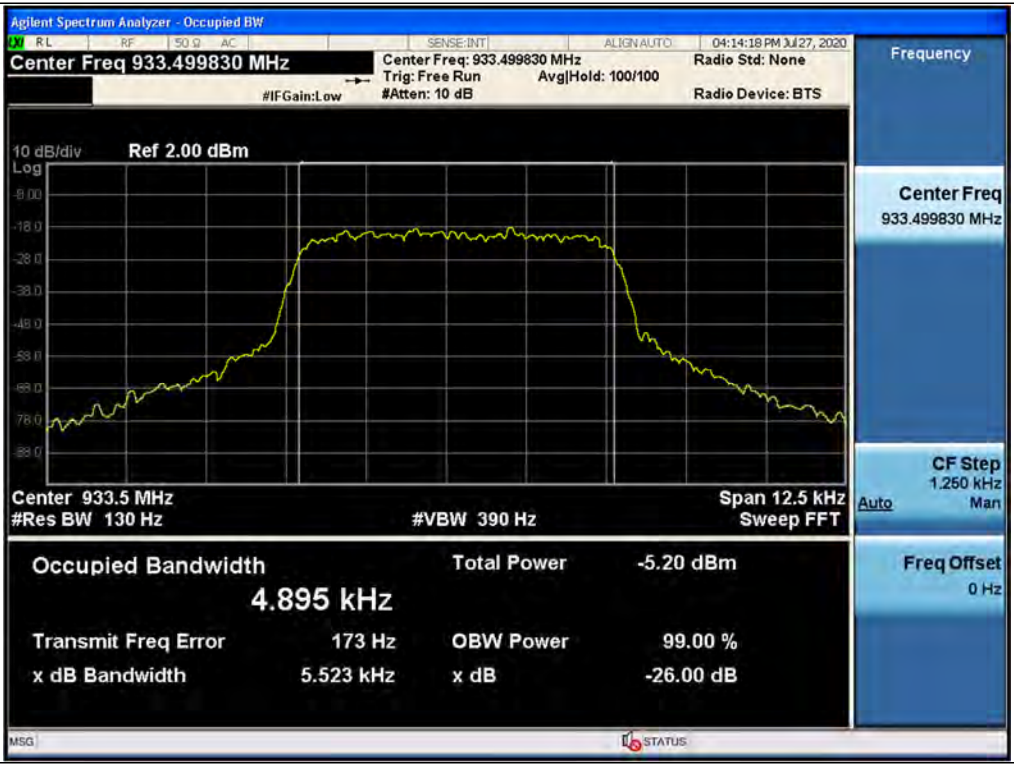
Output / 932 ~ 935 MHz / Downlink / P25 Phase 2



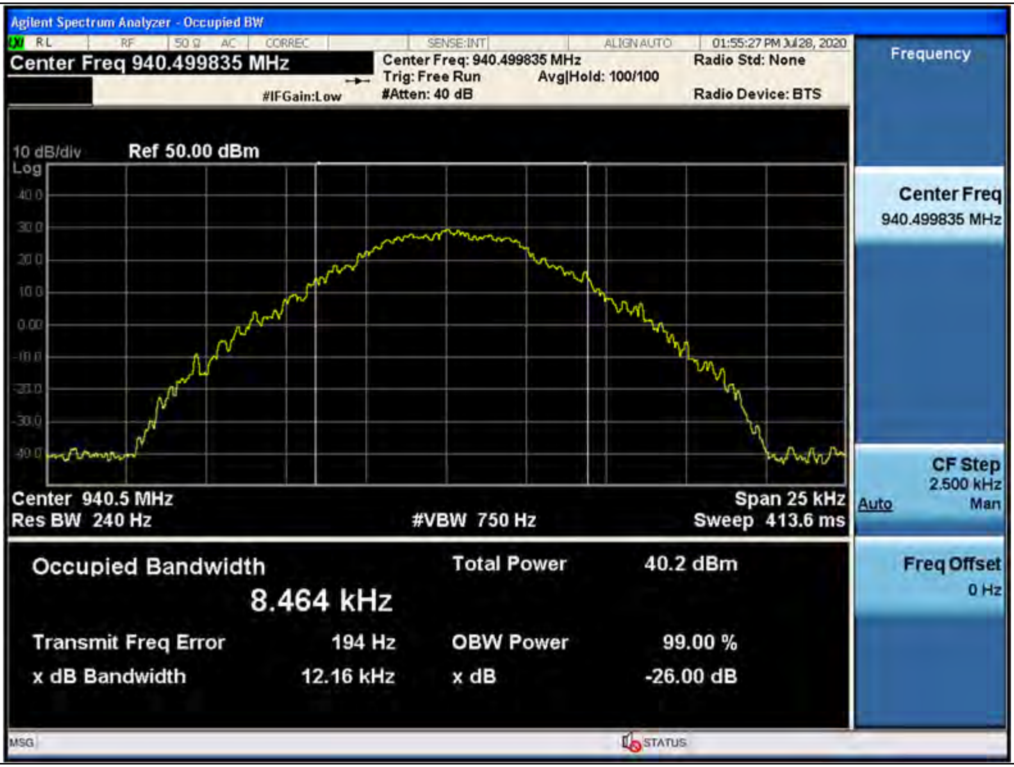
Input / 932 ~ 935 MHz / Downlink / P25 Phase 2



3 dB above the AGC threshold output / 932 ~ 935 MHz / Downlink / P25 Phase 2


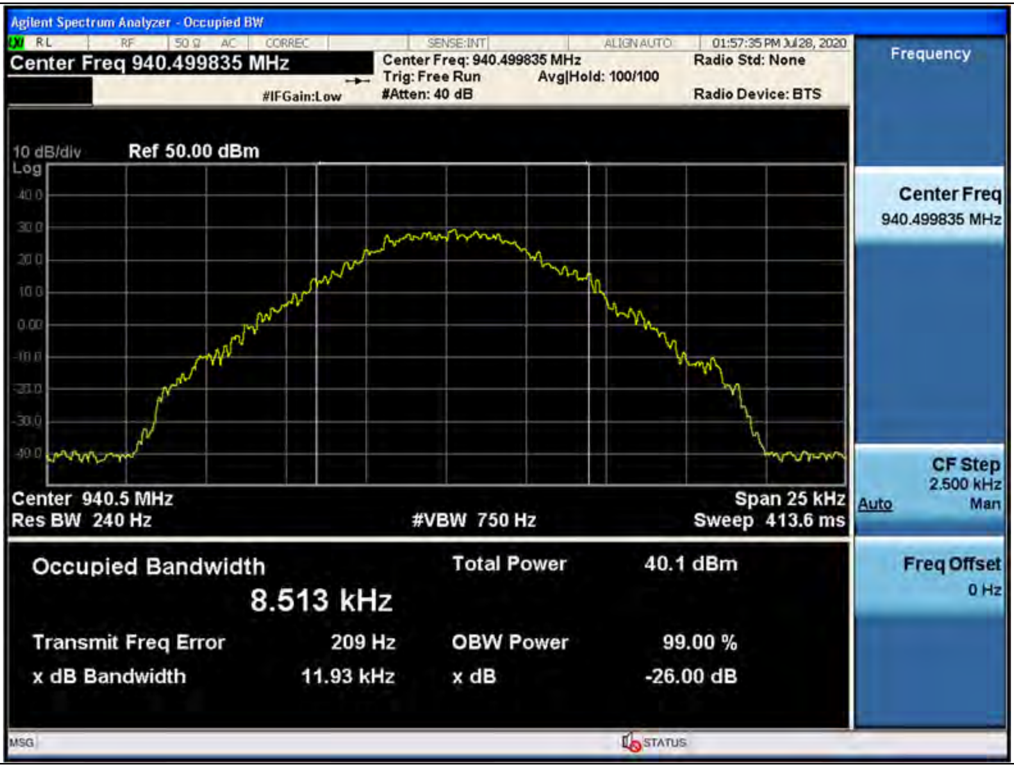
3 dB above the AGC threshold Input / 932 ~ 935 MHz / Downlink / P25 Phase 2


Output / 940 ~ 941 MHz / Downlink / P25 Phase 1

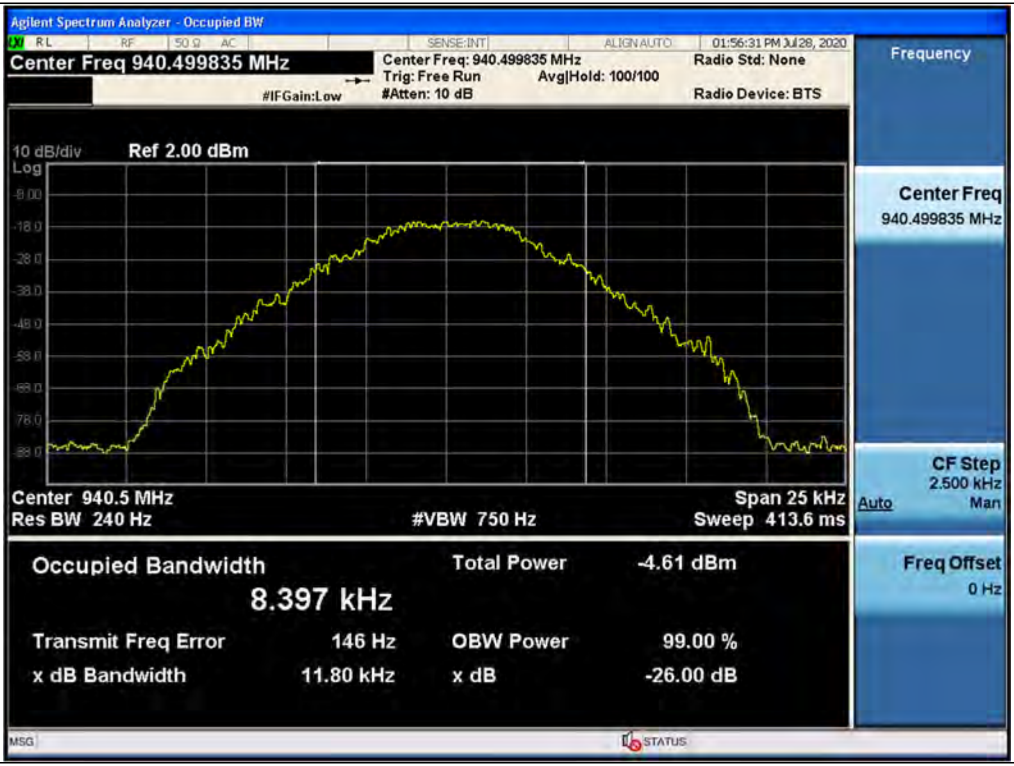


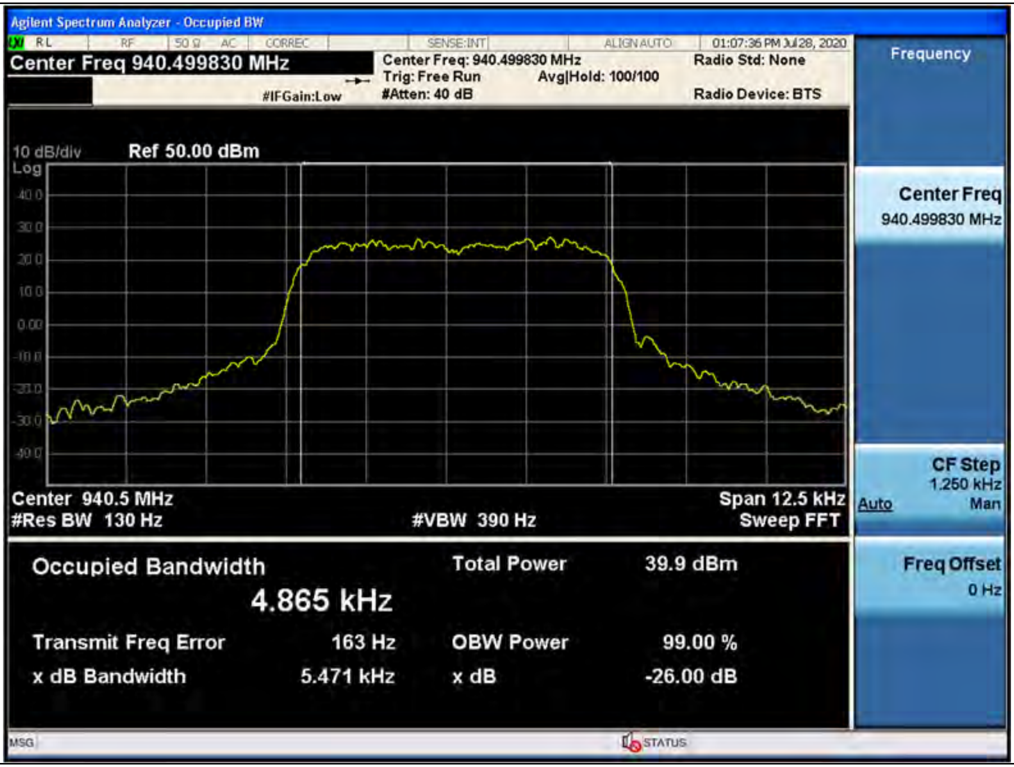
Input / 940 ~ 941 MHz / Downlink / P25 Phase 1

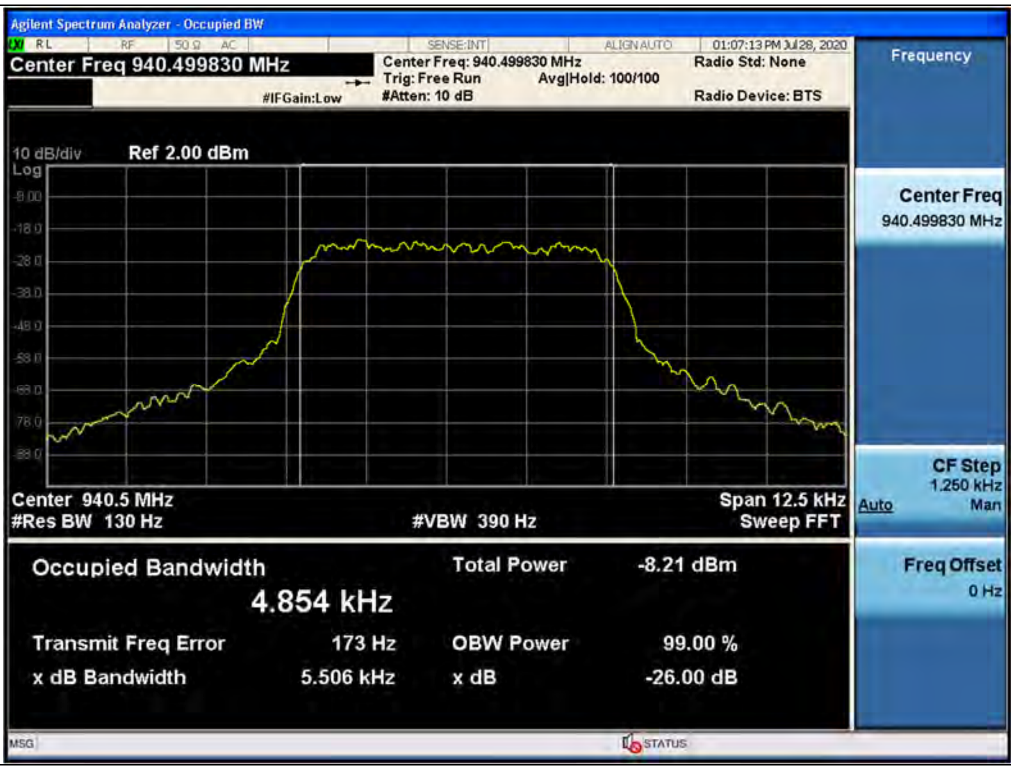
3 dB above the AGC threshold output / 940 ~ 941 MHz / Downlink / P25 Phase 1



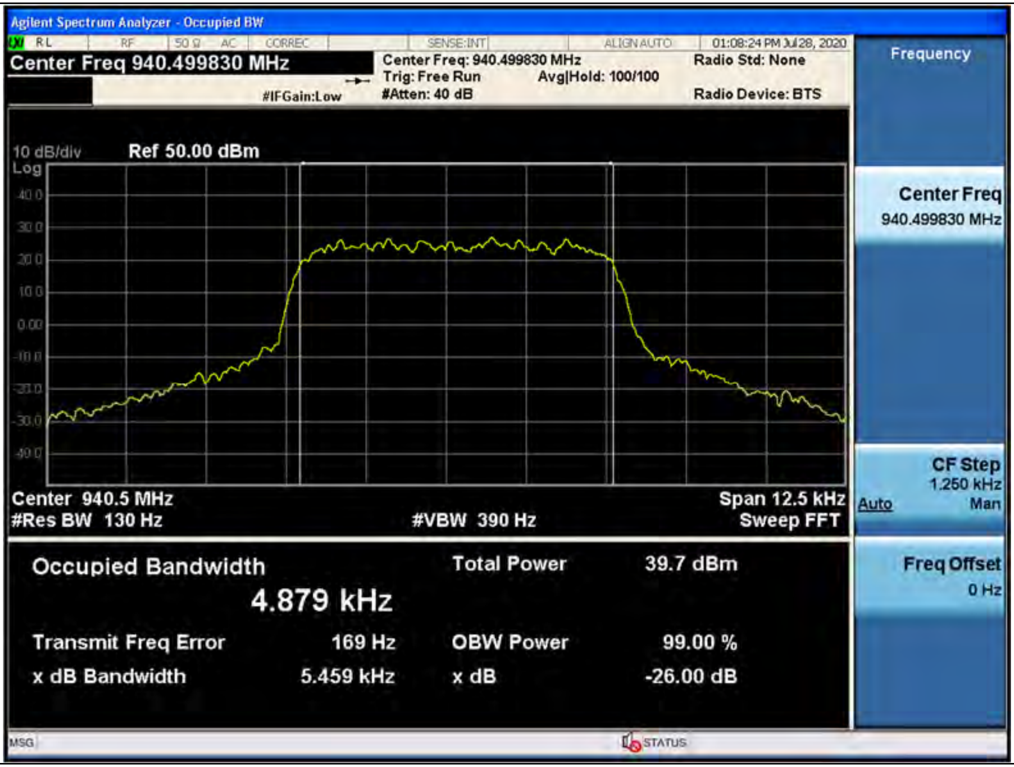
3 dB above the AGC threshold Input / 940 ~ 941 MHz / Downlink / P25 Phase 1



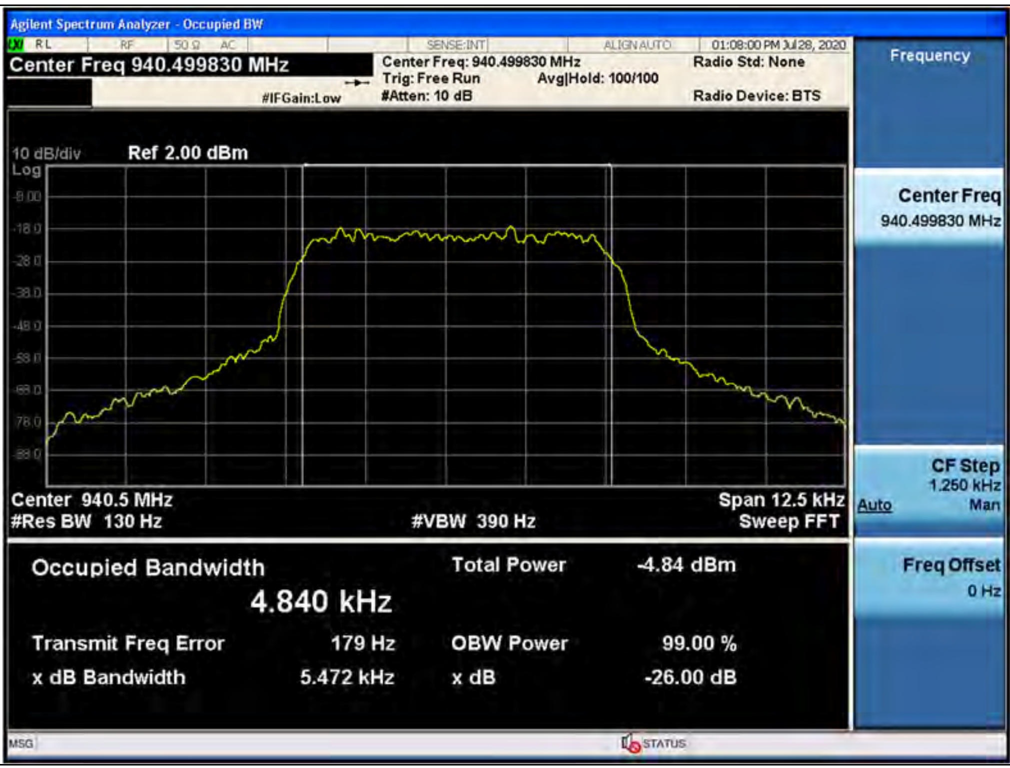
Output / 940 ~ 941 MHz / Downlink / P25 Phase 2


