On your side

TEST REPORT

FCC Test for PS2RDU_E_VHF_UHF

Certification

APPLICANT
SOLiD, Inc.

REPORT NO.
HCT-RF-1909-FC005-R1

DATE OF ISSUE
September 16, 2019

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

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

TEST REPORT

FCC Test for
PS2RDU_E_VHF_UHF

REPORT NO.
HCT-RF-1909-FC005-R1

DATE OF ISSUE
September 16, 2019

Other ID
-

Applicant	**SOLiD, Inc.** 10, 9th Floor, SOLiD Space, Pangyoyeok-ro 220, Bundang-gu, Seongnam-si, Gyeonggi-do, 463-400, South Korea
Eut Type Model Name	ALLIANCE_PS2ROU PS2RDU_E_VHF_UHF
FCC ID	W6UPSEVHFUHF
Output Power	24 dBm (0.25 W)
Date of Test	July 24, 2019 ~ September 03, 2019
FCC Rule Parts:	Part 2, Part 90

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

Tested by
Kyung Soo Kang (signature)

Technical Manager
Jong Seok Lee (signature)

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

REVISION HISTORY

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

Revision No.	Date of Issue	Description
0	September 03, 2019	Initial Release
1	September 16, 2019	Fixed formatting error on page 17.

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

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

CONTENTS

1. GENERAL INFORMATION

1.1. APPLICANT INFORMATION

Company Name	SOLiD, Inc.
Company Address	10, 9th Floor, SOLiD Space, Pangyoyeok-ro 220, Bundang-gu, Seongnam-si, Gyeonggi-do, 463-400, South Korea

1.2. PRODUCT INFORMATION

EUT Type	ALLIANCE_PS2ROU
Power Supply	120 V AC(100 ~ 240 V AC), -48 V DC(-42 ~ 56V DC)
Frequency Range	VHF: 150 ~ 174 MHz UHF: 406.1 ~ 512 MHz
Tx Output Power	24 dBm (0.25 W)
Antenna Peak Gain	Manufacturer does not provide an Antenna.

1.3. TEST INFORMATION

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

2. TEST STANDARDS

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

Description	Reference
AGC threshold	KDB 935210 D05 v01r03 4.2
Out-of-band rejection	KDB 935210 D05 v01r03 4.3
Occupied Bandwidth	§ 2.1049 § 90.219(e)(4)(ii)
Input-versus-output signal comparison	§ 90.210, § 90.219(e)(4)(iii)
Input/output power and amplifier/booster gain	§ 2.1046, § 90.205, § 90.219, § 90.279
Noise figure	§ 90.219(e)(2)
Emission masks Out-of-band/out-of-block emissions and spurious emissions	§ 2.1051, § 90.219(e)(3)
Spurious emissions radiated	§ 2.1053

2.1. ADDITIONAL DESCRIPTIONS ABOUT TEST

Except for the following cases, EUT was tested under normal operating conditions.
: Out-of-band rejection test requires maximum gain condition without AGC

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

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

EUT was tested with following modulated signals provide by applicant.

Band Name	Tested signals
VHF	IDEN
UHF	IDEN

The frequency stability measurement has been omitted in accordance with section 3.7 of KDB 935210 D05 v01r03.
: It can be confirmed through input-versus-output spectrum test that EUT does not alter the input signal.

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

Correction factor table			
Frequency (MHz)	Factor (dB)	Frequency (MHz)	Factor (dB)
100	0.721	400	0.632
150	0.923	450	0.834
200	0.825	500	0.983
250	0.627	550	0.735
300	0.928	600	0.494
350	0.730		

: Output Path

Correction factor table			
Frequency (MHz)	Factor (dB)	Frequency (MHz)	Factor (dB)
30	30.285	1500	32.138
50	30.766	2000	32.827
100	30.584	2500	32.373
150	31.302	3000	32.921
200	31.241	3500	33.048
250	31.033	4000	32.887
300	31.053	4500	33.039
350	31.246	5000	33.187
400	31.228	5500	32.994
450	30.876	6000	33.195
500	31.649	6500	33.325
550	31.399	7000	33.451
600	31.368	7500	33.334
650	31.544	8000	34.124
700	31.509	8500	33.867
750	31.576	9000	33.659
800	31.537		
850	31.652		
900	31.860		
950	31.796		
1000	31.965		

2.2. MEASUREMENTUNCERTAINTY

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

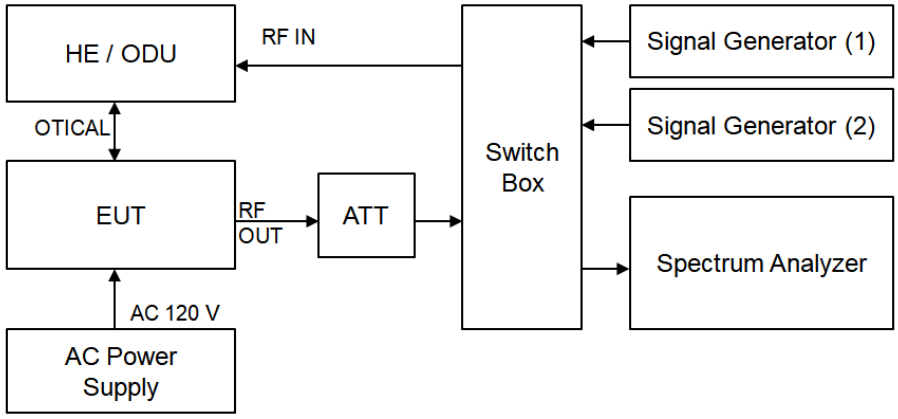
** Coverage factor k = 2, Confidence levels of 95 %*

2.3. STANDARDS ENVIRONMENTAL TEST CONDITIONS

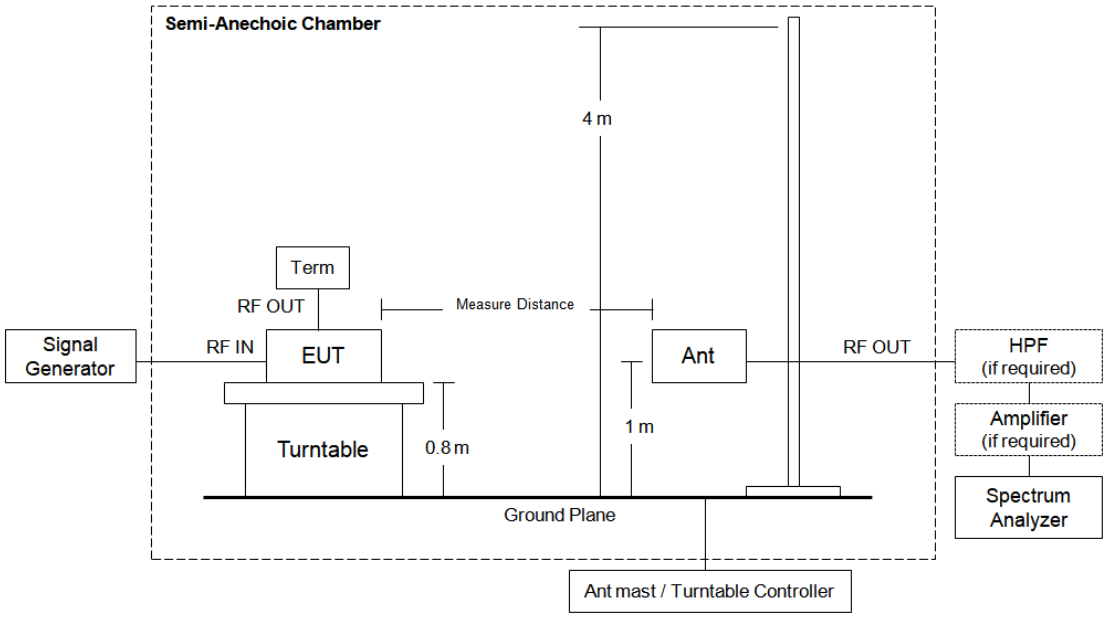
Temperature	+15 °C to +35 °C
Relative humidity	30 % to 60 %
Air pressure	860 mbar to 1 060 mbar

2.4. TEST DIAGRAMS

Conducted Test



Radiated Test



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

3. TEST EQUIPMENTS

Manufacturer	Model / Equipment	Calibration Date	Calibration Interval	Serial No.
Agilent	N9020A / MXA Signal Analyzer	05/08/2019	Annual	MY51110063
Agilent	N5182A / MXG Vector Signal Generator	08/30/2018	Annual	MY46240523
Agilent	N5182A / MXG Vector Signal Generator	01/18/2019	Annual	MY47070406
Agilent	8498A / 30 dB Attenuator	02/18/2019	Annual	51161
KEITHLEY	S46 / Switch	N/A	N/A	1088024
Deayoung ENT	DFSS60 / AC Power Supply	04/04/2019	Annual	1003030-1
Innco system	CO3000 / Controller(Antenna mast)	N/A	N/A	CO3000-4p
Innco system	MA4640/800-XP-EP / Antenna Position Tower	N/A	N/A	N/A
Audix	EM1000 / Controller	N/A	N/A	060520
Audix	- / Turn Table	N/A	N/A	N/A
Rohde&Schwarz	- / Loop Antenna	08/23/2018	Biennial	1513-175
Schwarzbeck	VULB 9168 / Hybrid Antenna	03/22/2019	Biennial	760
Schwarzbeck	BBHA 9120D / Horn Antenna	04/29/2019	Biennial	9120D-937
Rohde & Schwarz	FSP(9 kHz ~ 30 GHz) / Spectrum Analyzer	05/09/2019	Annual	100854
Wainwright Instruments	WHKX10-900-1000-15000-40SS	07/15/2019	Annual	5
CERNEX	CBLU1183540 / Power Amplifier	07/01/2019	Annual	22964
CERNEX	CBL06185030 / Power Amplifier	07/01/2019	Annual	22965

4. TEST RESULT

4.1. AGC THRESHOLD

Test Requirement:

KDB 935210 D05 v01r03

Testing at and above the AGC threshold is required.