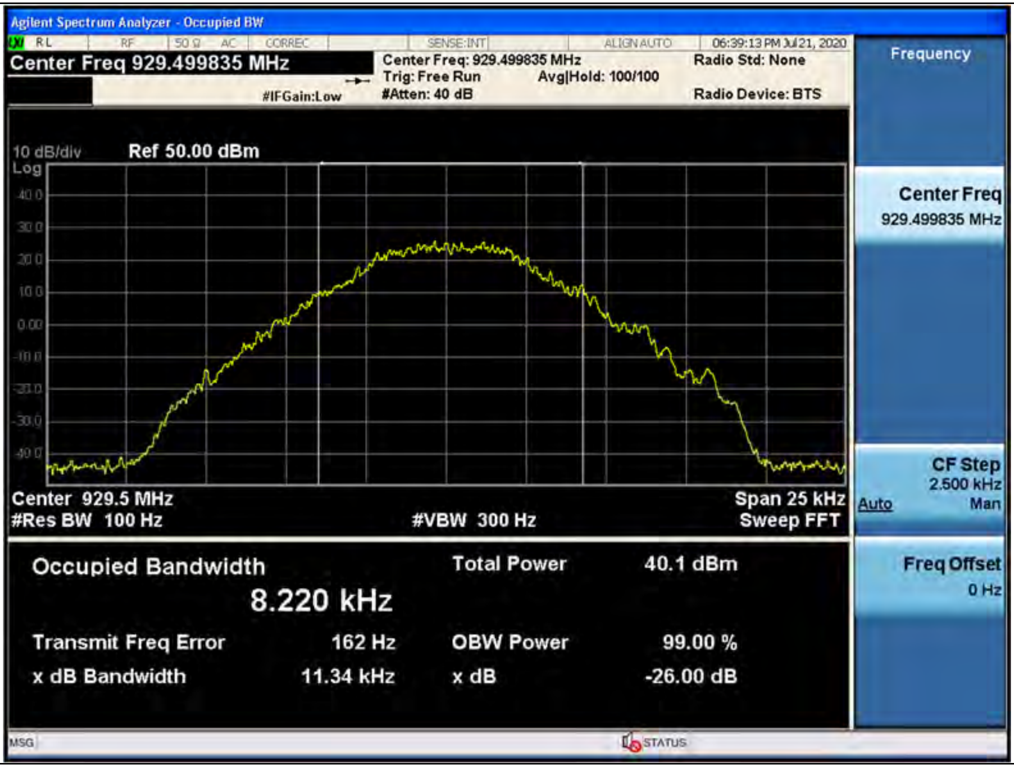
Input / 940 ~ 941 MHz / Downlink / P25 Phase 2


3 dB above the AGC threshold output / 940 ~ 941 MHz / Downlink / P25 Phase 2



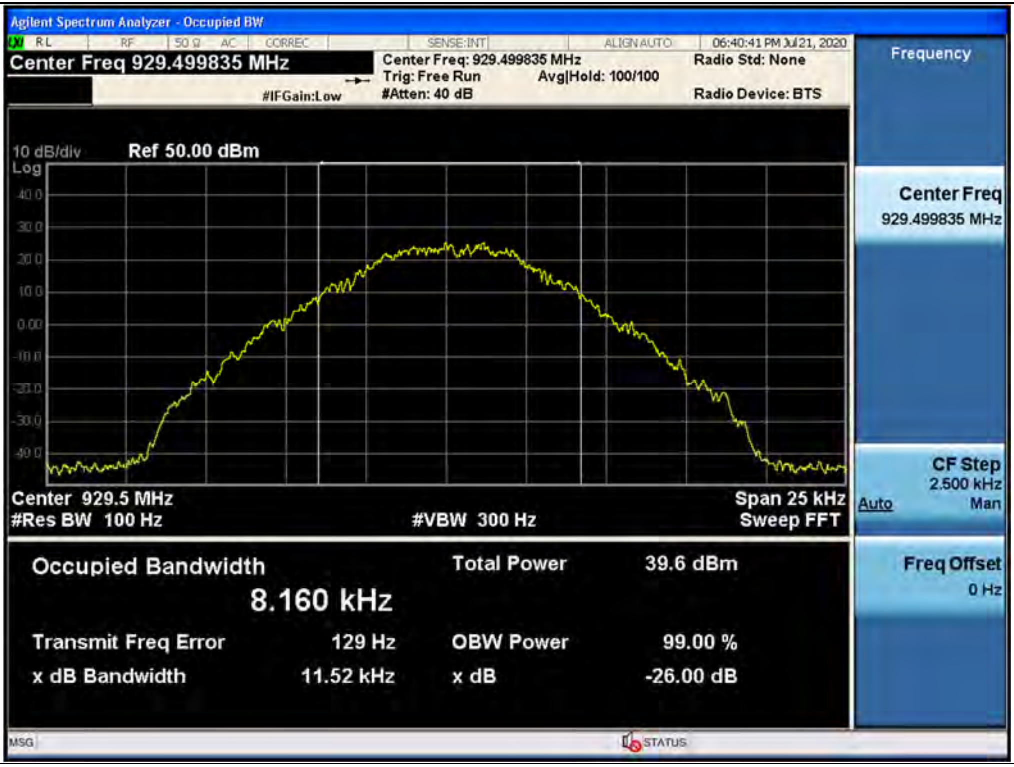
3 dB above the AGC threshold Input / 940 ~ 941 MHz / Downlink / P25 Phase 2



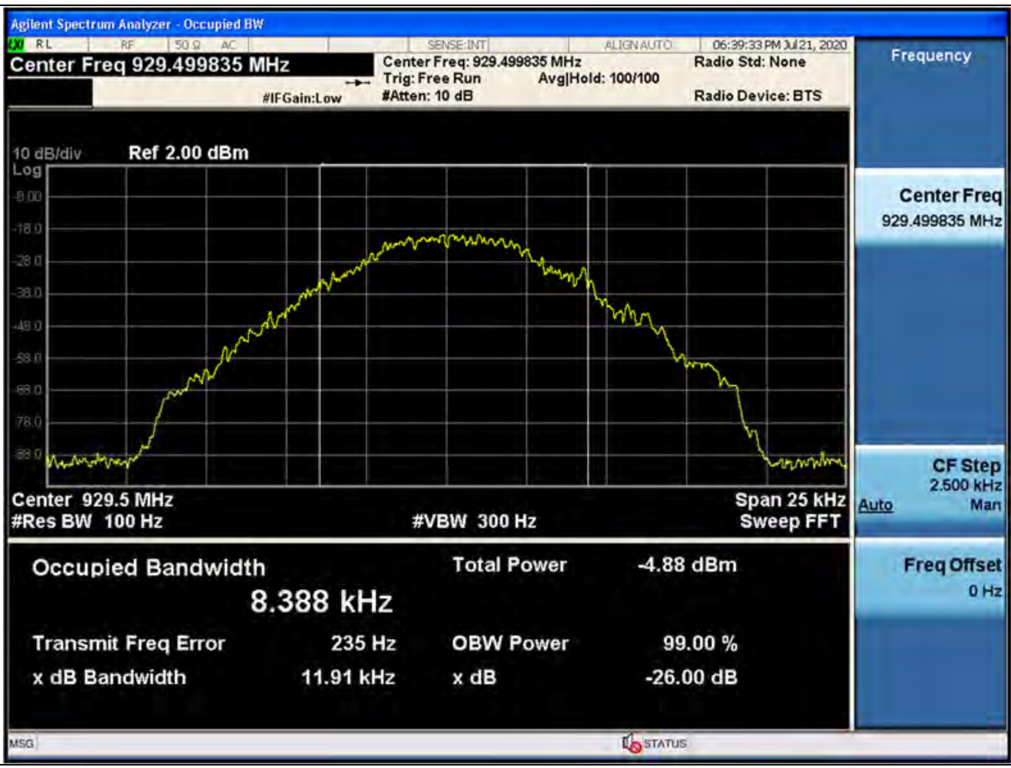
Output / 929 ~ 930 MHz / Downlink / P25 Phase 1


Input / 929 ~ 930 MHz / Downlink / P25 Phase 1

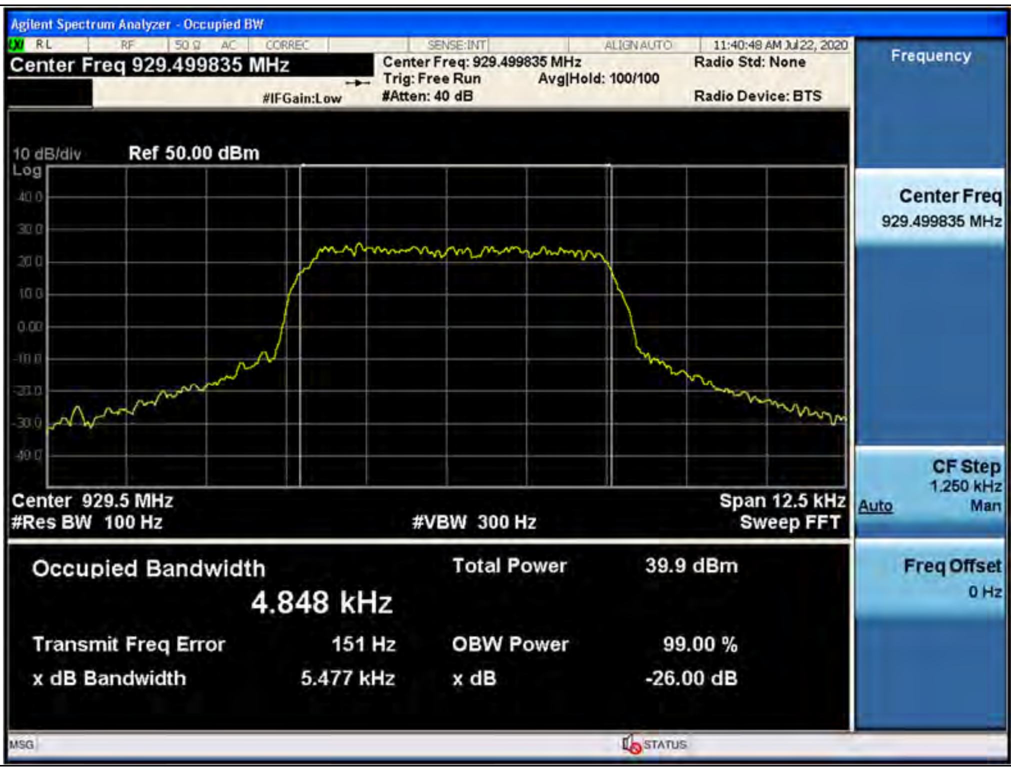

3 dB above the AGC threshold output / 929 ~ 930 MHz / Downlink / P25 Phase 1



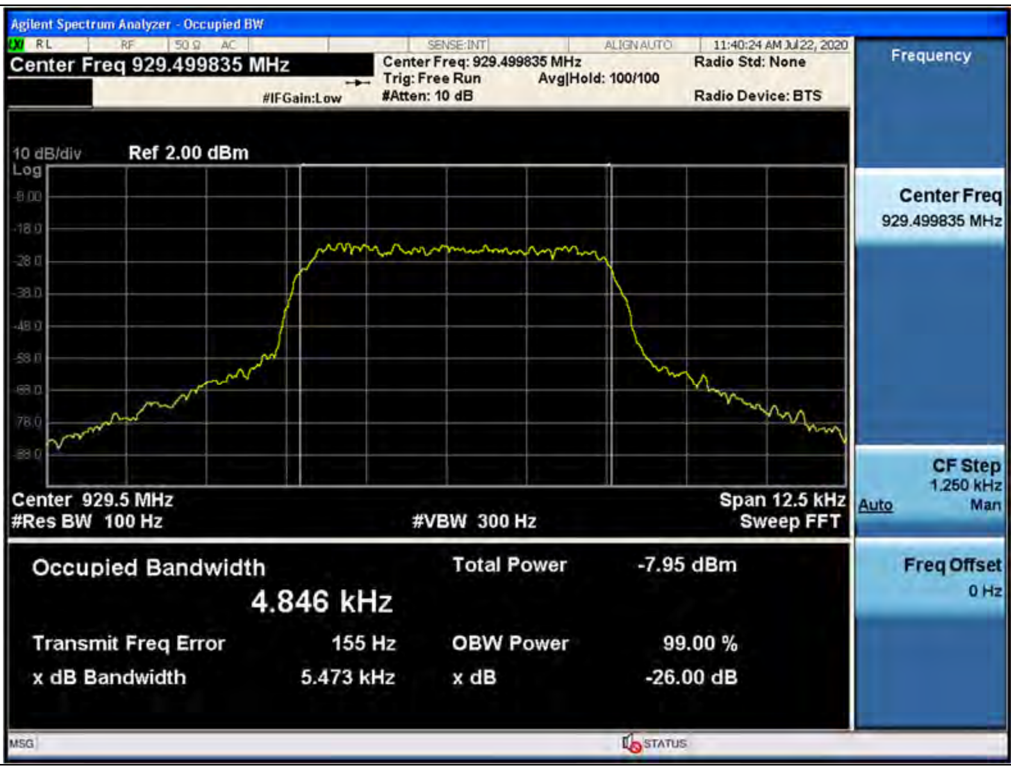
3 dB above the AGC threshold Input / 929 ~ 930 MHz / Downlink / P25 Phase 1



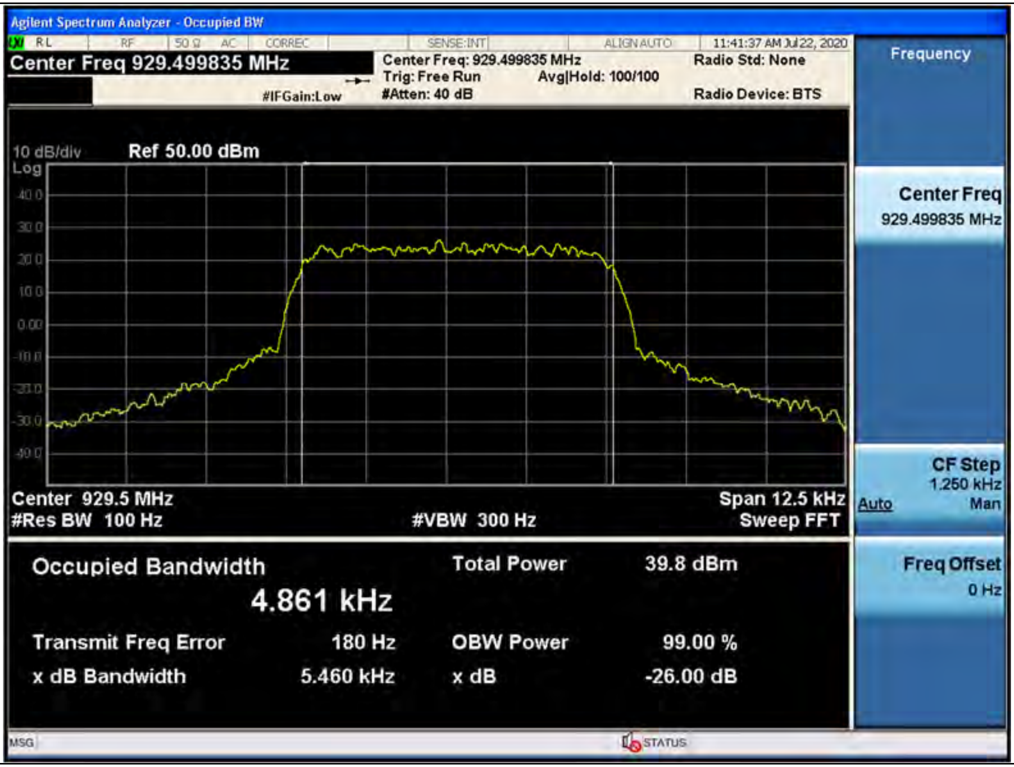
Output / 929 ~ 930 MHz / Downlink / P25 Phase 2



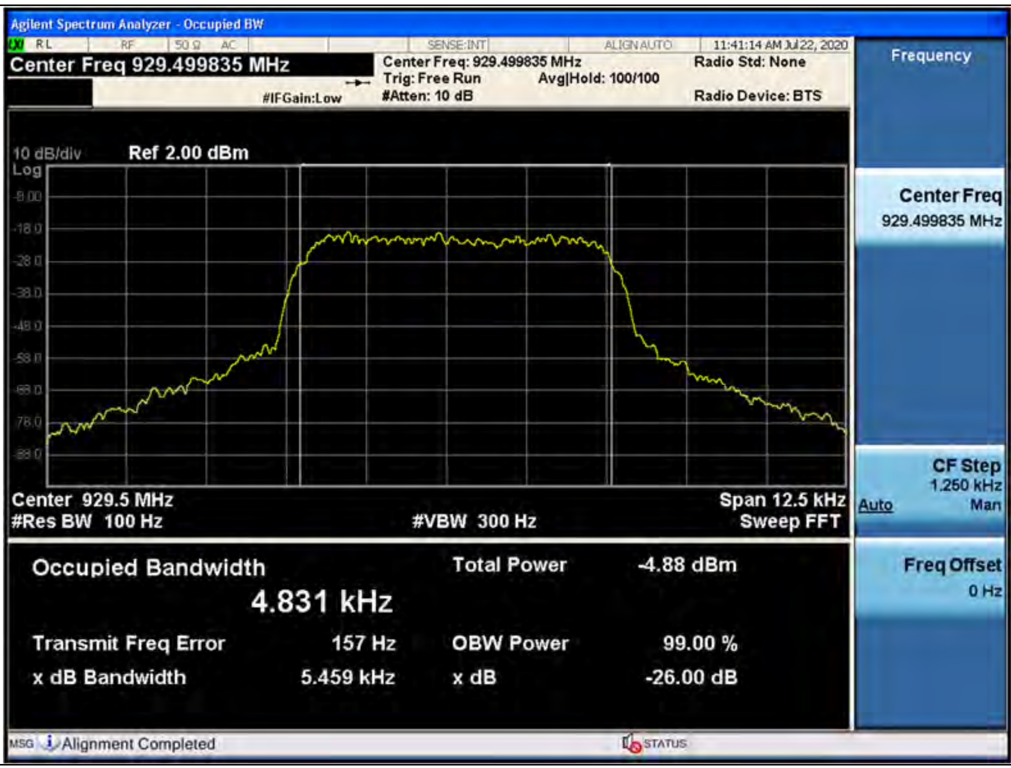
Input / 929 ~ 930 MHz / Downlink / P25 Phase 2



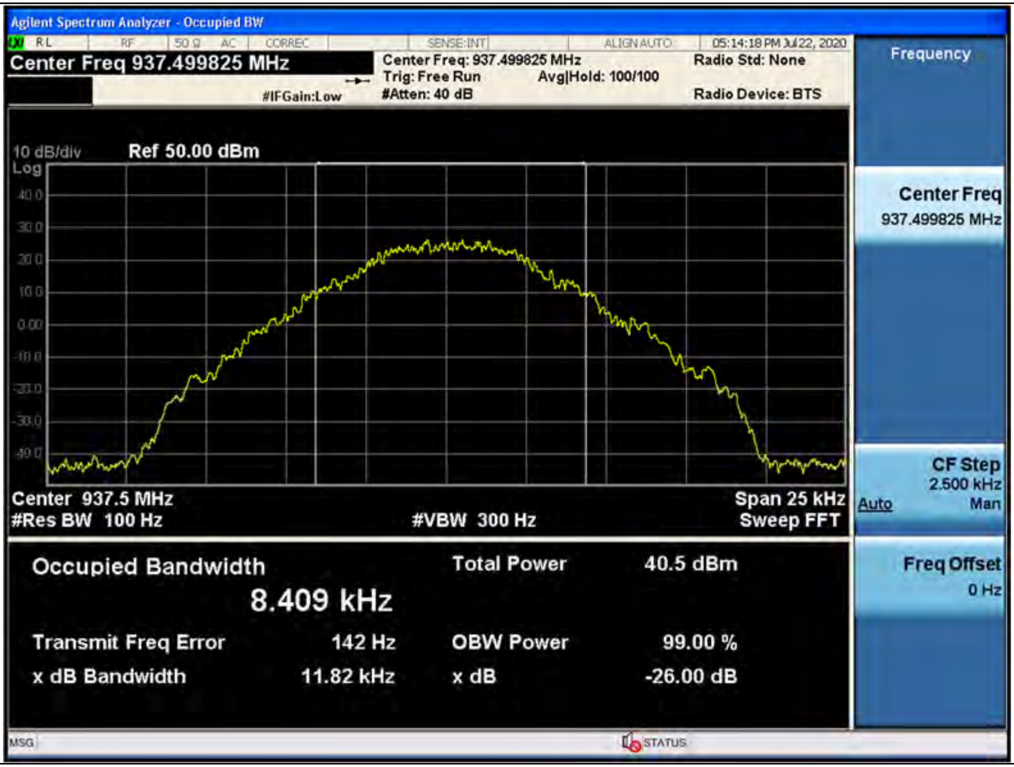
3 dB above the AGC threshold output / 929 ~ 930 MHz / Downlink / P25 Phase 2



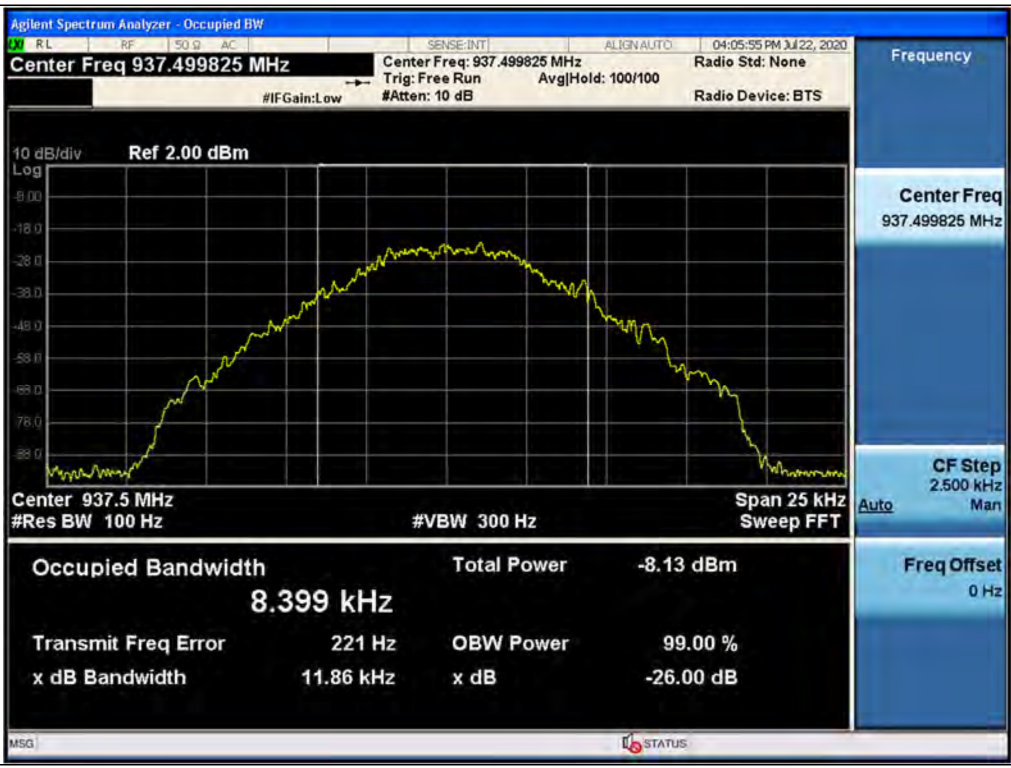
3 dB above the AGC threshold Input / 929 ~ 930 MHz / Downlink / P25 Phase 2



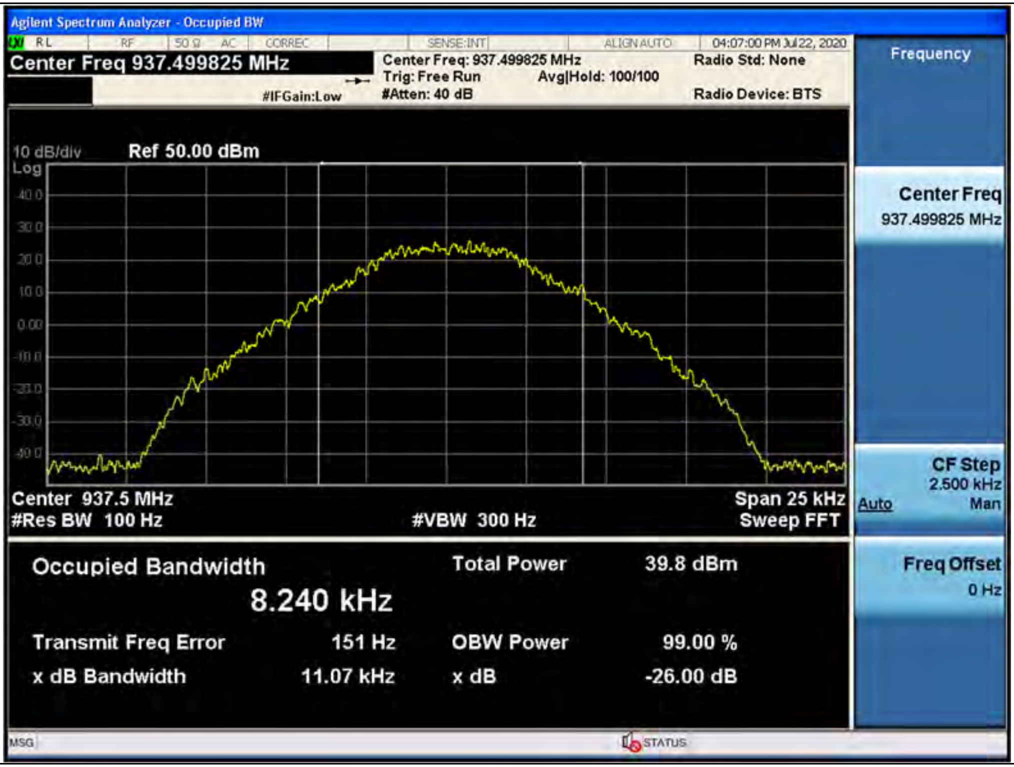
Output / 935 ~ 940 MHz / Downlink / P25 Phase 1



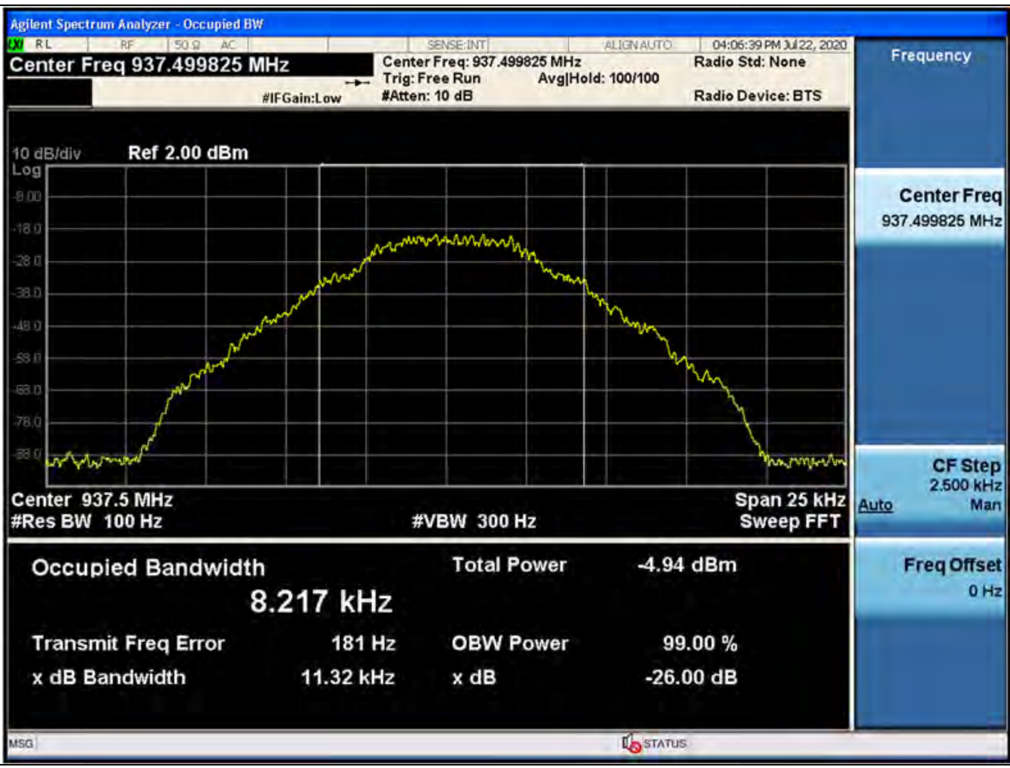
Input / 935 ~ 940 MHz / Downlink / P25 Phase 1



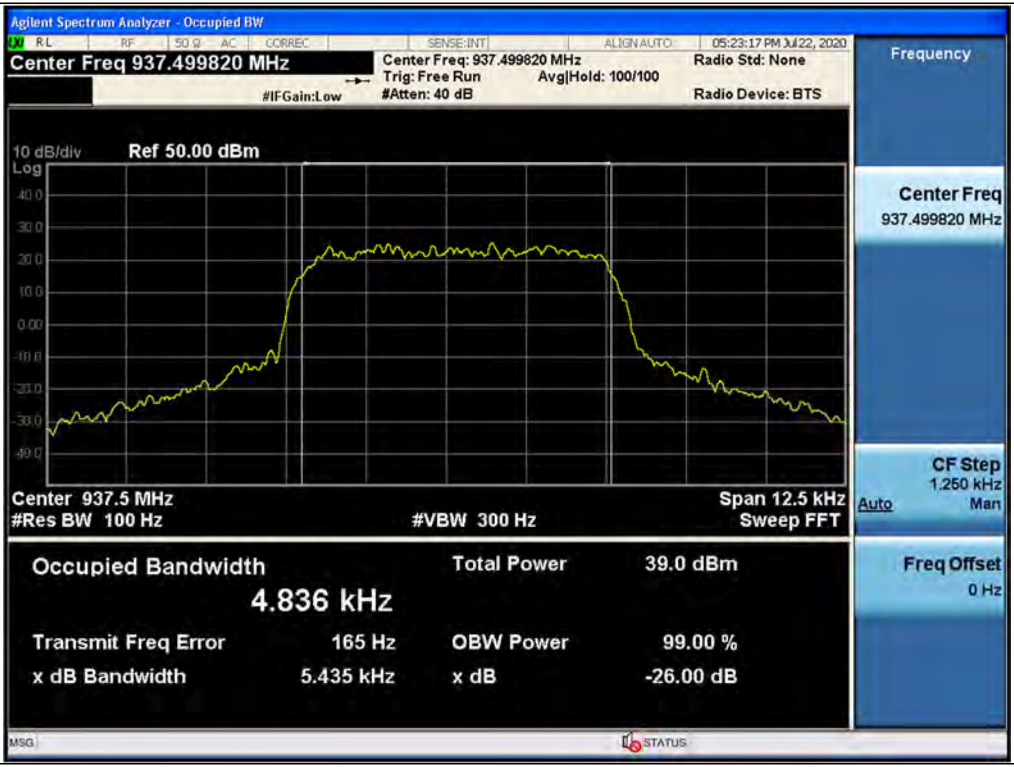
3 dB above the AGC threshold output / 935 ~ 940 MHz / Downlink / P25 Phase 1



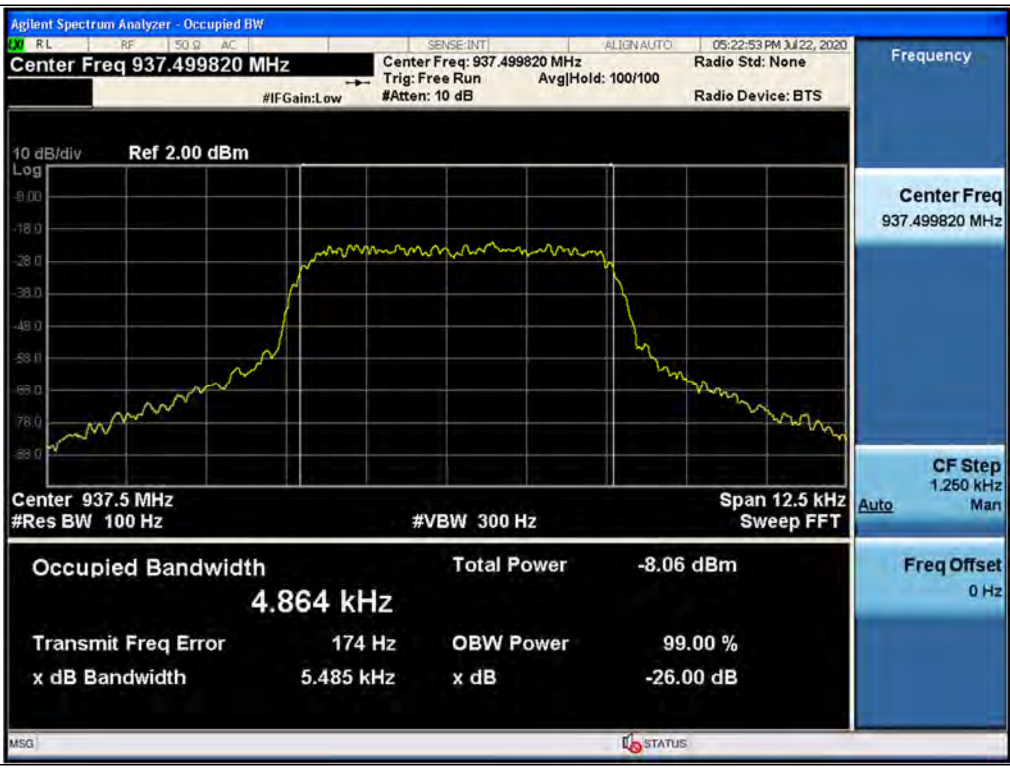
3 dB above the AGC threshold Input / 935 ~ 940 MHz / Downlink / P25 Phase 1

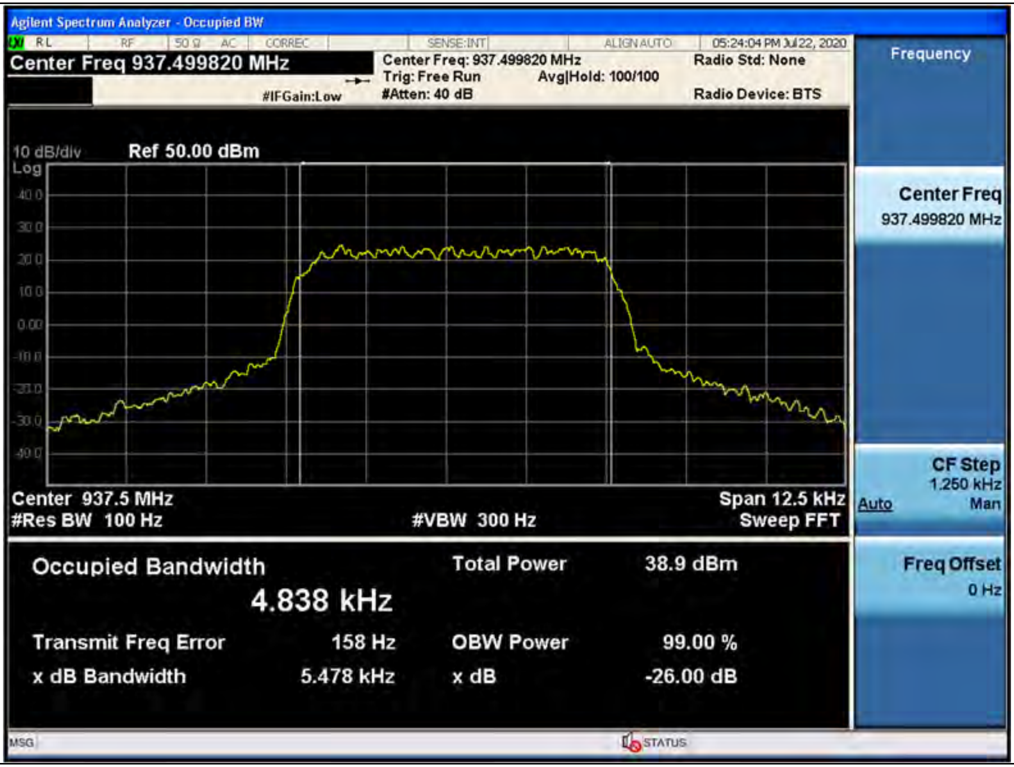


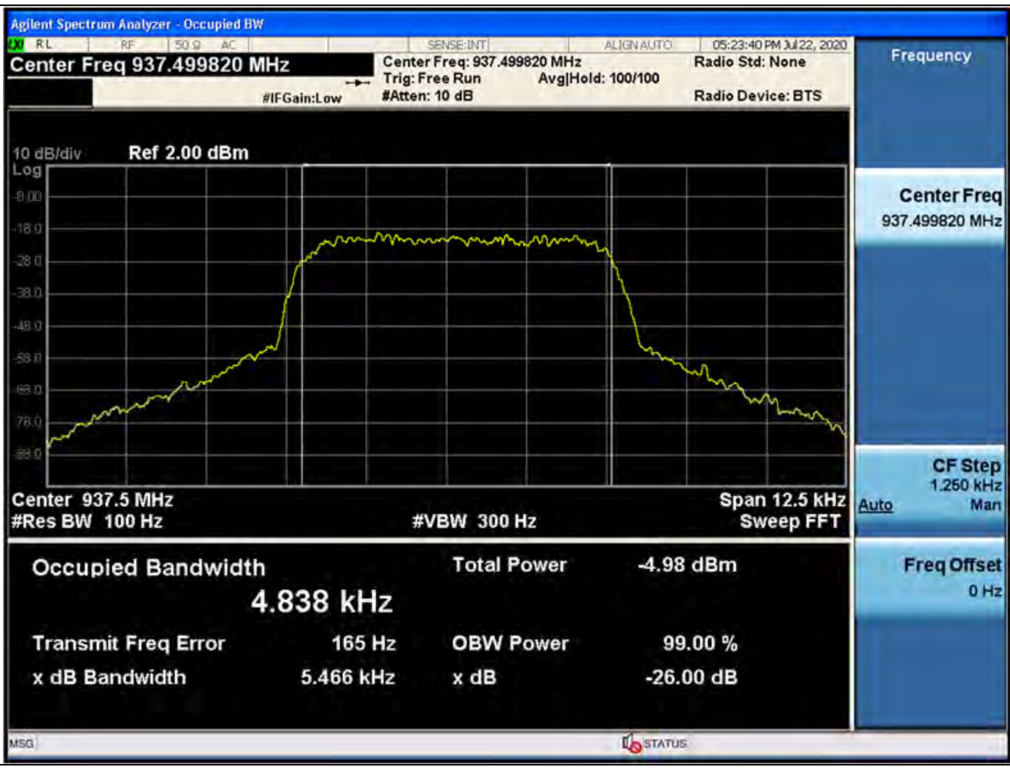
Output / 935 ~ 940 MHz / Downlink / P25 Phase 2



Input / 935 ~ 940 MHz / Downlink / P25 Phase 2



3 dB above the AGC threshold output / 935 ~ 940 MHz / Downlink / P25 Phase 2


3 dB above the AGC threshold Input / 935 ~ 940 MHz / Downlink / P25 Phase 2


5.4. 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.

§ 22.535 Effective radiated power limits.

The effective radiated power (ERP) of transmitters operating on the channels listed in § 22.531 must not exceed the limits in this section.

(f) Signal boosters. The effective radiated power of signal boosters must not exceed 5 watts ERP under any normal operating condition.