Test Procedures:

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

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

3.2 Measureing 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.

Output power measurement in subclause 5.2.4.4.1 of ANSI C63.26

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

e) Sweep time: auto-couple

f) Detector = power averaging (rms).

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

h) Omit

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

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

Test Results:

Test Band	Link	Center Frequency (MHz)	AGC Threshold Level (dBm)	Output Level (dBm)
VHF	Downlink	162.00	-15	23.47
UHF		459.05	-15	23.83

4.2. OUT-OF-BAND REJECTION

Test Requirement:

KDB 935210 D05 v01r03

Out-of-band rejection required.

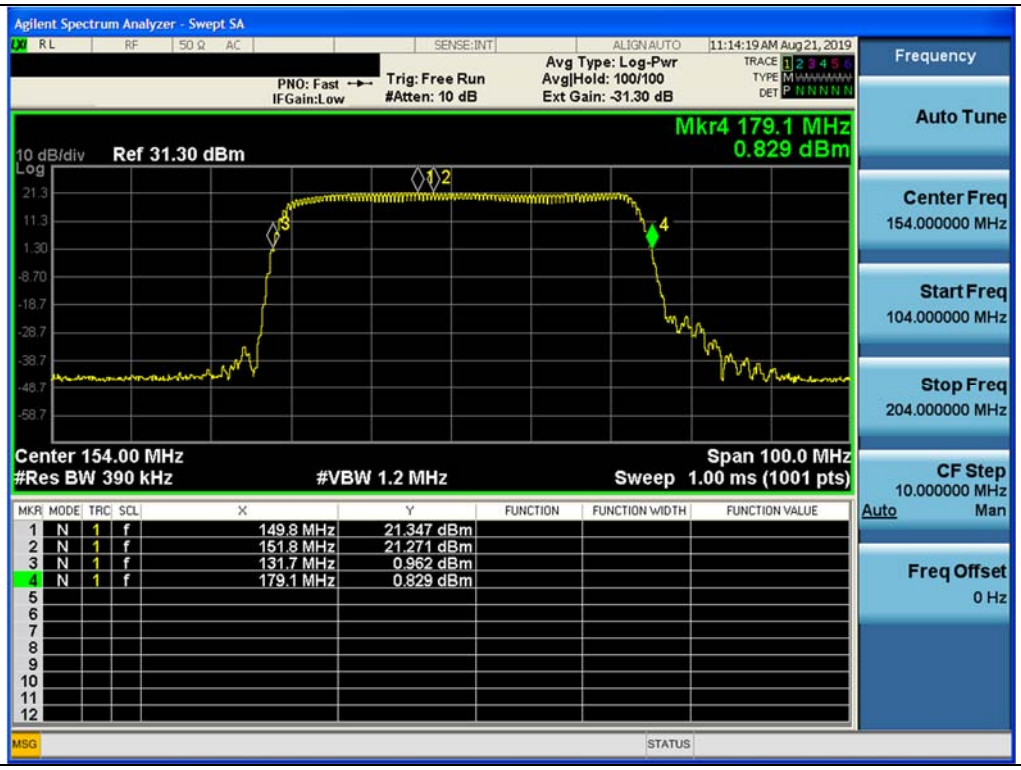
Test Procedures:

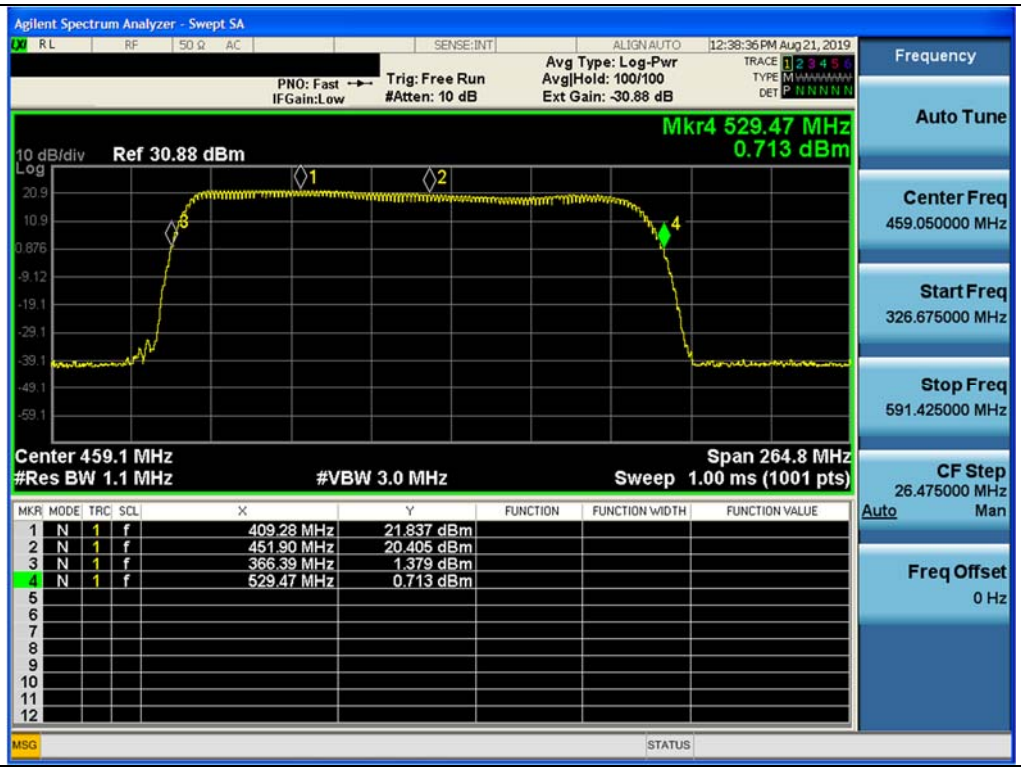
Measurements were in accordance with the test methods section 4.3 of KDB 935210 D05 v01r03.

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

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:

VHF / Downlink


UHF / Downlink


4.3. OCCUPIED BANDWIDTH

Test Requirement:

§ 2.1049 Measurements required: Occupied bandwidth.

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the specified conditions of § 2.1049 (a) through (i) as applicable.

§ 90.219 Use of signal boosters.

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

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

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

Test Procedures:

Because KDB 935210 D05 procedure does not provide this requirement, measurements were in accordance with the test methods section 5.4.4 of ANSI C63.26-2015.

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

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

c) Set the reference level of the instrument as required to prevent the signal amplitude from exceeding the maximum spectrum analyzer input mixer level for linear operation. See guidance provided in 4.2.3.
NOTE—Step a), step b), and step c) may require iteration to adjust within the specified tolerances.