§ 24.132 Power and antenna height limits.

(c) Base stations transmitting in the 930-931 MHz and 940-941 MHz bands are limited to 3500 watts e.r.p. per authorized channel and are unlimited in antenna height except as provided in paragraph (d) of this section.

§ 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.

§ 101.113 Transmitter power limitations.

(a) On any authorized frequency, the average power delivered to an antenna in this service must be the minimum amount of power necessary to carry out the communications desired. Application of this principle includes, but is not to be limited to, requiring a licensee who replaces one or more of its antennas with larger antennas to reduce its antenna input power by an amount appropriate to compensate for the increased primary lobe gain of the replacement antenna(s). In no event shall the average equivalent isotropically radiated power (EIRP), as referenced to an isotropic radiator, exceed the values specified below. In cases of harmful interference, the Commission may, after notice and opportunity for hearing, order a change in the effective radiated power of this station. Further, the output power of a transmitter on any authorized frequency in this service may not exceed the following:

Frequency band (MHz)	Maximum allowable EIRP	
	Fixed (dBW)	Mobile (dBW)
928.0-929.0	+ 17	-
932.0-932.5	+ 17	-
932.5-935.0	+ 40	-

Test Procedures:

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

3.5.1 General

a) 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.

b) 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:

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

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

4.5.1 General

a) 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.
b) 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.

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 frequency span to at least 1 MHz.
b) Set RBW = 100 kHz.
c) Set VBW $\geq$ 3 × RBW.
d) Set the detector to PEAK, and trace mode 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. If f_0 that determined from out-of-band 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.

Test Results:

Tabular data of Input / Output Power and Gain

Frequency (MHz)	Link	Signal	f_0 Frequency (MHz)	Input Power (dBm)	Output Power (dBm)	Gain (dB)
928 ~ 929	Downlink	P25 Phase 1	928.87	-14.94	33.41	48.35
		P25 Phase 2	928.87	-14.95	33.13	48.08
930 ~ 931		P25 Phase 1	930.99	-15.08	33.24	48.32
		P25 Phase 2	930.99	-15.07	32.66	47.73
931 ~ 932		P25 Phase 1	931.97	-15.06	32.91	47.97
		P25 Phase 2	931.97	-15.11	33.39	48.50
932 ~ 935		P25 Phase 1	934.91	-15.23	33.13	48.36
		P25 Phase 2	934.91	-15.11	33.03	48.14
940 ~ 941		P25 Phase 1	940.14	-15.23	32.83	48.06
		P25 Phase 2	940.14	-15.08	33.03	48.11
929 ~ 930		CW	929.854	-14.986	32.513	47.50
935 ~ 940		CW	935.078	-15.104	33.026	48.13

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

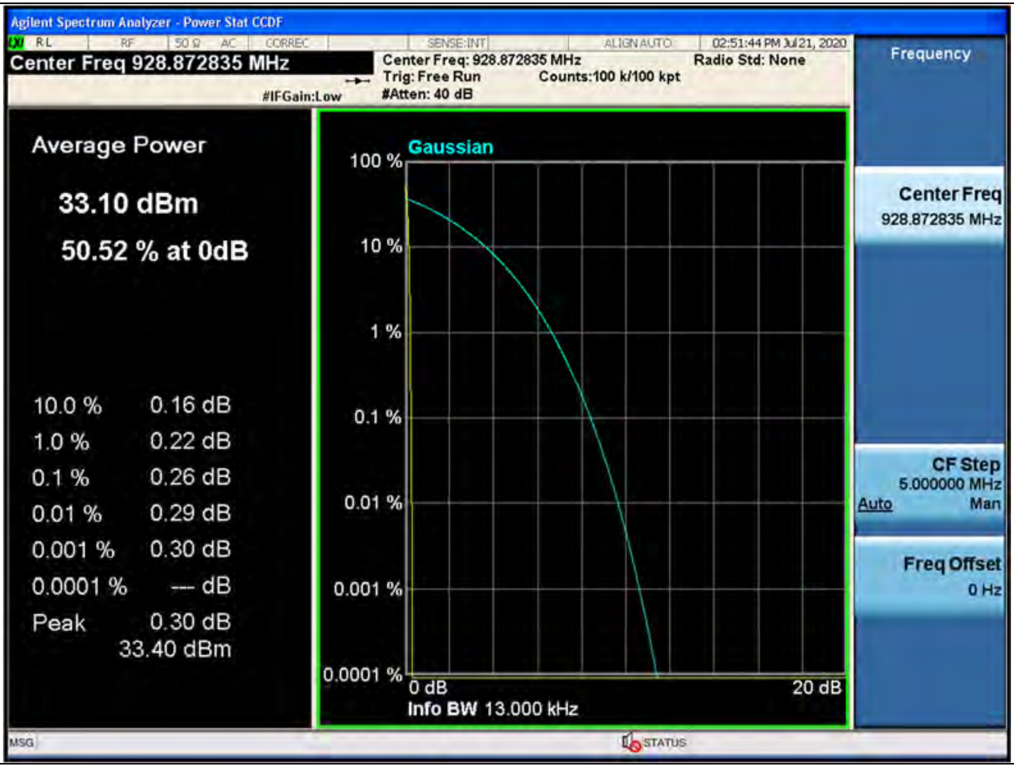
Frequency (MHz)	Link	Signal	f_0 Frequency (MHz)	Input Power (dBm)	+3 dB Output Power (dBm)	Gain (dB)
928 ~ 929	Downlink	P25 Phase 1	928.87	-12.01	33.10	45.11
		P25 Phase 2	928.87	-11.97	32.59	44.56
930 ~ 931		P25 Phase 1	930.99	-11.99	32.91	44.90
		P25 Phase 2	930.99	-11.93	32.77	44.70
931 ~ 932		P25 Phase 1	931.97	-11.87	33.14	45.01
		P25 Phase 2	931.97	-11.99	33.08	45.07
932 ~ 935		P25 Phase 1	934.91	-11.98	32.74	44.72
		P25 Phase 2	934.91	-12.07	32.73	44.80
940 ~ 941		P25 Phase 1	940.14	-12.01	32.59	44.60
		P25 Phase 2	940.14	-11.93	32.71	44.64
929 ~ 930		CW	929.854	-11.911	32.607	44.52
935 ~ 940		CW	935.078	-11.968	32.564	44.53

Tabular data of PAPR

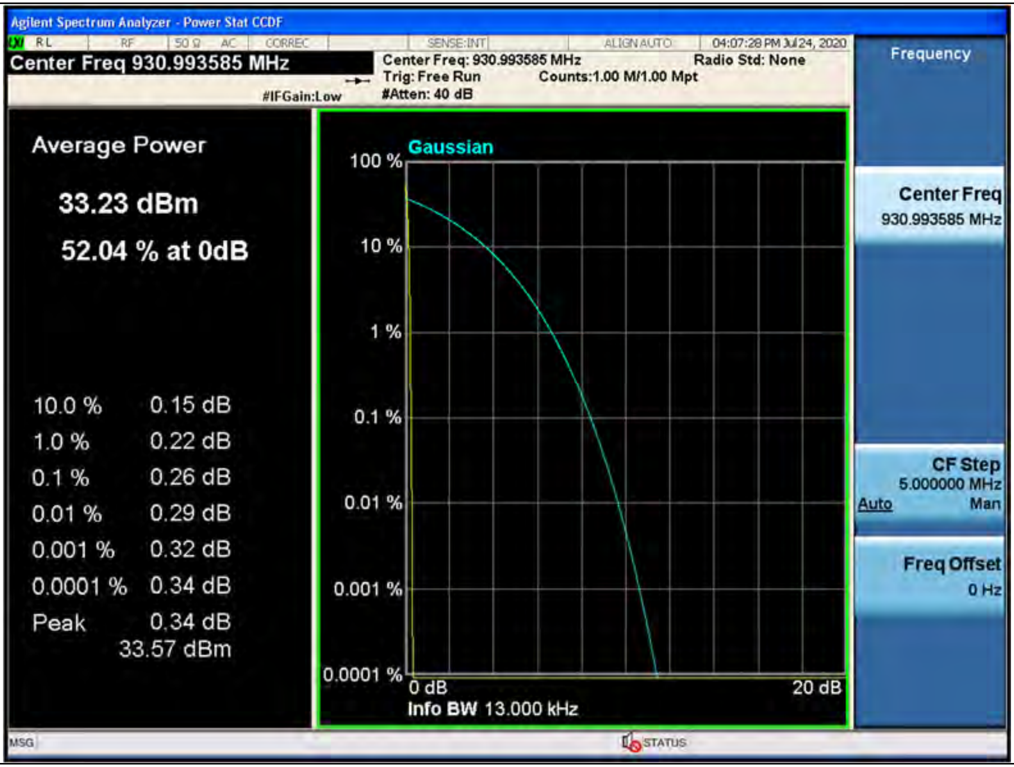
Frequency (MHz)	Link	Signal	f_0 Frequency (MHz)	0.1 % PAPR (dB)
928 ~ 929	Downlink	P25 Phase 1	928.87	0.26
		P25 Phase 2	928.87	5.33
930 ~ 931		P25 Phase 1	930.99	0.26
		P25 Phase 2	930.99	5.31
931 ~ 932		P25 Phase 1	931.97	0.24
		P25 Phase 2	931.97	5.32
932 ~ 935		P25 Phase 1	934.91	0.24
		P25 Phase 2	934.91	5.31
940 ~ 941		P25 Phase 1	940.14	0.73
		P25 Phase 2	940.14	5.30

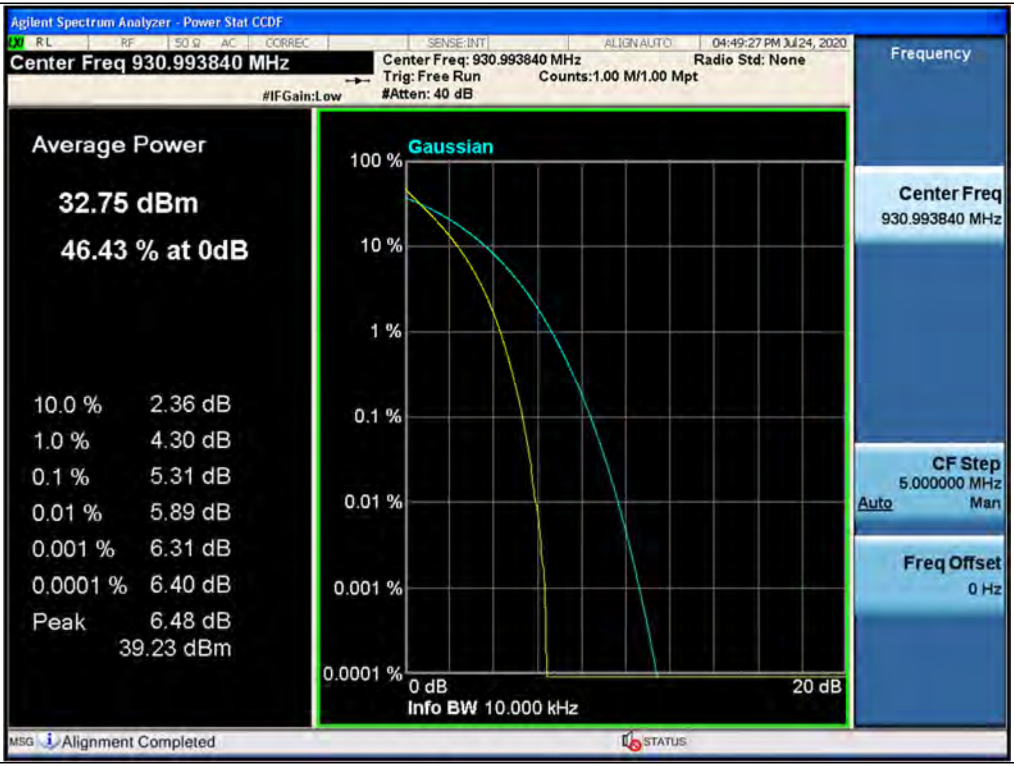
Plot data of PAPR

PAPR / 928 ~ 929 MHz / Downlink / P25 Phase 1

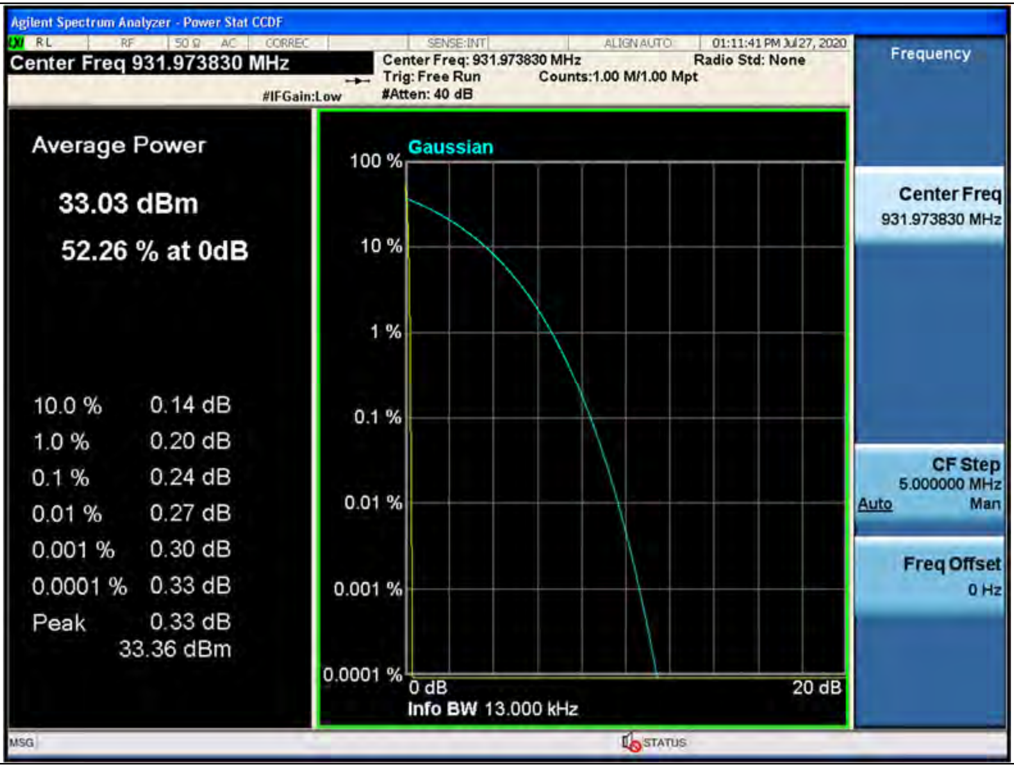


PAPR / 928 ~ 929 MHz / Downlink / P25 Phase 2

PAPR / 930 ~ 931 MHz / Downlink / P25 Phase 1


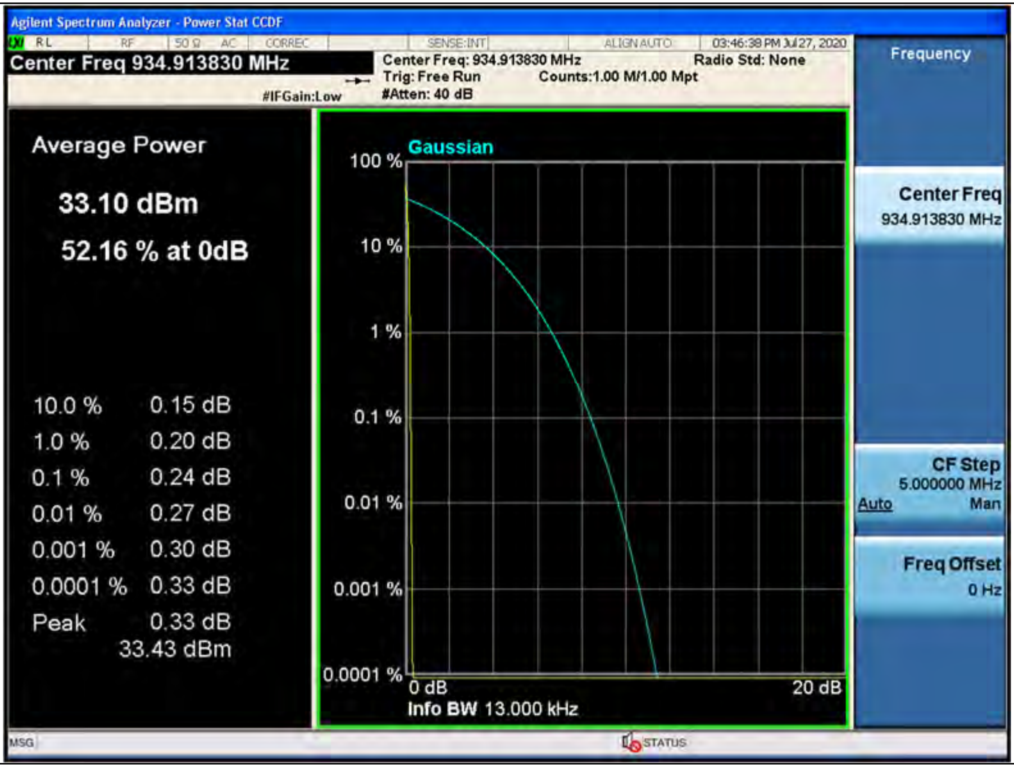
PAPR / 930 ~ 931 MHz / Downlink / P25 Phase 2


PAPR / 931 ~ 932 MHz / Downlink / P25 Phase 1



PAPR / 931 ~ 932 MHz / Downlink / P25 Phase 2

PAPR / 932 ~ 935 MHz / Downlink / P25 Phase 1



PAPR / 932 ~ 935 MHz / Downlink / P25 Phase 2

PAPR / 940 ~ 941 MHz / Downlink / P25 Phase 1

PAPR / 940 ~ 941 MHz / Downlink / P25 Phase 2

5.5. NOISE FIGURE

Test Requirements:

KDB 935210 D02 v04r02

V. PART 90 SIGNAL BOOSTER SPECIFIC REQUIREMENTS

(j) Other provisions for Part 90 boosters in specific bands and/or for specific conditions.

(5) For the remote unit of a conventional fiber-connected host/remote DAS booster system, it is acceptable to submit compliance information and test data consistent with Section 90.219(d)(6)(ii) (i.e., ERP of noise ≤ −43 dBm in 10 kHz RBW) for the downlink path only, in place of Section 90.219(e)(2) noise figure test data (i.e., NF ≤ 9 dB for both UL and DL). Test reports must provide explicit details about the instrumentation and test procedure used for Section 90.219(d)(6)(ii) testing.

§ 90.219 Use of signal boosters.

(d) Deployment rules. Deployment of signal boosters must be carried out in accordance with the rules in this paragraph.

(6) Good engineering practice must be used in regard to the radiation of intermodulation products and noise, such that interference to licensed communications systems is avoided. In the event of harmful interference caused by any given deployment, the FCC may require additional attenuation or filtering of the emissions and/or noise from signal boosters or signal booster systems, as necessary to eliminate the interference.

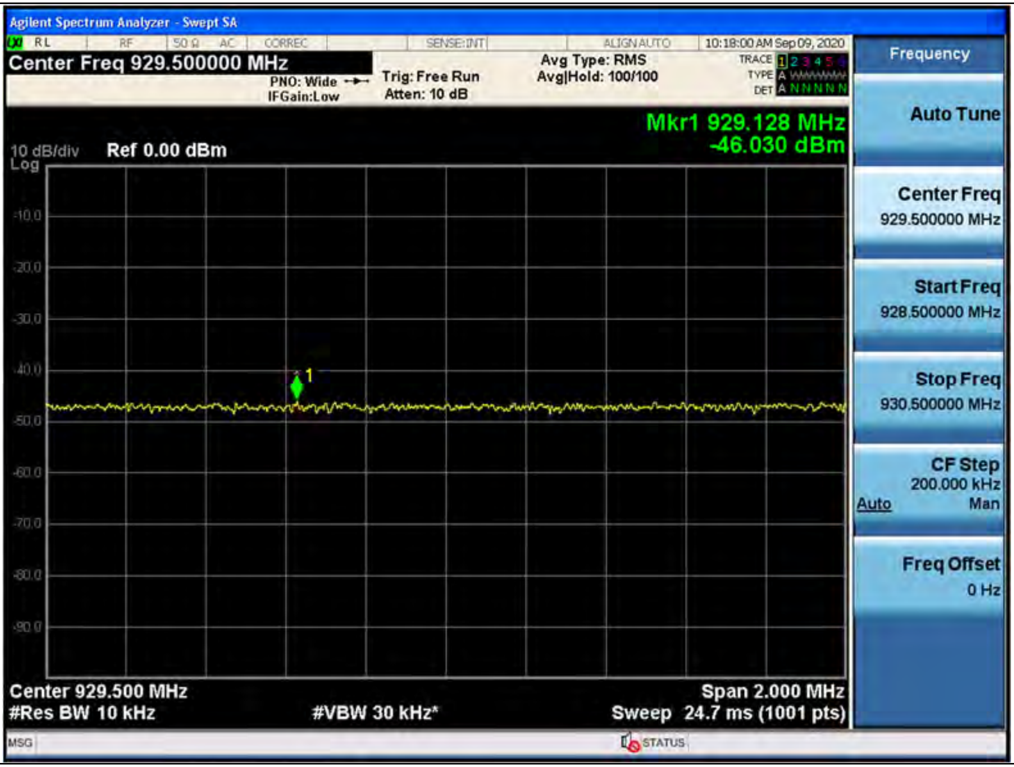
(ii) In general, the ERP of noise within the passband should not exceed −43 dBm in 10 kHz measurement bandwidth.

Test Results:

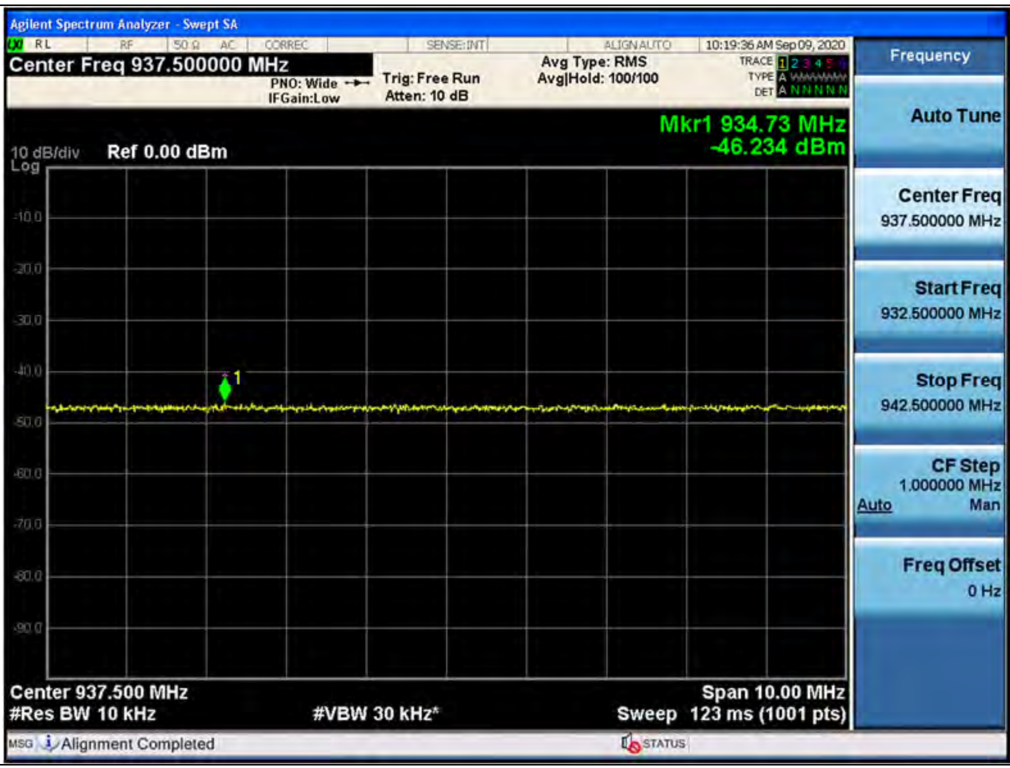
Test Band (MHz)	Link	Measured Value (dBm/10kHz)	Ant. Peak Gain (dBi)	E.R.P. (dBm/10kHz)	Limit
929 ~ 930	Downlink	-46.030	3.0	-43.030	-43 dBm in 10 kHz
935 ~ 940		-46.234	3.0	-43.234	

Plot data of Noise Figure

Noise Figure / 929 MHz ~ 930 MHz / Downlink



Noise Figure / 935 MHz ~ 940 MHz / Downlink



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

Test Requirements:

§ 2.1051 Measurements required: Spurious emissions at antenna terminals.

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

§ 22.359 Emission limitations.

The rules in this section govern the spectral characteristics of emissions in the Public Mobile Services, except for the Air-Ground Radiotelephone Service (see § 22.861, instead) and the Cellular Radiotelephone Service (see § 22.917, instead).

(a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log (P) dB.

(b) Measurement procedure. Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 30 kHz or more. In the 60 kHz bands immediately outside and adjacent to the authorized frequency range or channel, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e., 30 kHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

(c) Alternative out of band emission limit. Licensees in the Public Mobile Services may establish an alternative out of band emission limit to be used at specified frequencies (band edges) in specified geographical areas, in lieu of that set forth in this section, pursuant to a private contractual arrangement of all affected licensees and applicants. In this event, each party to such contract shall maintain a copy of the contract in their station files and disclose it to prospective assignees or transferees and, upon request, to the FCC.

(d) Interference caused by out of band emissions. If any emission from a transmitter operating in any of the Public Mobile Services results in interference to users of another radio service, the FCC may require a greater attenuation of that emission than specified in this section.

§ 24.133 Emission limits.

(a) The power of any emission shall be attenuated below the transmitter power (P), as measured in accordance with § 24.132(f), in accordance with the following schedule:

(1) For transmitters authorized a bandwidth greater than 10 kHz:

(i) On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (fd in kHz) of up to and including 40 kHz: at least 116 Log10 ((fd + 10)/6.1) decibels or 50 plus 10 Log10 (P) decibels or 70 decibels, whichever is the lesser attenuation;

(ii) On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 40 kHz: at least 43 + 10 Log10 (P) decibels or 80 decibels, whichever is the lesser attenuation.

(2) For transmitters authorized a bandwidth of 10 kHz:

(i) On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (fd in kHz) of up to and including 20 kHz: at least 116 × Log10 ((fd + 5)/3.05) decibels or 50 + 10 × Log10 (P) decibels or 70 decibels, whichever is the lesser attenuation;

(ii) On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 20 kHz: at least 43 + 10 Log 10 (P) decibels or 80 decibels, whichever is the lesser attenuation.mission limits.

§ 90.210 Emission masks.

(g) Emission Mask G. 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 more than 10 kHz, but no more than 250 percent of the authorized bandwidth: At least 116 log (fd/6.1) dB, or 50 + 10 log (P) dB, or 70 dB, whichever is the lesser attenuation;

(2) 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.

(j) Emission Mask J. 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 of the transmitter (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 2.5 kHz, but no more than 6.25 kHz: At least 53 log (fd/2.5) dB;

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 6.25 kHz, but no more than 9.5 kHz: At least 103 log (fd/3.9) dB;

(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 9.5 kHz: At least 157 log (fd/5.3) dB, or 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

§ 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.

§ 101.111 Emission limitations.

(a) The mean power of emissions must be attenuated below the mean output power of the transmitter in accordance with the following schedule:

(5) When using transmissions employing digital modulation techniques on the 900 MHz multiple address frequencies with a 12.5 KHz bandwidth, the power of any emission must be attenuated below the unmodulated carrier power of the transmitter (P) in accordance with the following schedule:

(i) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 2.5 KHz up to and including 6.25 KHz: At least 53 log10 (fd/2.5) decibels;

(ii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 6.25 KHz up to and including 9.5 KHz: At least 103 log10 (fd/3.9) decibels;

(iii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 9.5 KHz up to and including 15 KHz: At least 157 log10 (fd/5.3) decibels; and

(iv) On any frequency removed from the center of the authorized bandwidth by a displacement frequency greater than 15 KHz: At least 50 plus 10 log10(P) or 70 decibels, whichever is the lesser attenuation.

(6) When using transmissions employing digital modulation techniques on the 900 MHz multiple address frequencies with a bandwidth greater than 12.5 KHz, the power of any emission must be attenuated below the unmodulated carrier power of the transmitter (P) in accordance with the following schedule:

(i) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 5 KHz up to and including 10 KHz: At least 83 log10 (fd/5) decibels;

(ii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 10 KHz up to and including 250 percent of the authorized bandwidth: At least 116 log10 (fd/6.1) decibels or 50 plus 10 log10 (P) or 70 decibels, whichever is the lesser attenuation; and

(iii) On any frequency removed from the center of the authorized bandwidth by more that 250 percent of the authorized bandwidth: At least 43 plus 10 log10 (output power in watts) decibels or 80 decibels, whichever is the lesser attenuation.

Test Procedures:

Measurements were in accordance with the test methods section 3.6 / section 4.7 of KDB 935210 D05 v01r04.

3.6.1 General

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 × 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 1 MHz.
   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 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 ≥ (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.

4.4 Input-versus-output signal comparison

Compliance with the emission mask of the EUT output shall be measured for the public safety service signal types as specified in 4.1.

Refer to the applicable regulatory requirements (e.g., Section 90.210) for emission mask specifications.

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 (see Table 1).
c) Configure the signal level to be just below the AGC threshold (see results from 4.2).
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 × to 5 × 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 f0 per 4.3.
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.

4.7.1 General

Refer to the applicable rule part(s) for specified limits on unwanted (out-of-band/out-of-block and spurious) emissions (e.g., Section 90.210).

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.

Intermodulation products shall be measured using two CW signals with all available channel spacings (e.g., 12.5 kHz and 6.25 kHz) with the center between these channels being equal to the center frequency f0 as determined from 4.3.

NOTE—Intermodulation-product spurious emission measurements are not required for single-channel boosters that cannot accommodate two simultaneous signals within the passband.

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 4.7.1, with amplitude levels set to just below the AGC threshold (see 4.2). Set the signal generator amplitudes so that the power from each into the EUT is equivalent.
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.

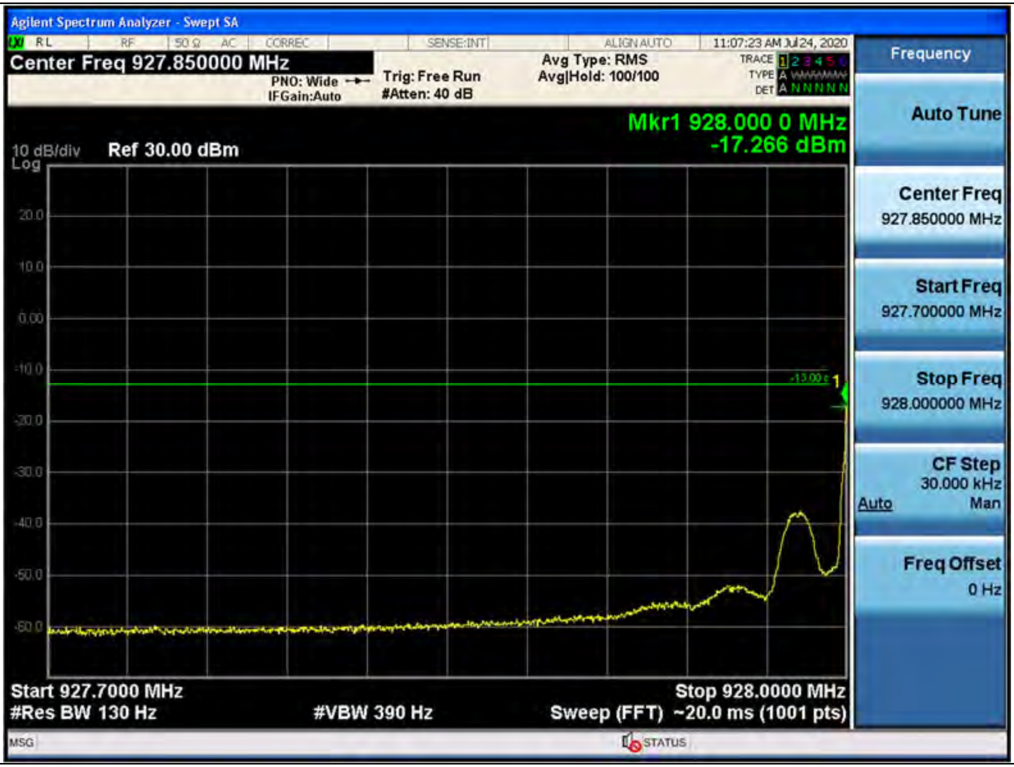
4.7.3 EUT spurious emissions conducted measurements

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 (see 4.2).
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 × 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.

Note: In 9 kHz-150 kHz and 150 kHz-30 MHz bands, RBW was reduced to 1 % and 10 % of the reference bandwidth for measuring unwanted emission level (typically, 1 MHz if the authorized frequency band is above 1 GHz) and power was integrated.(1% = +20 dB, 10% = +10 dB)

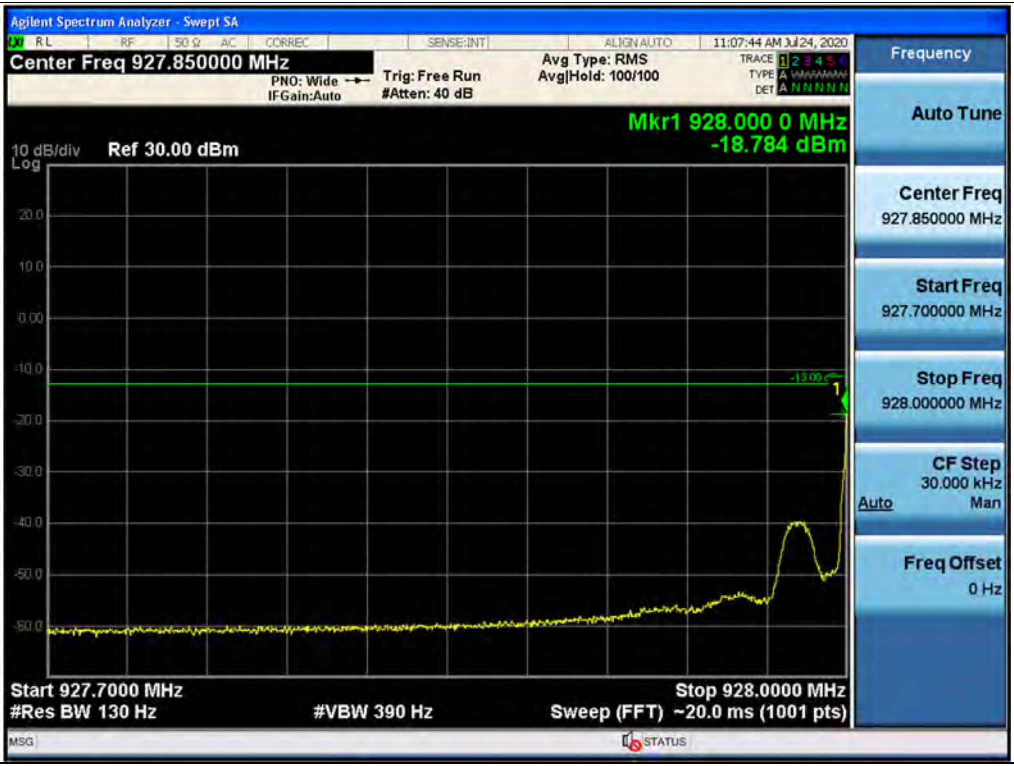
Test Results: Plot data of Out-of-band/out-of-block emissions

Out-of-band (two adjacent test signals) / 928 ~ 929 MHz / Downlink / P25 Phase 1 / Lower



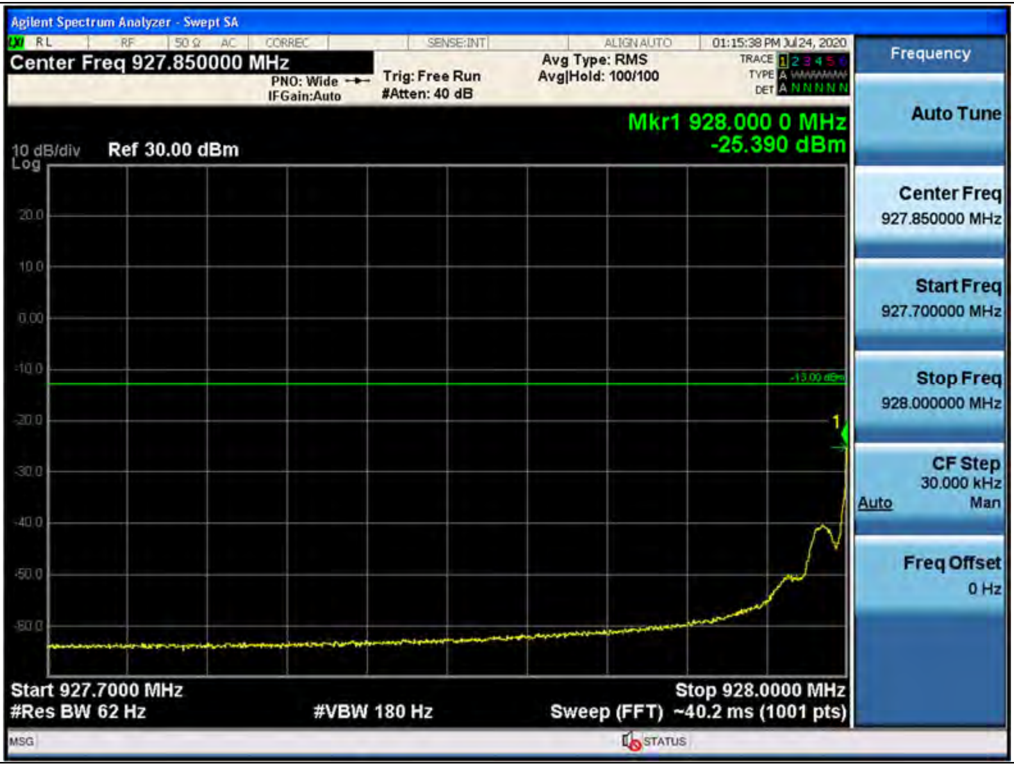
Out-of-band (two adjacent test signals) / 928 ~ 929 MHz / Downlink / P25 Phase 1 / Upper

+3 dB above Out-of-band (two adjacent test signals) / 928 ~ 929 MHz / Downlink / P25 Phase 1 / Lower



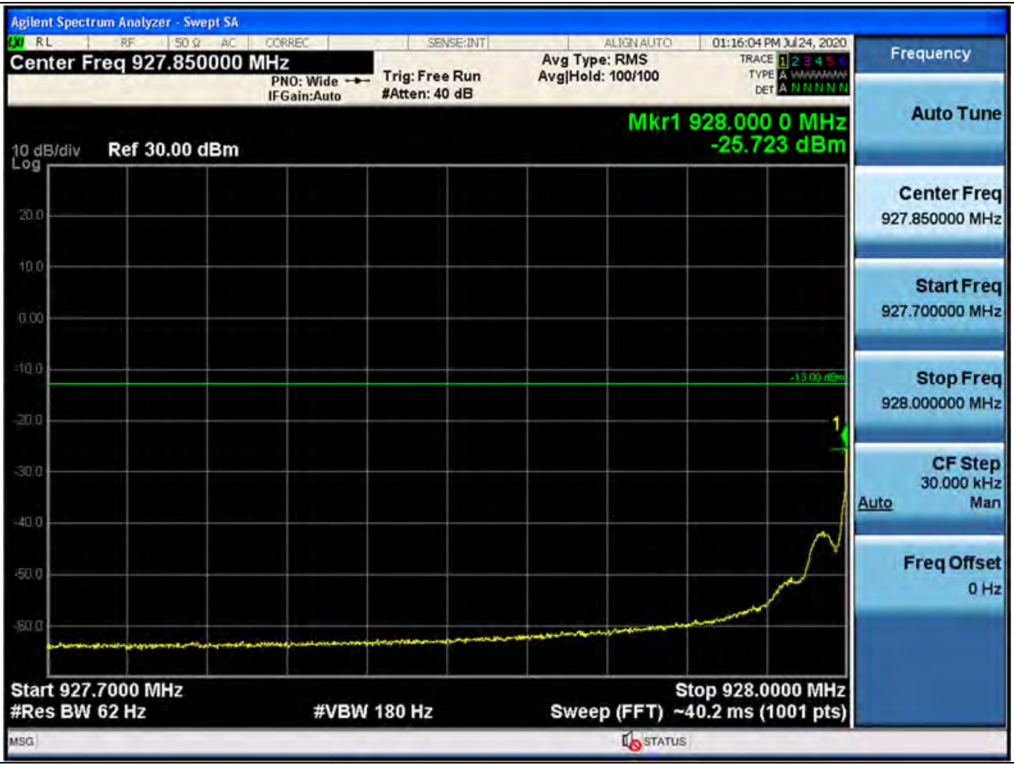
+3 dB above Out-of-band (two adjacent test signals) / 928 ~ 929 MHz / Downlink / P25 Phase 1 / Upper