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

e) Omit

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

Test Results:

Tabular data of Output Occupied Bandwidth

Test Band	Link	Center Frequency (MHz)	99 % OBW (kHz)	26 dB OBW (kHz)
VHF	Downlink	162.00	18.571	20.49
UHF		459.05	18.523	20.46

Tabular data of Input Occupied Bandwidth

Test Band	Link	Center Frequency (MHz)	99 % OBW (kHz)	26 dB OBW (kHz)
VHF	Downlink	162.00	18.457	20.49
UHF		459.05	18.539	20.52

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

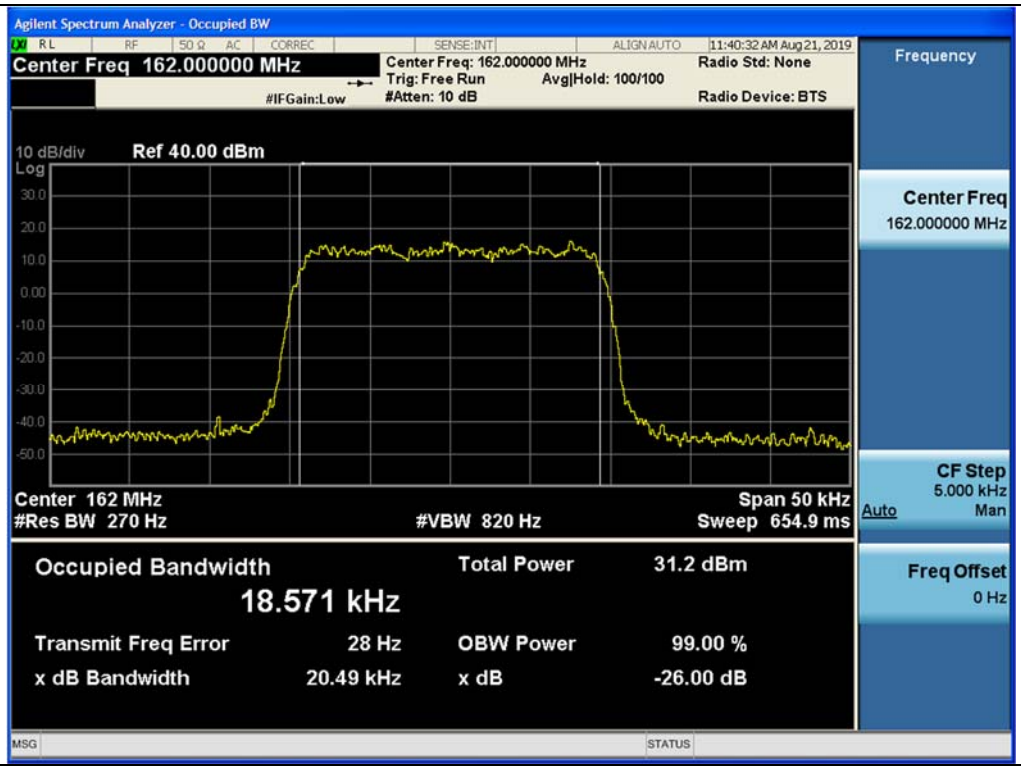
Test Band	Link	Center Frequency (MHz)	99 % OBW (kHz)	26 dB OBW (kHz)
VHF	Downlink	162.00	18.520	20.42
UHF		459.05	18.517	20.47

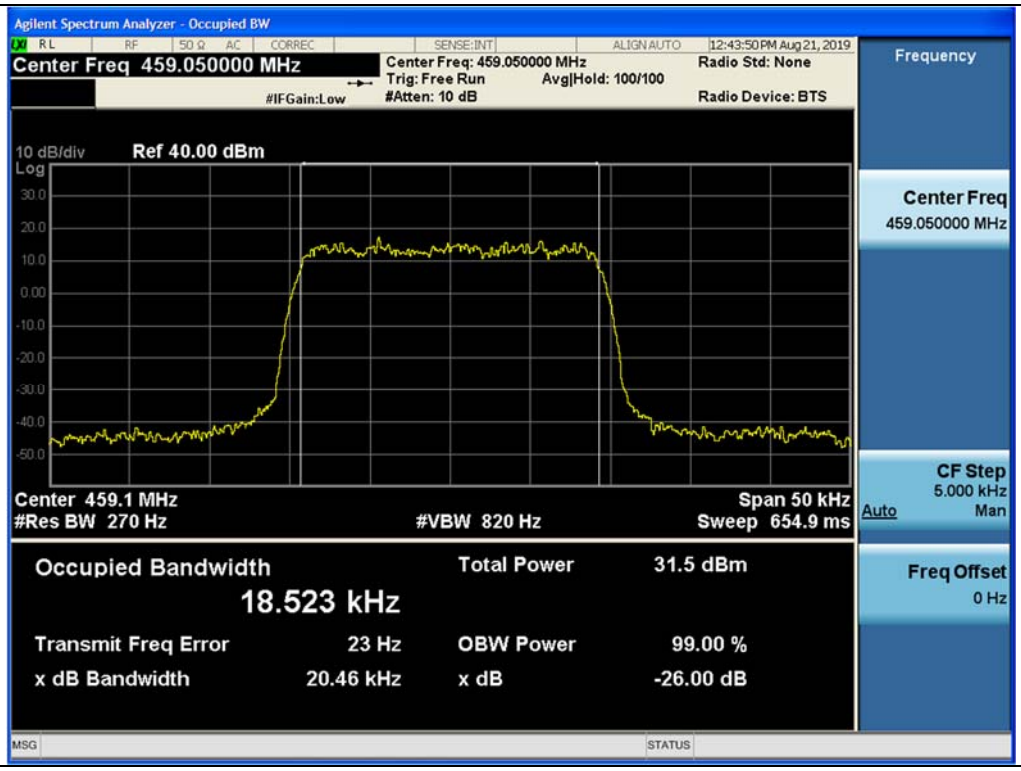
Measured Occupied Bandwidth Comparison

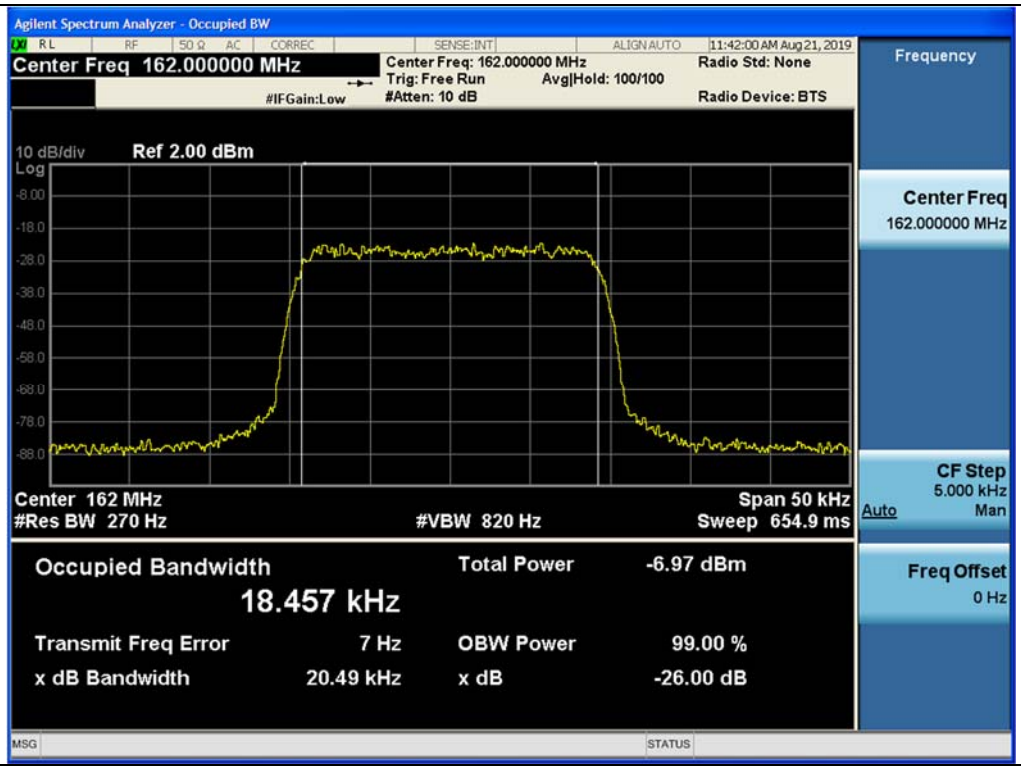
Test Band	Link	Variant of Input and output Occupied Bandwidth (%)	Variant of Input and 3 dB above the AGC threshold output Occupied Bandwidth (%)
VHF	Downlink	-0.03	-0.37
UHF		-0.34	-0.26