Out-of-band (two adjacent test signals) / 928 ~ 929 MHz / Downlink / P25 Phase 2 / Lower



Out-of-band (two adjacent test signals) / 928 ~ 929 MHz / Downlink / P25 Phase 2 / Upper

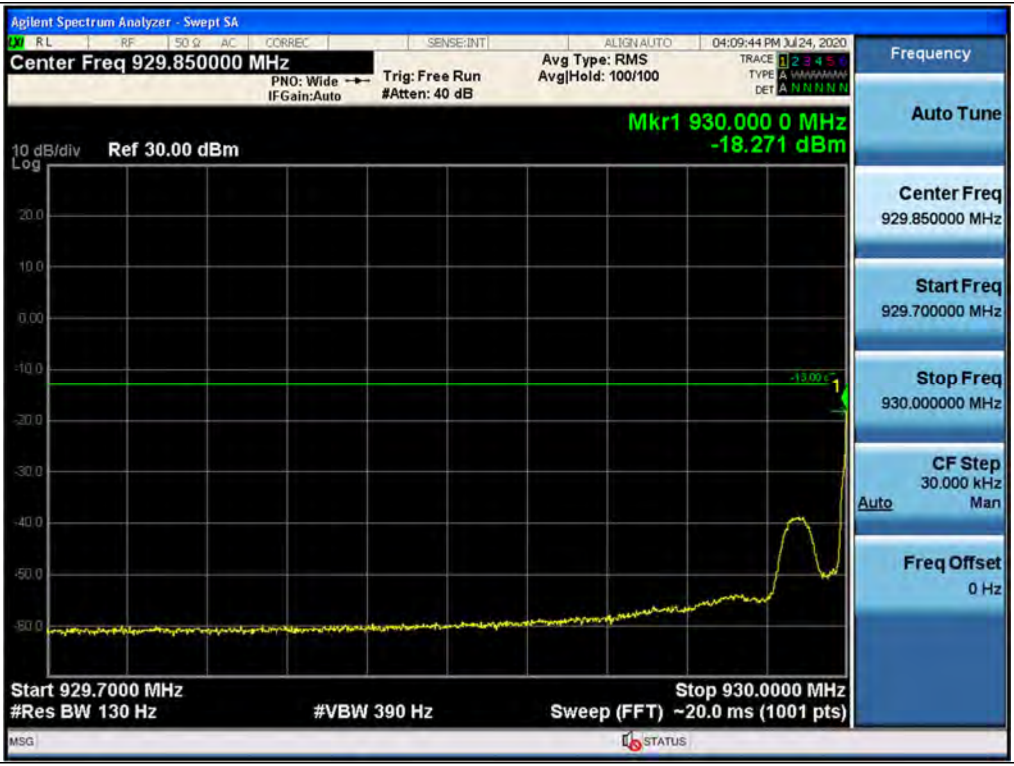
+3 dB above Out-of-band (two adjacent test signals) / 928 ~ 929 MHz / Downlink / P25 Phase 2 / Lower



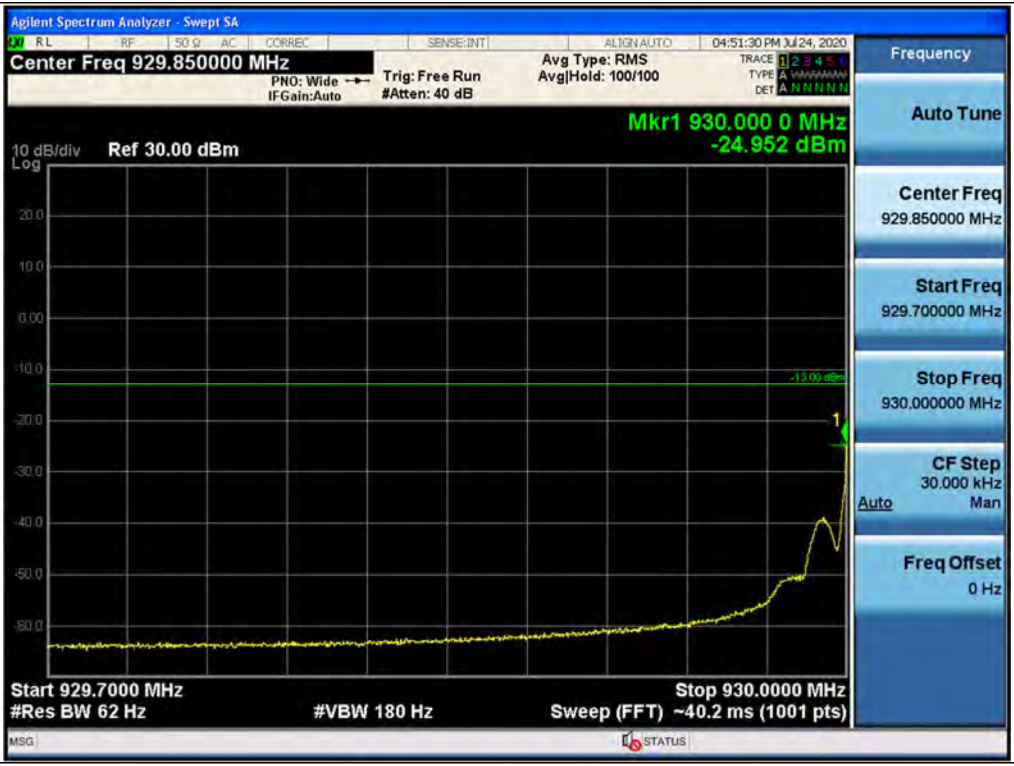
+3 dB above Out-of-band (two adjacent test signals) / 928 ~ 929 MHz / Downlink / P25 Phase 2 / Upper

Out-of-band (two adjacent test signals) / 930 ~ 931 MHz / Downlink / P25 Phase 1 / Lower

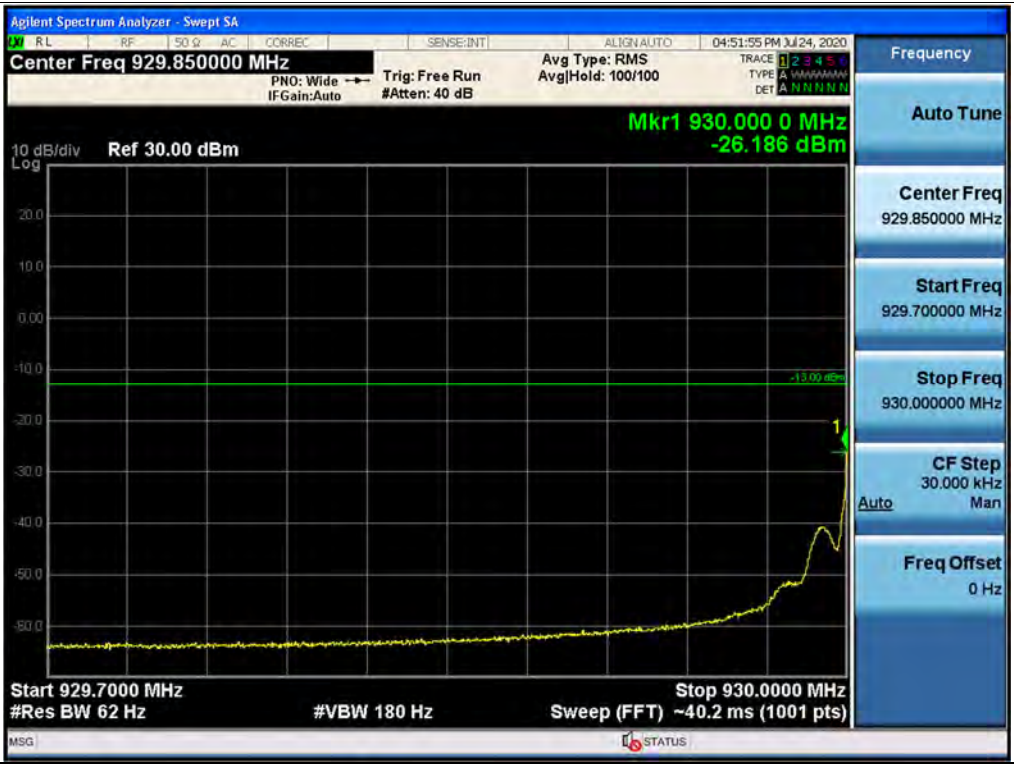
Out-of-band (two adjacent test signals) / 930 ~ 931 MHz / Downlink / P25 Phase 1 / Upper

+3 dB above Out-of-band (two adjacent test signals) / 930 ~ 931 MHz / Downlink / P25 Phase 1 / Lower


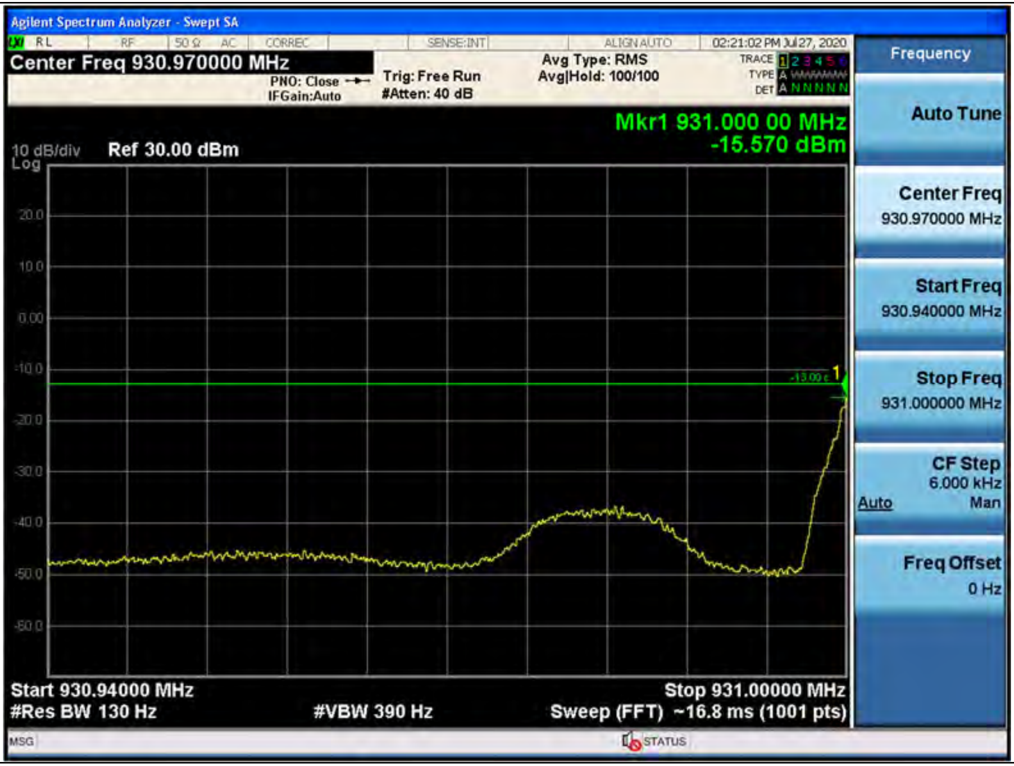
+3 dB above Out-of-band (two adjacent test signals) / 930 ~ 931 MHz / Downlink / P25 Phase 1 / Upper


Out-of-band (two adjacent test signals) / 930 ~ 931 MHz / Downlink / P25 Phase 2 / Lower


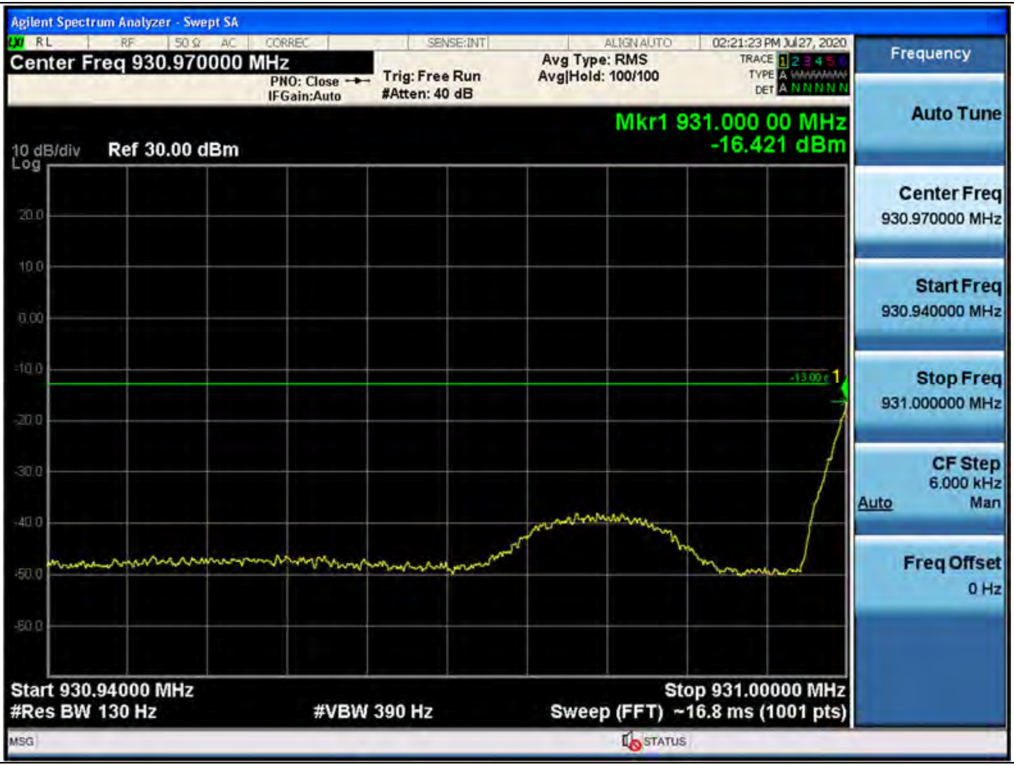
Out-of-band (two adjacent test signals) / 930 ~ 931 MHz / Downlink / P25 Phase 2 / Upper

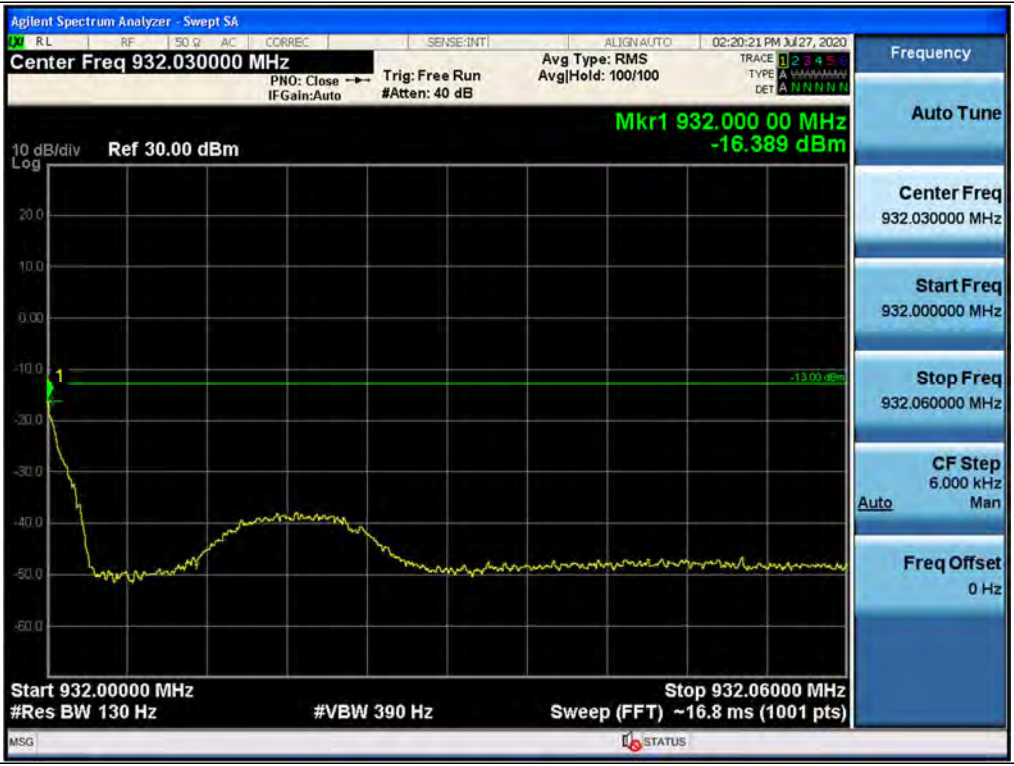

+3 dB above Out-of-band (two adjacent test signals) / 930 ~ 931 MHz / Downlink / P25 Phase 2 / Lower


+3 dB above Out-of-band (two adjacent test signals) / 930 ~ 931 MHz / Downlink / P25 Phase 2 / Upper


Out-of-band (two adjacent test signals) / 931 ~ 932 MHz / Downlink / P25 Phase 1 / Lower


Out-of-band (two adjacent test signals) / 931 ~ 932 MHz / Downlink / P25 Phase 1 / Upper


+3 dB above Out-of-band (two adjacent test signals) / 931 ~ 932 MHz / Downlink / P25 Phase 1 / Lower


+3 dB above Out-of-band (two adjacent test signals) / 931 ~ 932 MHz / Downlink / P25 Phase 1 / Upper


Out-of-band (two adjacent test signals) / 931 ~ 932 MHz / Downlink / P25 Phase 2 / Lower

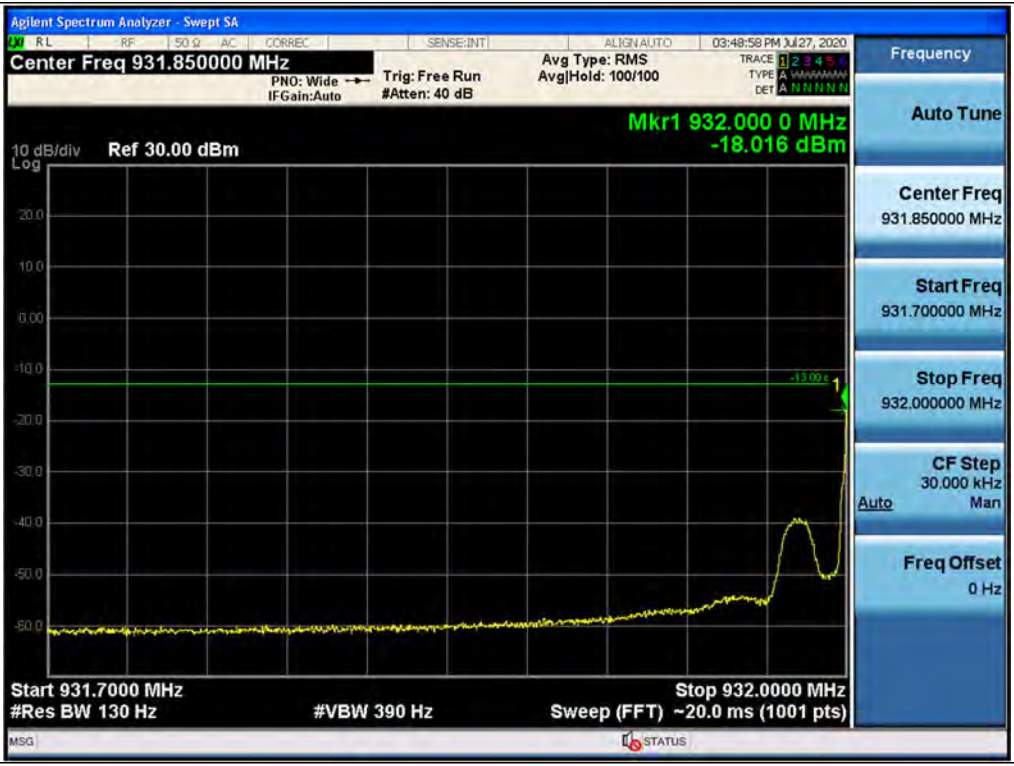

Out-of-band (two adjacent test signals) / 931 ~ 932 MHz / Downlink / P25 Phase 2 / Upper