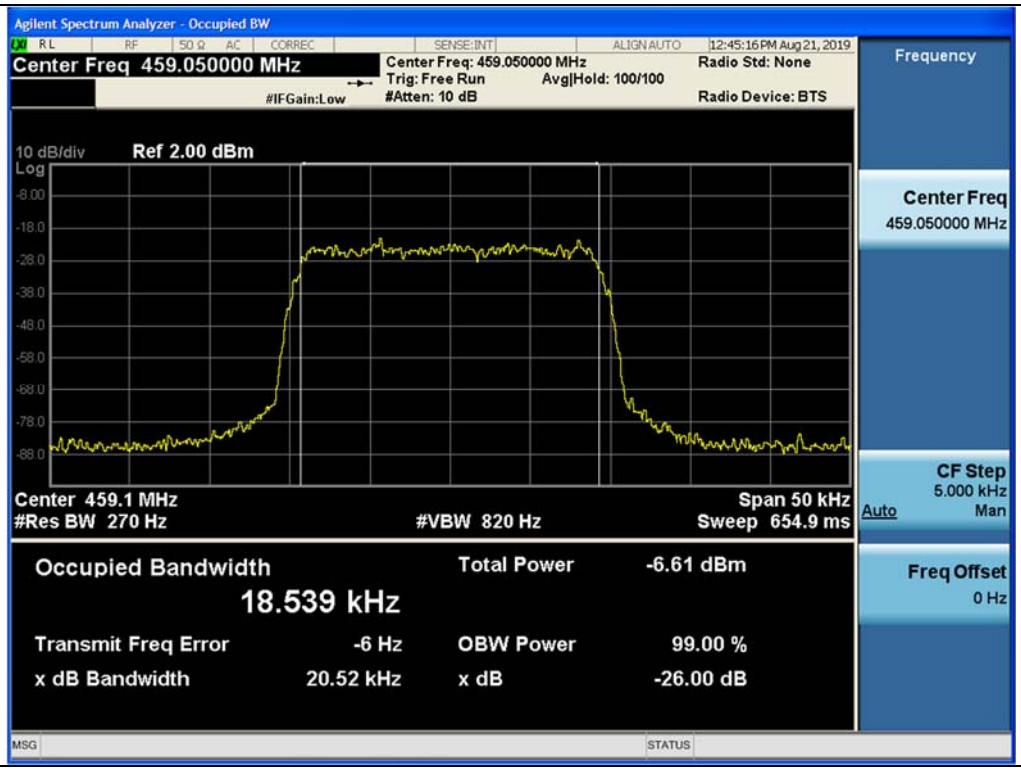
* Change in input-output OBW is less than ±5 %.

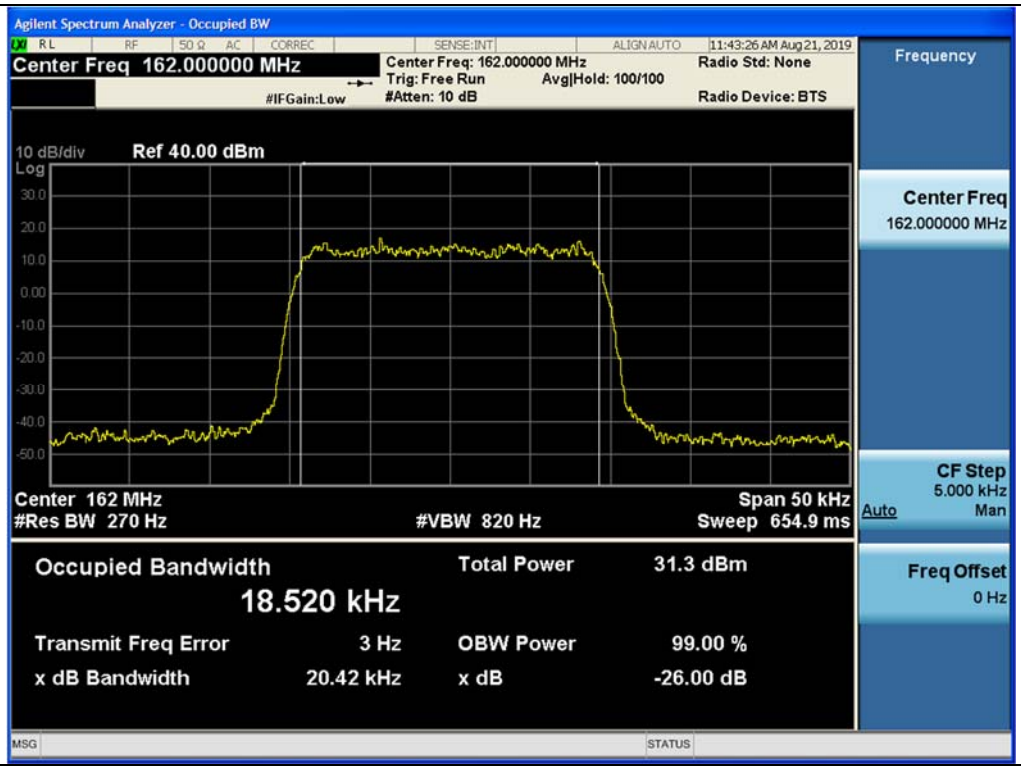
Plot data of Occupied Bandwidth

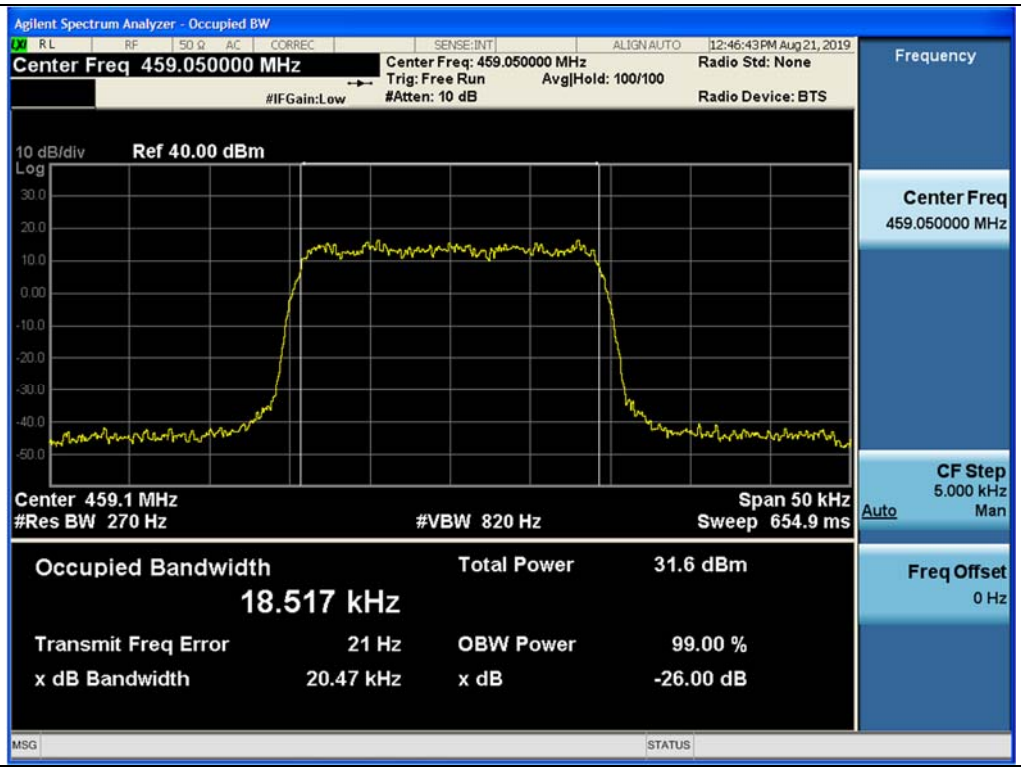
Output / VHF / Downlink


Output / UHF / Downlink


Input / VHF / Downlink


Input / UHF / Downlink


3 dB above the AGC threshold output / VHF / Downlink


3 dB above the AGC threshold output / UHF / Downlink


4.4. 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

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

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

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

dB or 50 dB, whichever is the lesser attenuation;

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

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

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

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

§ 90.219 Use of signal boosters.

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

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

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

Test Procedures:

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

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

b) Configure the signal generator to transmit the appropriate test signal associated with the public safety emission designation.

c) Configure the signal level to be just below the AGC threshold.

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

e) Set the spectrum analyzer center frequency to the nominal EUT channel center frequency. The span range for the spectrum analyzer shall be between 2 times to 5 times the EBW (or OBW).

f) The nominal RBW shall be 300 Hz for 16K0F3E, and 100 Hz for all other emissions types.

g) Set the reference level of the spectrum analyzer to accommodate the maximum input amplitude level, i.e., the level at f_0 per Out-of-band rejection test.

h) Set spectrum analyzer detection mode to peak, and trace mode to max hold.

i) Allow the trace to fully stabilize.

j) Confirm that the signal is contained within the appropriate emissions mask.

k) Use the marker function to determine the maximum emission level and record the associated frequency.

l) Capture the emissions mask plot for inclusion in the test report (output signal spectra).

m) Measure the EUT input signal power (signal generator output signal) directly from the signal generator using power measurement guidance provided in KDB Publication 971168 [R8] (input signal spectra).

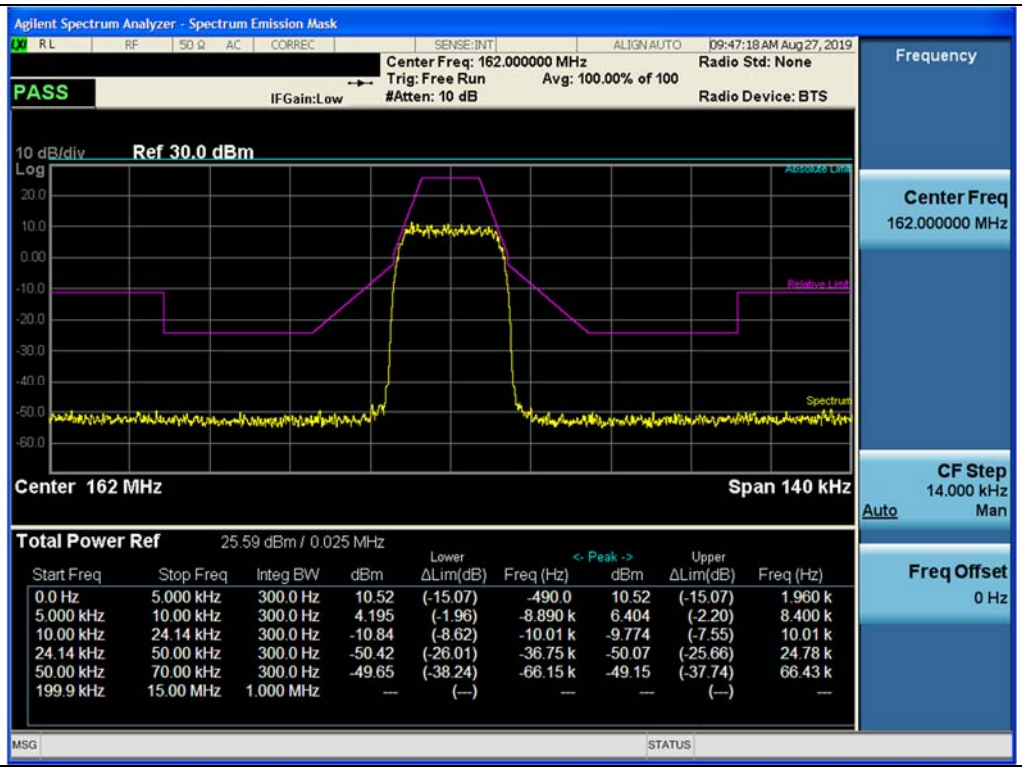
n) Compare the spectral plot of the output signal (determined in step k), to the input signal (determined in step l) to affirm they are similar (in passband and rolloff characteristic features and relative spectral locations).

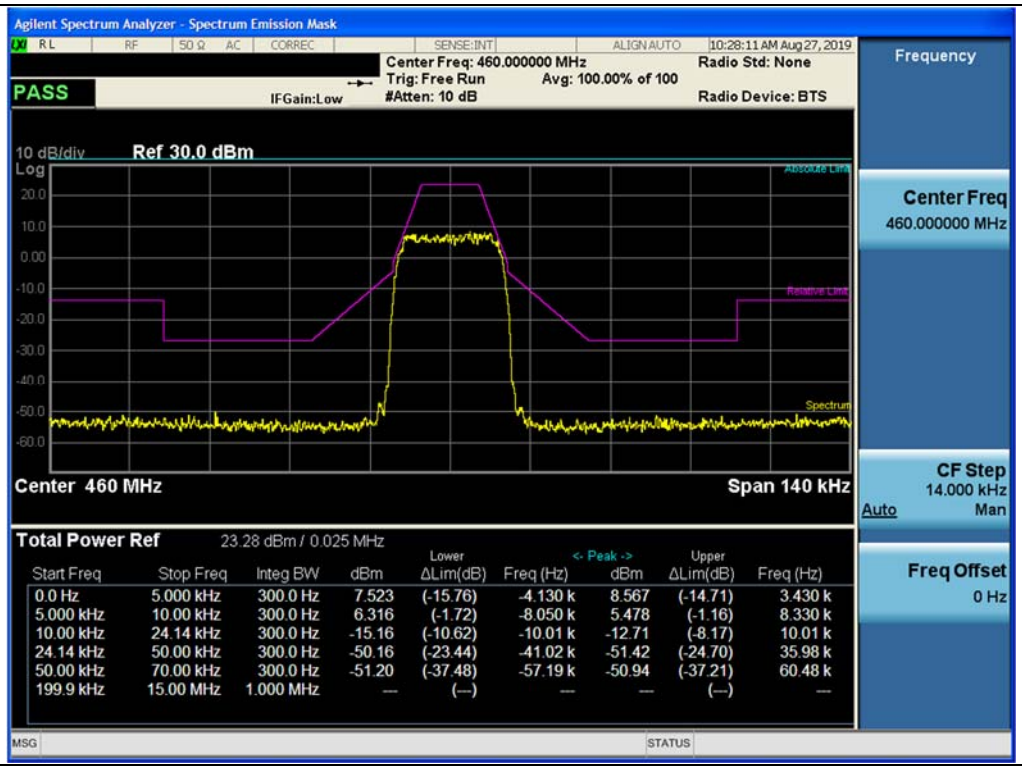
o) Repeat steps d) to n) with the input signal amplitude set 3 dB above the AGC threshold.

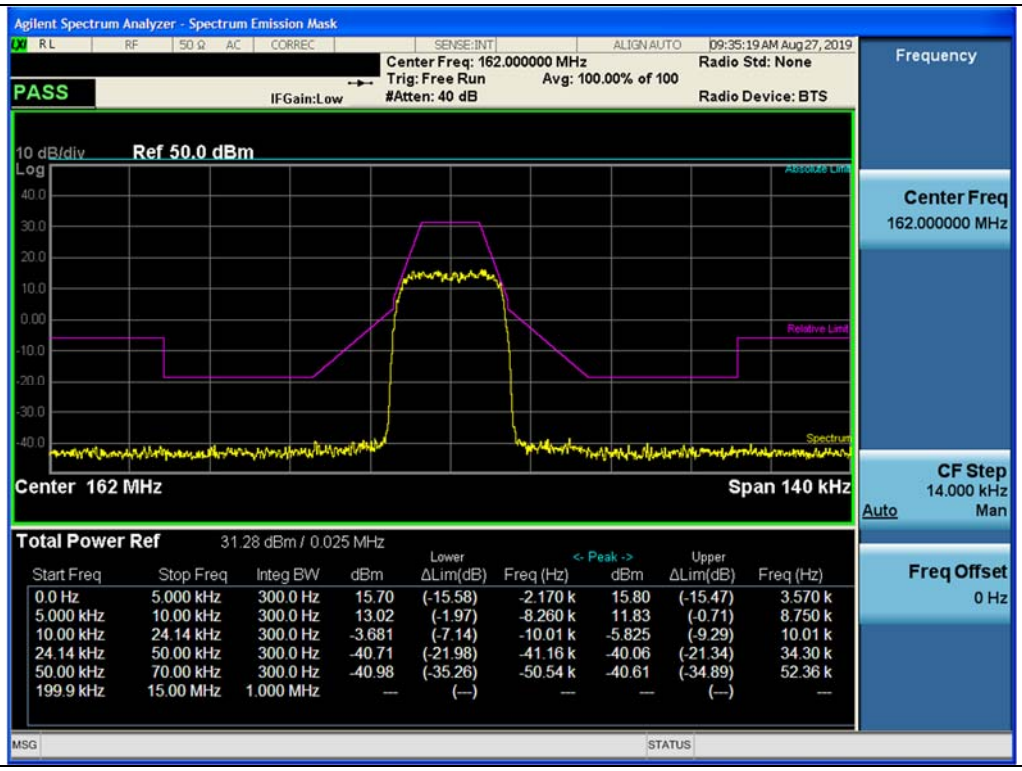
p) Repeat steps b) to o) for all authorized operational bands and emissions types (see applicable regulatory specifications, e.g., Section 90.210).