+3 dB above Out-of-band (two adjacent test signals) / 931 ~ 932 MHz / Downlink / P25 Phase 2 / Lower

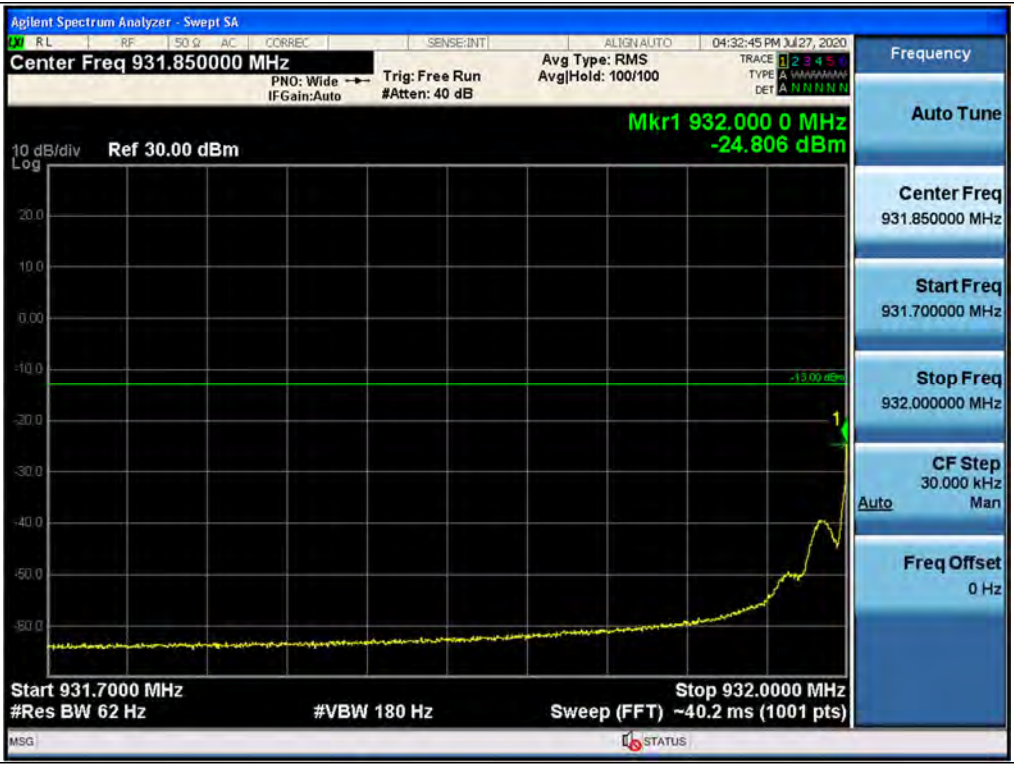

+3 dB above Out-of-band (two adjacent test signals) / 931 ~ 932 MHz / Downlink / P25 Phase 2 / Upper


Out-of-band (two adjacent test signals) / 932 ~ 935 MHz / Downlink / P25 Phase 1 / Lower

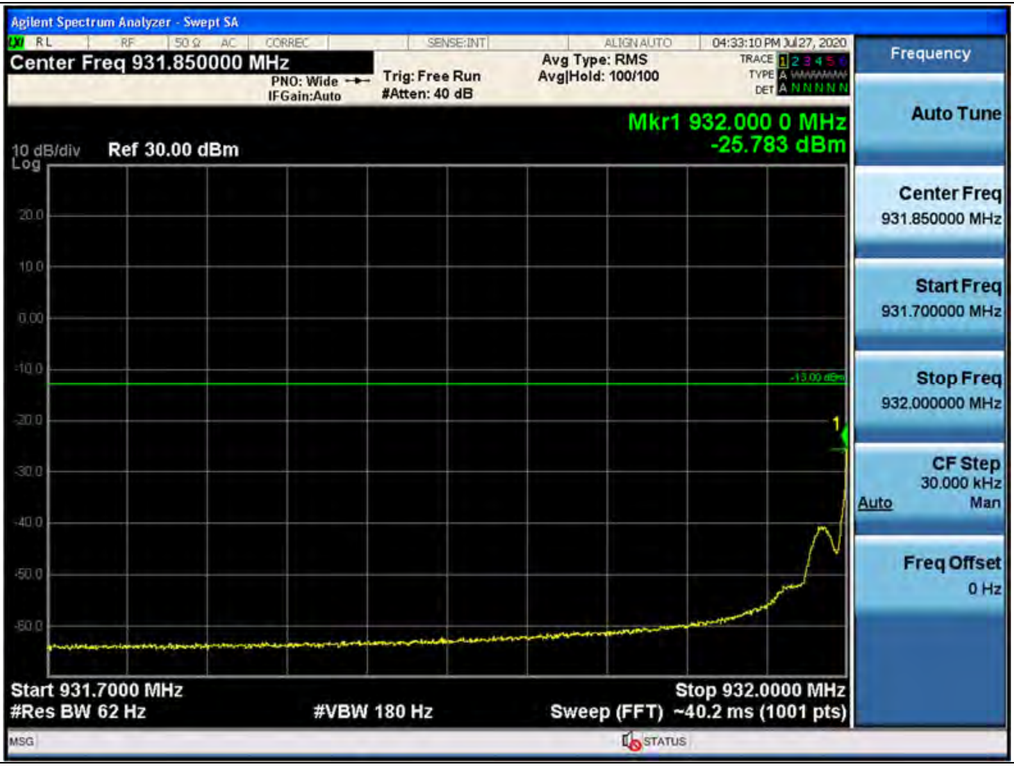

Out-of-band (two adjacent test signals) / 932 ~ 935 MHz / Downlink / P25 Phase 1 / Upper


+3 dB above Out-of-band (two adjacent test signals) / 932 ~ 935 MHz / Downlink / P25 Phase 1 / Lower


+3 dB above Out-of-band (two adjacent test signals) / 932 ~ 935 MHz / Downlink / P25 Phase 1 / Upper


Out-of-band (two adjacent test signals) / 932 ~ 935 MHz / Downlink / P25 Phase 2 / Lower


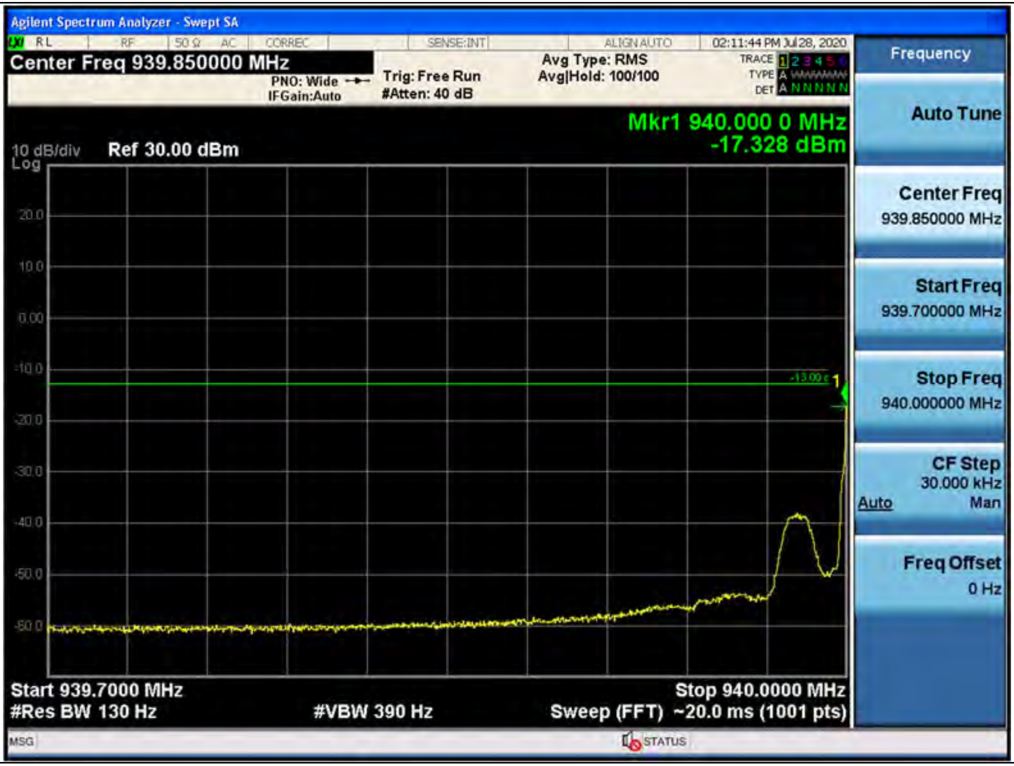
Out-of-band (two adjacent test signals) / 932 ~ 935 MHz / Downlink / P25 Phase 2 / Upper


+3 dB above Out-of-band (two adjacent test signals) / 932 ~ 935 MHz / Downlink / P25 Phase 2 / Lower


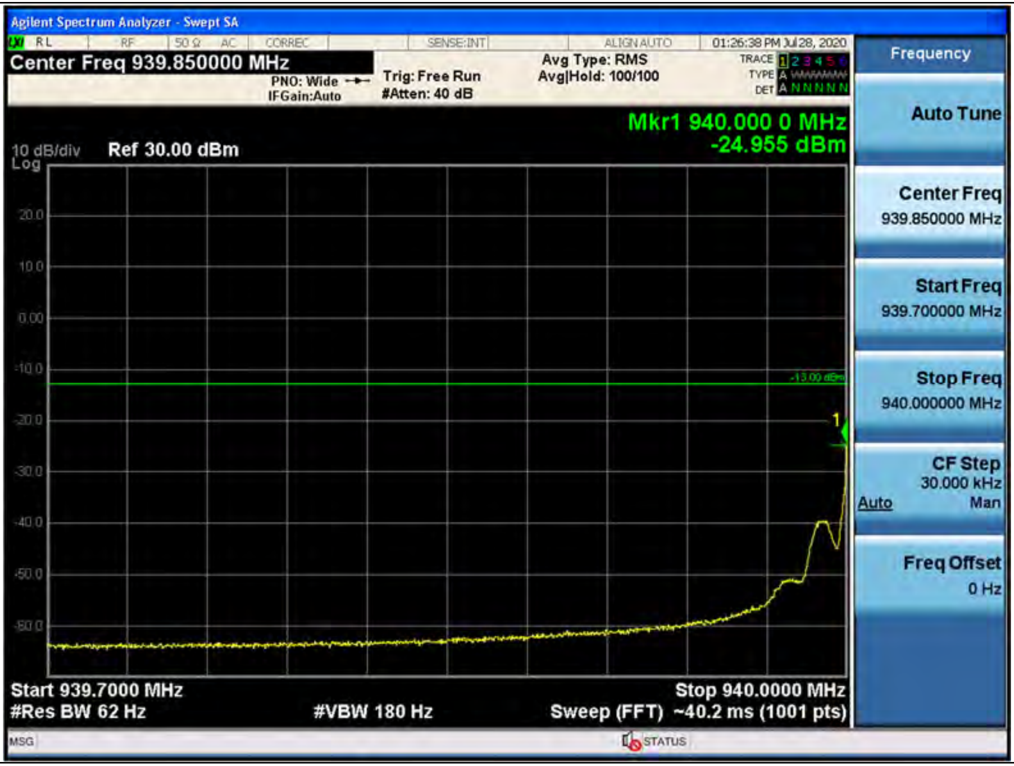
+3 dB above Out-of-band (two adjacent test signals) / 932 ~ 935 MHz / Downlink / P25 Phase 2 / Upper


Out-of-band (two adjacent test signals) / 940 ~ 941 MHz / Downlink / P25 Phase 1 / Lower


Out-of-band (two adjacent test signals) / 940 ~ 941 MHz / Downlink / P25 Phase 1 / Upper

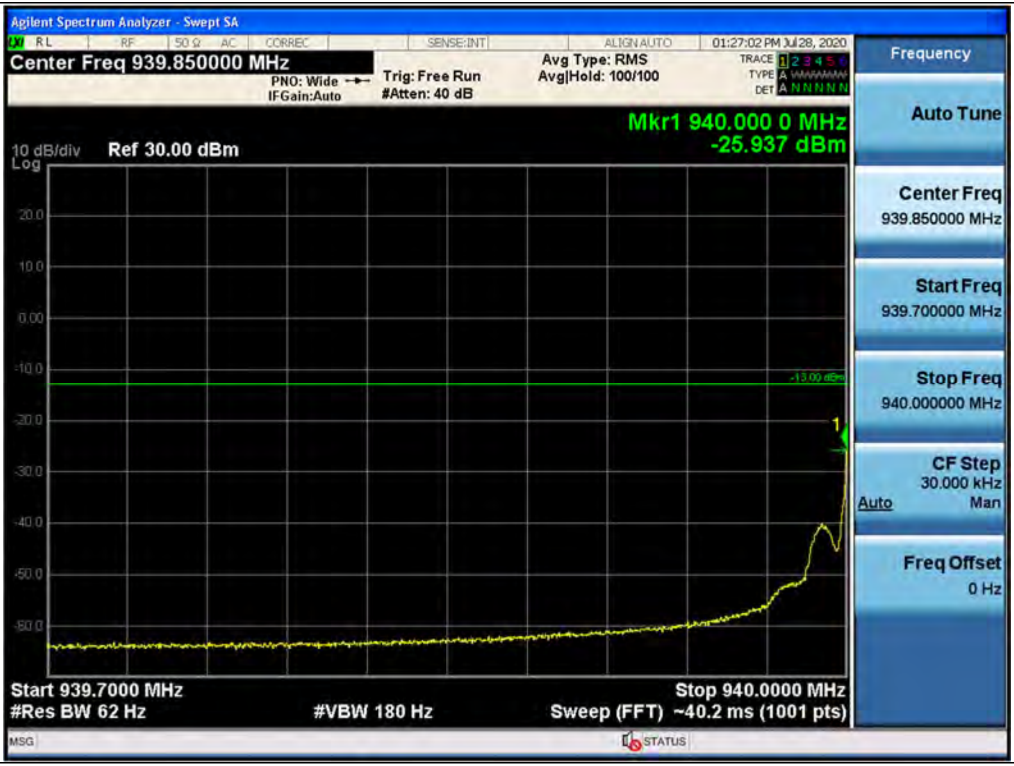

+3 dB above Out-of-band (two adjacent test signals) / 940 ~ 941 MHz / Downlink / P25 Phase 1 / Lower


+3 dB above Out-of-band (two adjacent test signals) / 940 ~ 941 MHz / Downlink / P25 Phase 1 / Upper

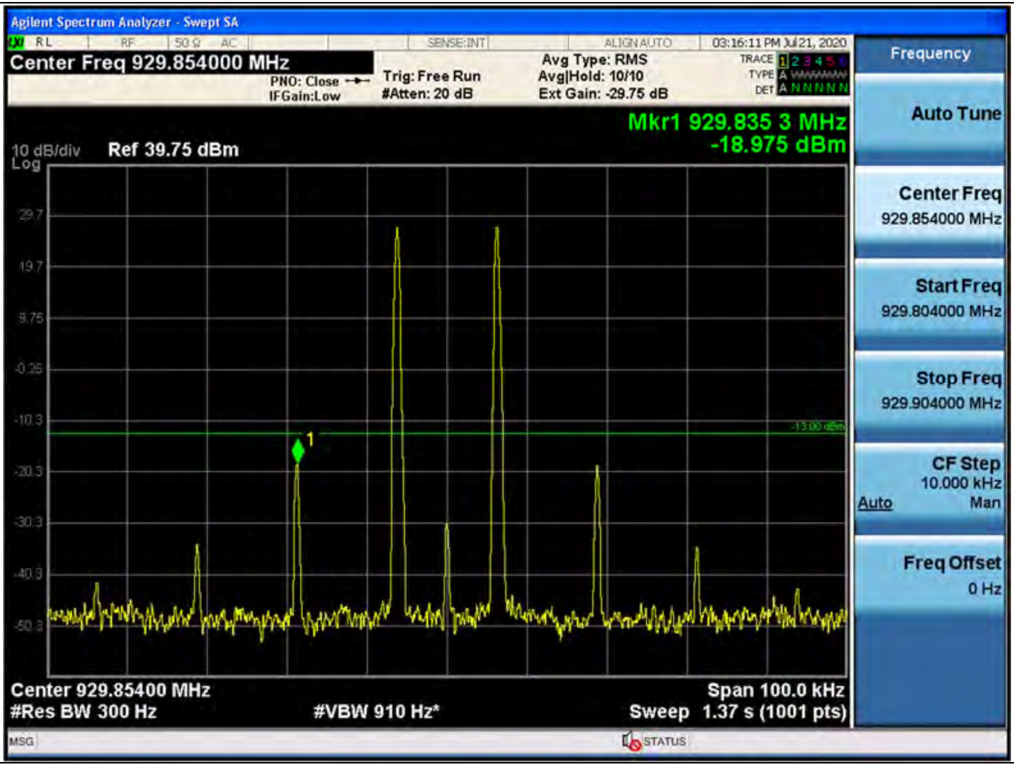

Out-of-band (two adjacent test signals) / 940 ~ 941 MHz / Downlink / P25 Phase 2 / Lower


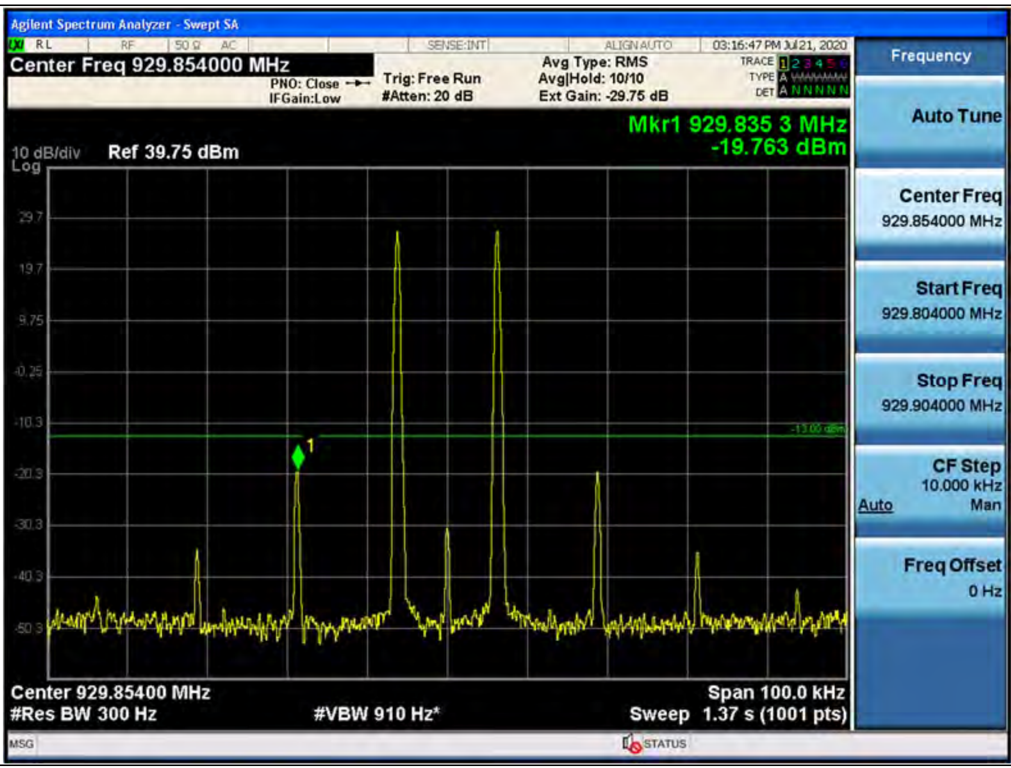
Out-of-band (two adjacent test signals) / 940 ~ 941 MHz / Downlink / P25 Phase 2 / Upper