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

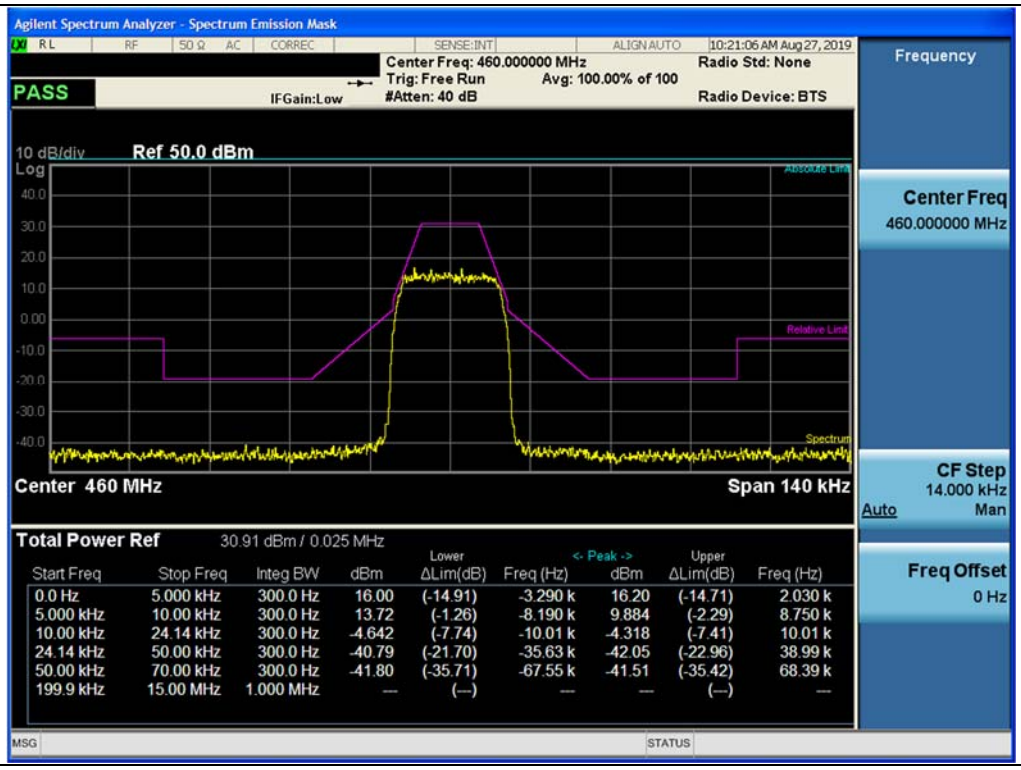
Plot data of Emission mask:

Input / VHF / Downlink / Mask C


Input / UHF / Downlink / Mask C


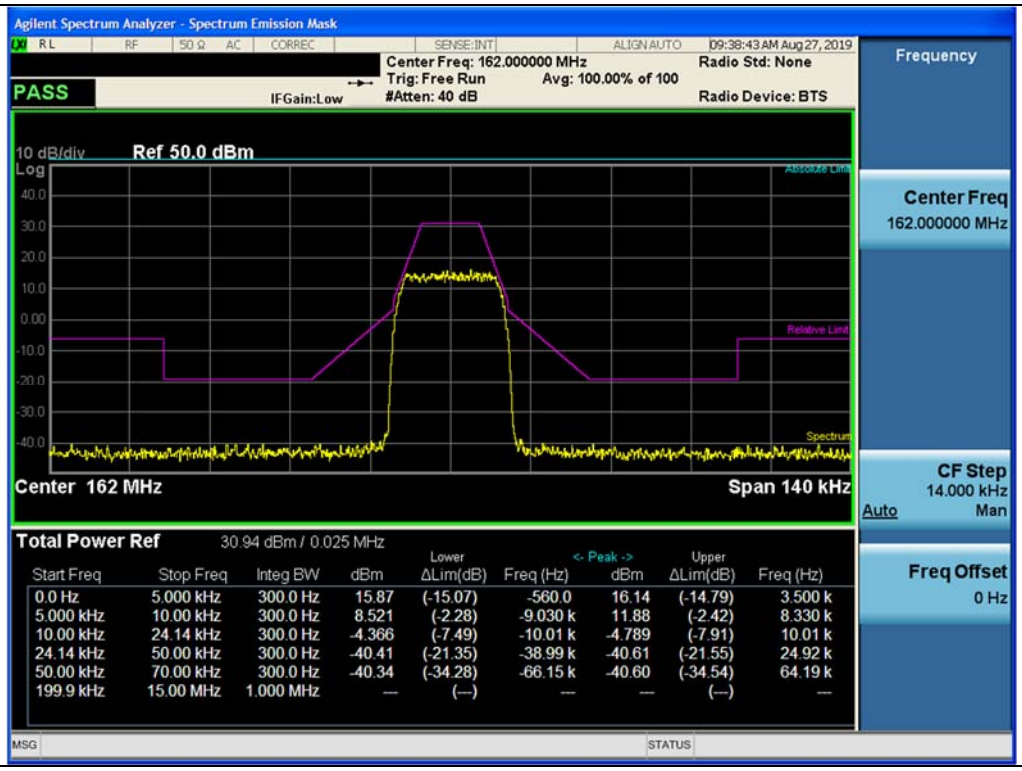
Output / VHF / Downlink / Mask C


Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLim(dB)	Lower Freq (Hz)	<- Peak -> dBm	Upper ΔLim(dB)	Upper Freq (Hz)
0.0 Hz	5.000 kHz	300.0 Hz	15.70	(-15.58)	-2.170 k	15.80	(-15.47)	3.570 k
5.000 kHz	10.00 kHz	300.0 Hz	13.02	(-1.97)	-8.260 k	11.83	(-0.71)	8.750 k
10.00 kHz	24.14 kHz	300.0 Hz	-3.681	(-7.14)	-10.01 k	-5.825	(-9.29)	10.01 k
24.14 kHz	50.00 kHz	300.0 Hz	-40.71	(-21.98)	-41.16 k	-40.06	(-21.34)	34.30 k
50.00 kHz	70.00 kHz	300.0 Hz	-40.98	(-35.26)	-50.54 k	-40.61	(-34.89)	52.36 k
199.9 kHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---

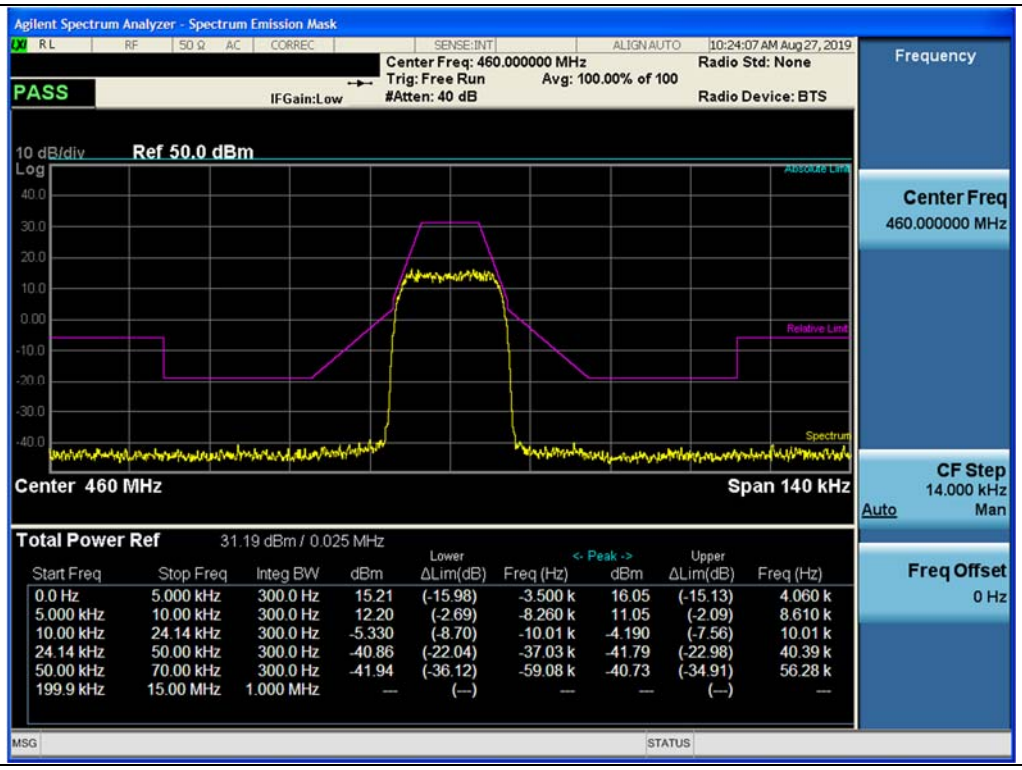
Output / UHF / Downlink / Mask C


Start Freq	Stop Freq	Integ BW	dBm	Lower ΔLim(dB)	Lower Freq (Hz)	<- Peak -> dBm	Upper ΔLim(dB)	Upper Freq (Hz)
0.0 Hz	5.000 kHz	300.0 Hz	16.00	(-14.91)	-3.290 k	16.20	(-14.71)	2.030 k
5.000 kHz	10.00 kHz	300.0 Hz	13.72	(-1.26)	-8.190 k	9.884	(-2.29)	8.750 k
10.00 kHz	24.14 kHz	300.0 Hz	-4.642	(-7.74)	-10.01 k	-4.318	(-7.41)	10.01 k
24.14 kHz	50.00 kHz	300.0 Hz	-40.79	(-21.70)	-35.63 k	-42.05	(-22.96)	38.99 k
50.00 kHz	70.00 kHz	300.0 Hz	-41.80	(-35.71)	-67.55 k	-41.51	(-35.42)	68.39 k
199.9 kHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---

3 dB above the AGC threshold Output / VHF / Downlink / Mask C



3 dB above the AGC threshold Output / UHF / Downlink / Mask C



4.5. 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.

§ 90.205 Power and antenna height limits.

(d) 150-174 MHz.

(1) The maximum allowable station ERP is dependent upon the station's antenna HAAT and required service area and will be authorized in accordance with table 1. Applicants requesting an ERP in excess of that listed in table 1 must submit an engineering analysis based upon generally accepted engineering practices and standards that includes coverage contours to demonstrate that the requested station parameters will not produce coverage in excess of that which the applicant requires.

(2) Applications for stations where special circumstances exist that make it necessary to deviate from the ERP and antenna heights in Table 1 will be submitted to the frequency coordinator accompanied by a technical analysis, based upon generally accepted engineering practices and standards, that demonstrates that the requested station parameters will not produce a signal strength in excess of 37 dBu at any point along the edge of the requested service area. The coordinator may then recommend any ERP appropriate to meet this condition.

(3) An applicant for a station with a service area radius greater than 40 km (25 mi) must justify the requested service area radius, which will be authorized only in accordance with table 1, note 4. For base stations with service areas greater than 80 km, all operations 80 km or less from the base station will be on a primary basis and all operations outside of 80 km from the base station will be on a secondary basis and

will be entitled to no protection from primary operations.

Table 1—150-174MHz—Maximum ERP/Reference HAAT for a Specific Service Area Radius

	Service area radius (km)									
	3	8	13	16	24	32	40	48	64	80
Maximum ERP (w)	1	28	178	500	500	500	500	500	500	500
Up to reference HAAT (m)	15	15	15	15	33	65	110	160	380	670

(h) 450-470 MHz.

(1) The maximum allowable station effective radiated power (ERP) is dependent upon the station's antenna HAAT and required service area and will be authorized in accordance with table 2. Applicants requesting an ERP in excess of that listed in table 2 must submit an engineering analysis based upon generally accepted engineering practices and standards that includes coverage contours to demonstrate that the requested station parameters will not produce coverage in excess of that which the applicant requires.

(2) Applications for stations where special circumstances exist that make it necessary to deviate from the ERP and antenna heights in Table 2 will be submitted to the frequency coordinator accompanied by a technical analysis, based upon generally accepted engineering practices and standards, that demonstrates that the requested station parameters will not produce a signal strength in excess of 39 dBu at any point along the edge of the requested service area. The coordinator may then recommend any ERP appropriate to meet this condition.

(3) An applicant for a station with a service area radius greater than 32 km (20 mi) must justify the requested service area radius, which may be authorized only in accordance with table 2, note 4. For base stations with service areas greater than 80 km, all operations 80 km or less from the base station will be on a primary basis and all operations outside of 80 km from the base station will be on a secondary basis and will be entitled to no protection from primary operations.

Table 2—450-470 MHz—Maximum ERP/Reference HAAT for a Specific Service Area Radius

	Service area radius (km)									
	3	8	13	16	24	32	40	48	64	80
Maximum ERP (w)	2	100	500	500	500	500	500	500	500	500
Up to reference HAAT (m)	15	15	15	27	63	125	250	410	950	2700

§ 90.219 Use of signal boosters.

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

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

§ 90.279 Power limitations applicable to the 421-430 MHz band.

(a) Base station authorizations in the 421-430 MHz band will be subject to Effective Radiated Power (ERP) and Effective Antenna Height (EAH) limitations as shown in the table below. ERP is defined as the product of the power supplied to the antenna and its gain relative to a half-wave dipole in a given direction. EAH is calculated by subtracting the Assumed Average Terrain Elevation (AATE) as listed in table 7 of § 90.619 from the antenna height above mean sea level.

Limits of Effective Radiated Power (ERP) Corresponding to Effective Antenna Heights (EAH) of Base Stations in the 421-430 MHz Band

Effective antenna height (EAH) in meters (feet)	Maximum effective radiated power (ERP) (watts)
0-152 (0-500)	250
Above 152-305 (above 500-1000)	150
Above 305-457 (above 1000-1500)	75
Above 457-610 (above 1500-2000)	40
Above 610-762 (above 2000-2500)	20
Above 762-914 (above 2500-3000)	15
Above 914-1219 (above 3000-4000)	10
Above 1219 (above 4000)	5

(b) The maximum transmitter power output that will be authorized for control stations is 20 watts.

Test Procedures:

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

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

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

b) Configure to generate the CW test signal.

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

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

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

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

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

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

i) Omit

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

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

a) Set the span to at least 1 MHz.

b) Set the RBW 100 kHz.

c) Set the VBW to ≥ 3 × RBW.

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

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

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

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

4.5.5 Calculating amplifier, repeater, or industrial booster gain

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

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

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

Test Results:

Tabular data of Input / Output Power and Gain

Test Band	Link	f_0 Frequency (MHz)	Input Power (dBm)	Output Power (dBm)	Gain (dB)
VHF	Downlink	151.80	-14.771	23.876	38.65
UHF		409.28	-14.314	23.942	38.26

4.6. NOISE FIGURE

Test Requirements:

§ 90.219 Use of signal boosters.

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

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

Test Procedures:

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

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

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

F_{sys} = System Noise Factor

N_0 = Output Noise Power

k = Boltzmann's Constant

T_0 = Standard Noise Temperature (290K)

B = Noise Bandwidth

G = Gain

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

'Gain' *v*alue can be obtained from the test performed previously.

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

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

b) Turn off the AGC function in EUT.

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

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

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

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

Noise Figure = Noise Output Power - kT0B - Gain

Test Results:

Test Band	Link	Input Power (dBm)	Output Power (dBm)	Gain (dB)	kT_0B (dBm/MHz)	Measured Value (dBm)	Noise Figure (dB)
VHF	Downlink	-13.5	24.0	37.5	-114	-69.920	6.58
UHF		-8.5	24.0	32.5	-114	-72.738	8.76

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

4.7. 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.

Test Procedures:

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

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

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

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

a) Connect a signal generator to the input of the EUT.
   If the signal generator is not capable of producing two independent modulated carriers simultaneously, then two discrete signal generators can be connected, with an appropriate combining network to support the two-signal test.
b) Configure the two signal generators to produce CW on frequencies spaced consistent with f_0, with amplitude levels set to just below the AGC threshold.
c) Connect a spectrum analyzer to the EUT output.
d) Set the span to 100 kHz.
e) Set RBW = 300 Hz with VBW ≥ 3 × RBW.
f) Set the detector to power averaging (rms).
g) Place a marker on highest intermodulation product amplitude.
h) Capture the plot for inclusion in the test report.
i) Repeat steps c) to h) with the composite input power level set to 3 dB above the AGC threshold.
j) Repeat steps b) to i) for all operational bands.

4.7.3 EUT spurious emissions conducted measurements

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

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

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

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

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

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

g) Set the VBW = 3 × RBW.

h) Set the Sweep time = auto-couple.

i) Set the detector to PEAK.

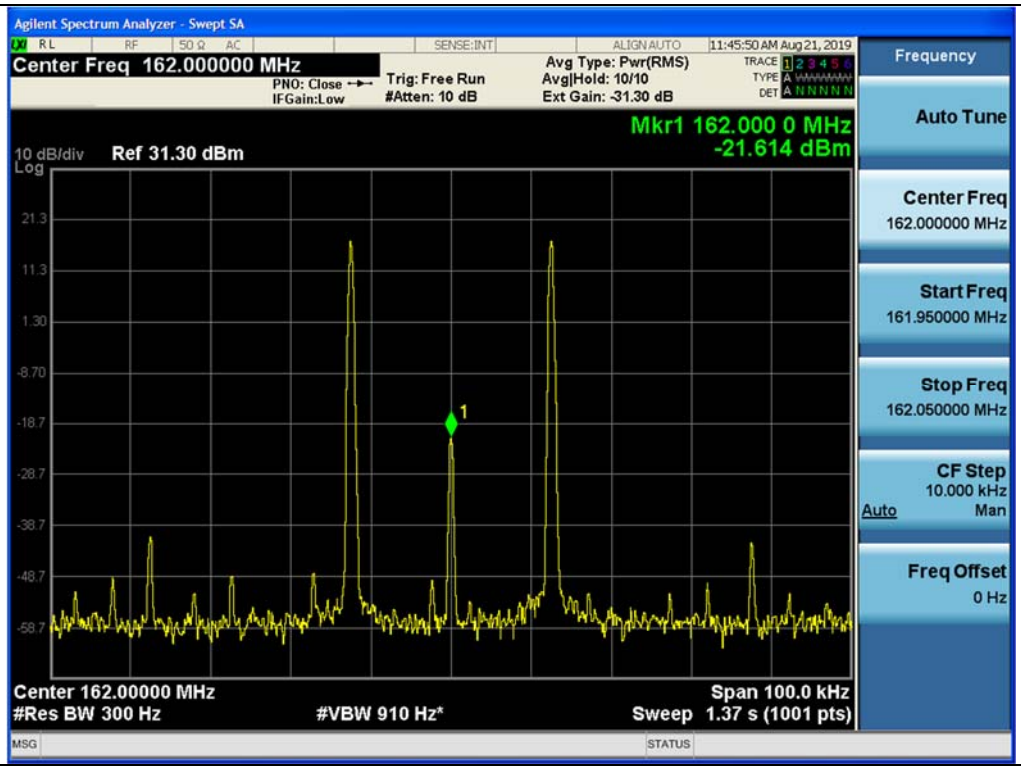
j) Set the spectrum analyzer start frequency to 30 MHz (or the lowest radio frequency signal generated in the EUT, without going below 9 kHz if the EUT has additional internal clock frequencies), and the stop frequency to 10 times the highest allowable frequency of the EUT passband.