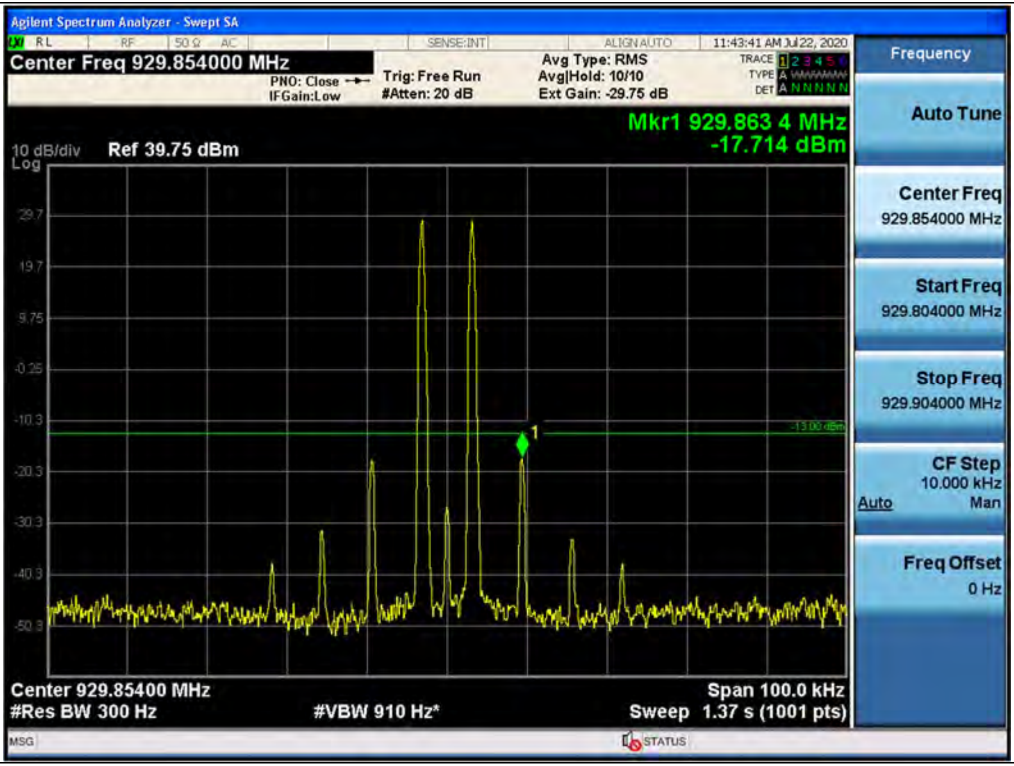

+3 dB above Out-of-band (two adjacent test signals) / 940 ~ 941 MHz / Downlink / P25 Phase 2 / Lower

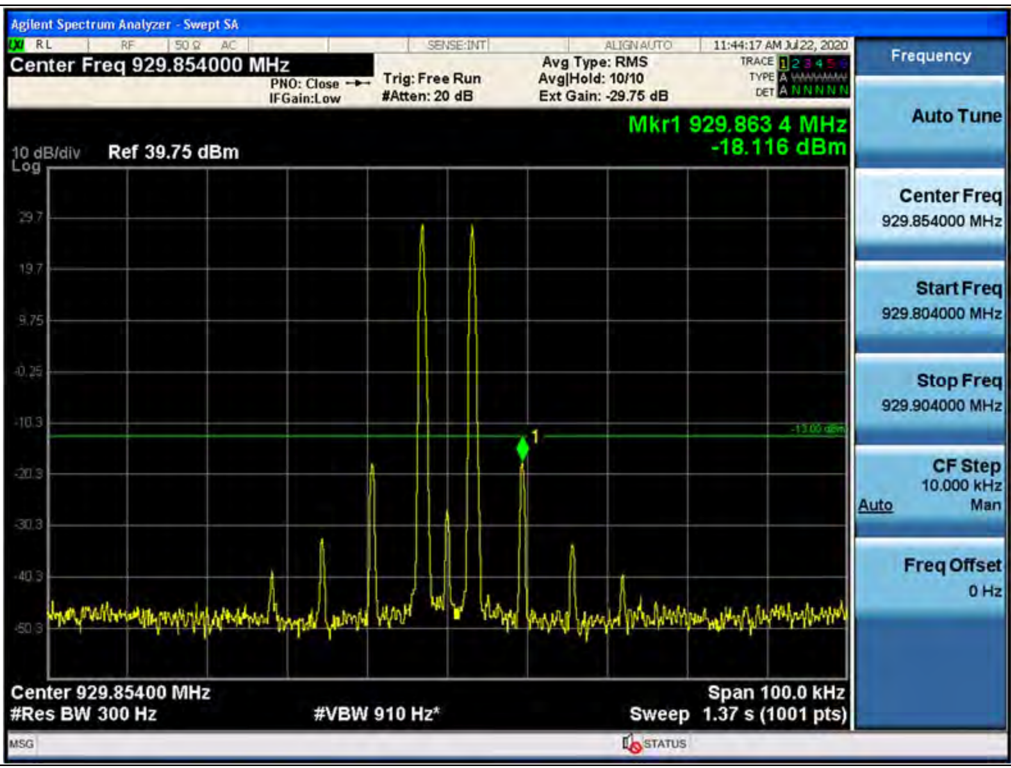


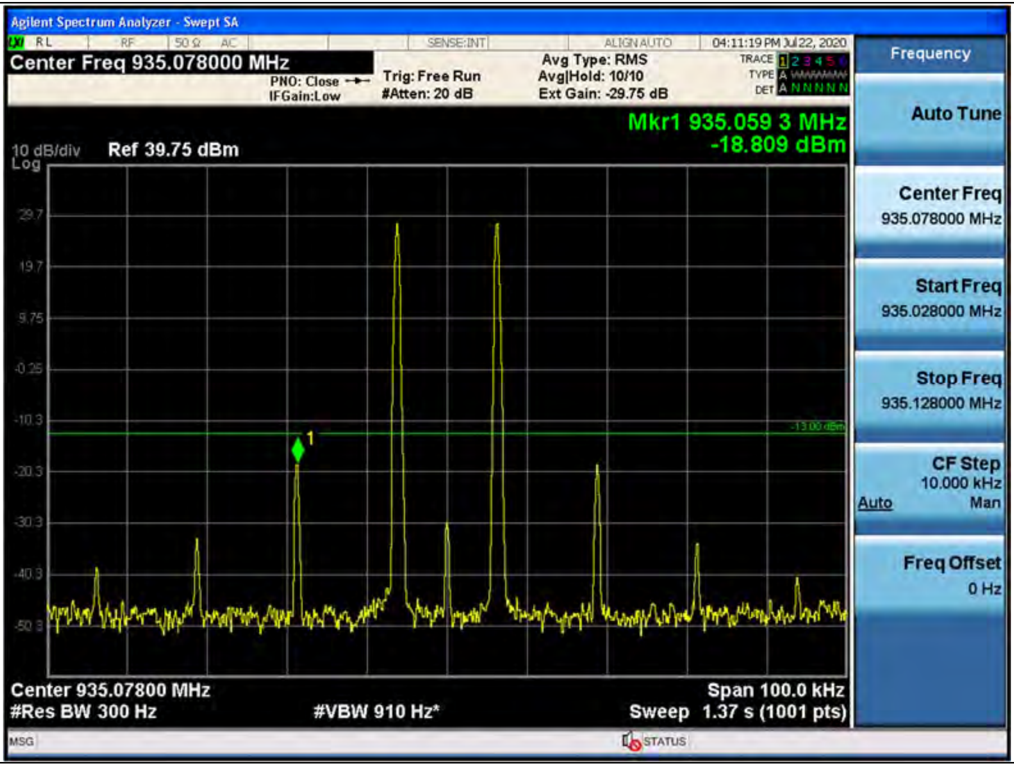
+3 dB above Out-of-band (two adjacent test signals) / 940 ~ 941 MHz / Downlink / P25 Phase 2 / Upper

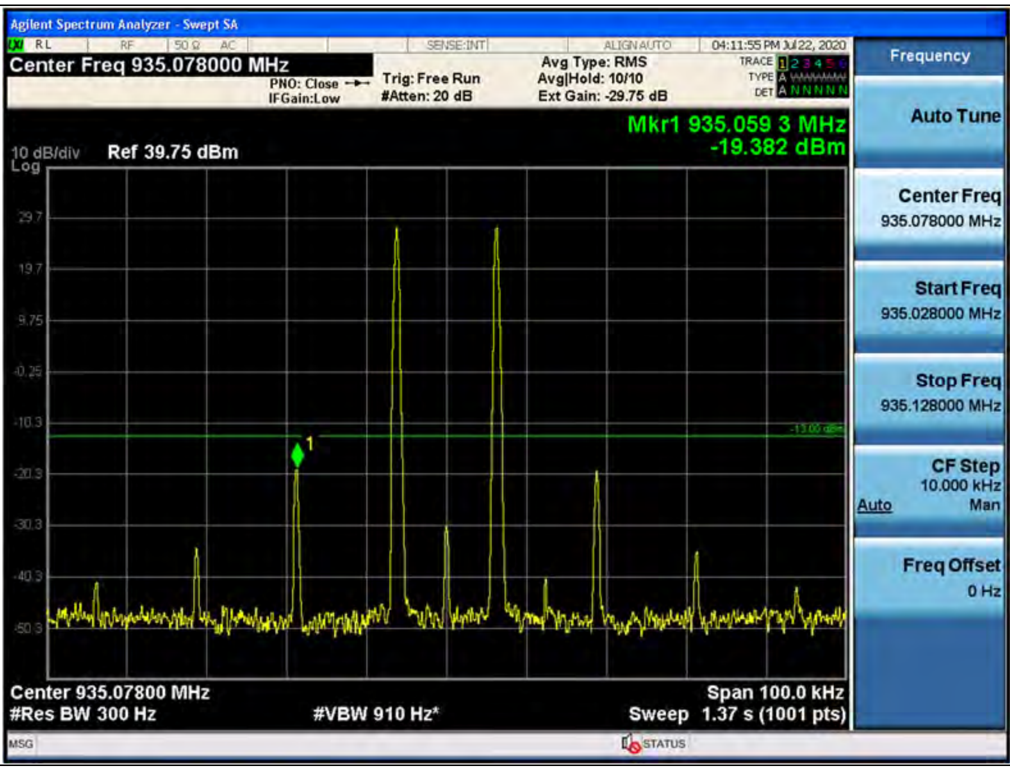
Out-of-band (two adjacent test signals) / 929 ~ 930 MHz / Downlink / CW


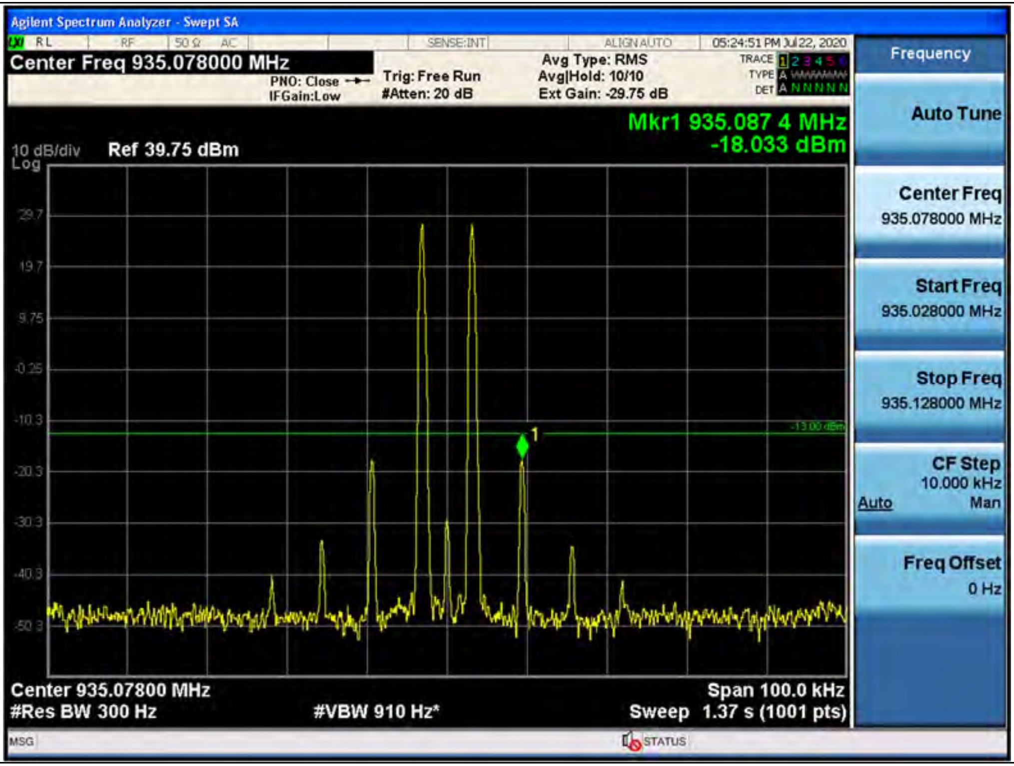
+3 dB above Out-of-band (two adjacent test signals) / 929 ~ 930 MHz / Downlink / CW


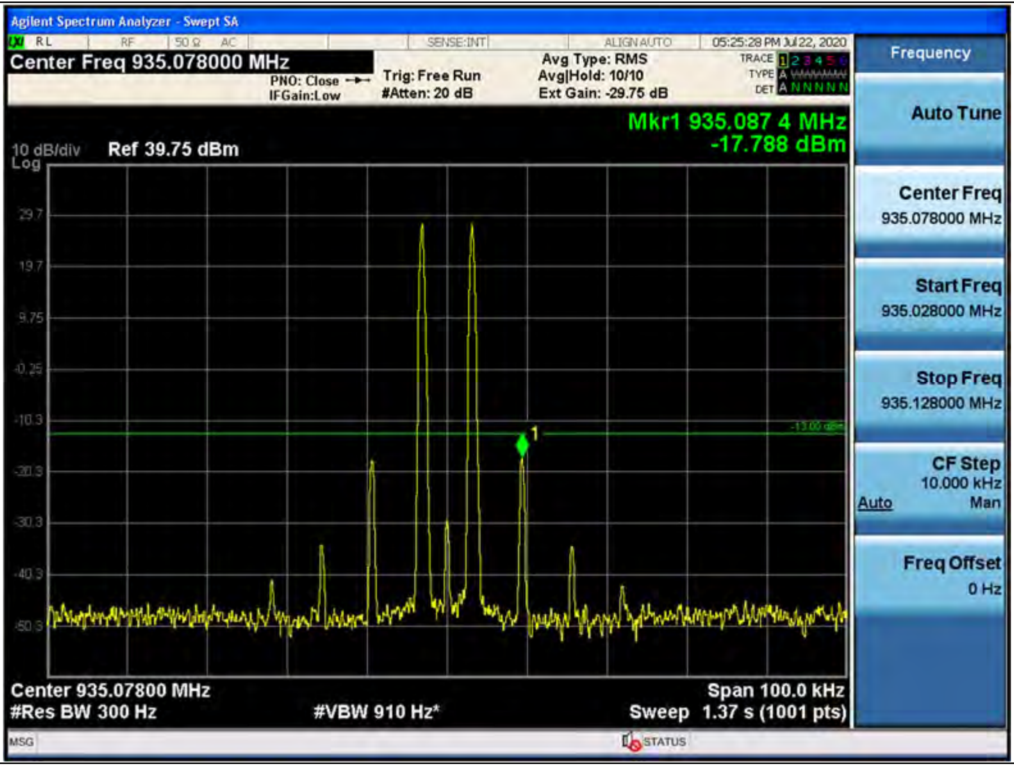
Out-of-band (two adjacent test signals) / 929 ~ 930 MHz / Downlink / CW


+3 dB above Out-of-band (two adjacent test signals) / 929 ~ 930 MHz / Downlink / CW


Out-of-band (two adjacent test signals) / 935 ~ 940 MHz / Downlink / CW


+3 dB above Out-of-band (two adjacent test signals) / 935 ~ 940 MHz / Downlink / CW


Out-of-band (two adjacent test signals) / 935 ~ 940 MHz / Downlink / CW


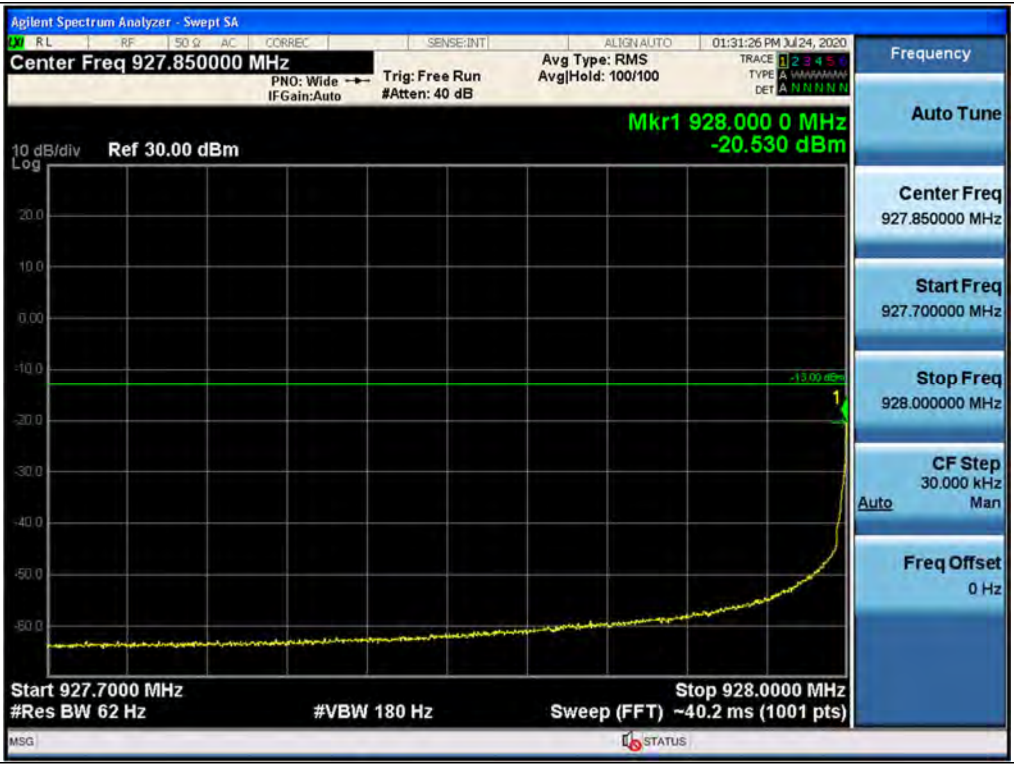
+3 dB above Out-of-band (two adjacent test signals) / 935 ~ 940 MHz / Downlink / CW


Out-of-band (single test signals) / 928 ~ 929 MHz / Downlink / P25 Phase 1 / Lower


Out-of-band (single test signals) / 928 ~ 929 MHz / Downlink / P25 Phase 1 / Upper


+3 dB above Out-of-band (single test signals) / 928 ~ 929 MHz / Downlink / P25 Phase 1 / Lower


+3 dB above Out-of-band (single test signals) / 928 ~ 929 MHz / Downlink / P25 Phase 1 / Upper


Out-of-band (single test signals) / 928 ~ 929 MHz / Downlink / P25 Phase 2 / Lower


Out-of-band (single test signals) / 928 ~ 929 MHz / Downlink / P25 Phase 2 / Upper


+3 dB above Out-of-band (single test signals) / 928 ~ 929 MHz / Downlink / P25 Phase 2 / Lower


+3 dB above Out-of-band (single test signals) / 928 ~ 929 MHz / Downlink / P25 Phase 2 / Upper


Out-of-band (single test signals) / 930 ~ 931 MHz / Downlink / P25 Phase 1 / Lower


Out-of-band (single test signals) / 930 ~ 931 MHz / Downlink / P25 Phase 1 / Upper


+3 dB above Out-of-band (single test signals) / 930 ~ 931 MHz / Downlink / P25 Phase 1 / Lower

+3 dB above Out-of-band (single test signals) / 930 ~ 931 MHz / Downlink / P25 Phase 1 / Upper

Out-of-band (single test signals) / 930 ~ 931 MHz / Downlink / P25 Phase 2 / Lower


Out-of-band (single test signals) / 930 ~ 931 MHz / Downlink / P25 Phase 2 / Upper