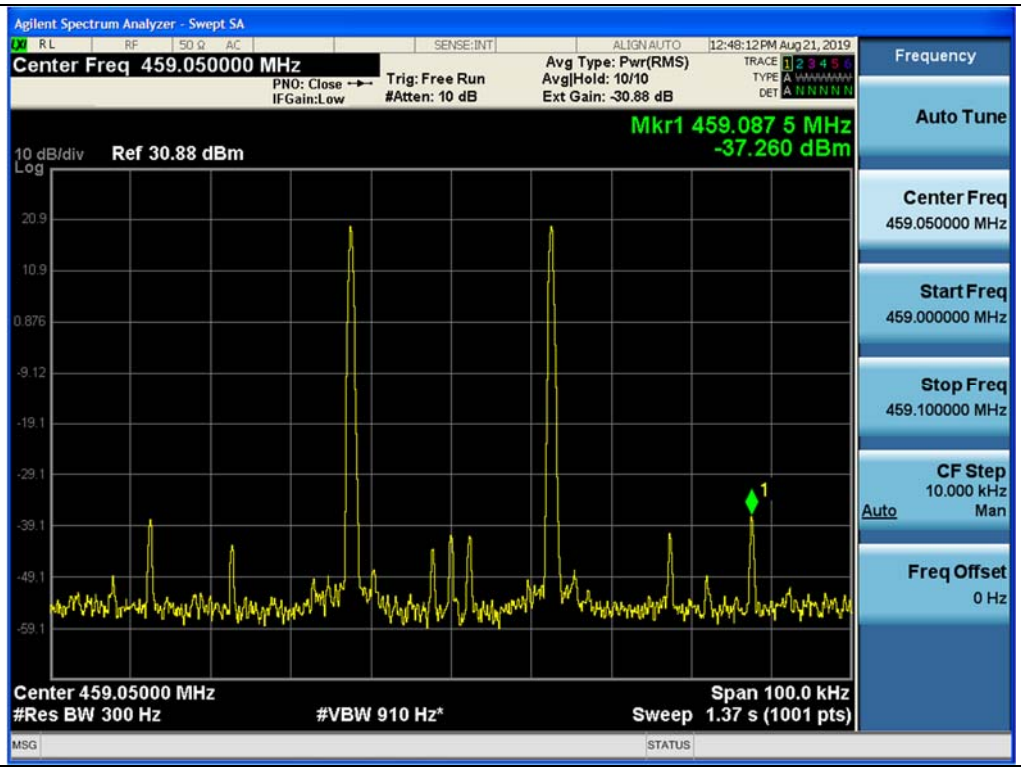
k) Select MAX HOLD, and use the marker peak function to find the highest emission(s) outside the passband. (This could be either at a frequency lesser or greater than the passband frequencies.)

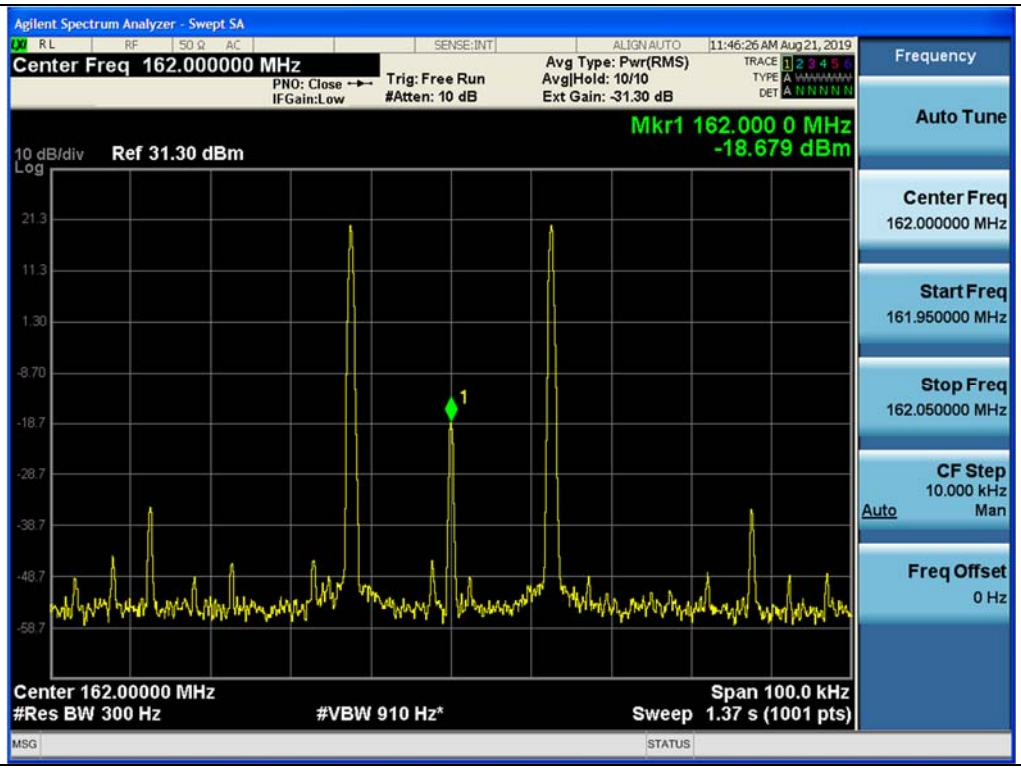
l) Capture a plot for inclusion in the test report.

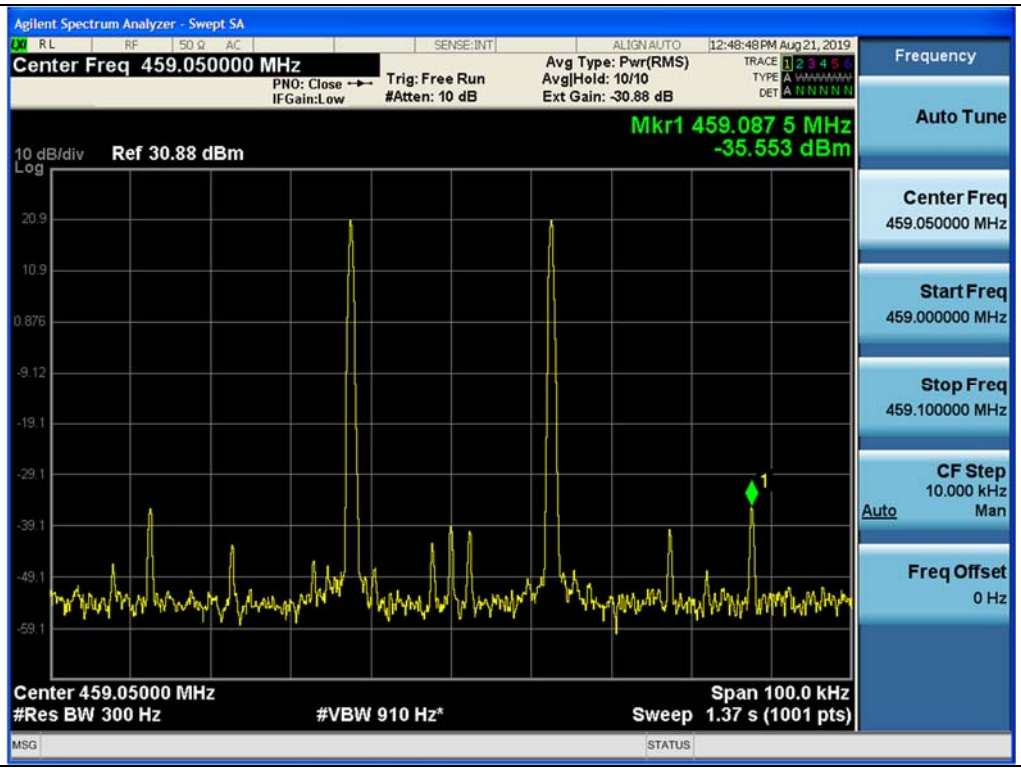
m) Repeat steps c) to l) for each authorized frequency band/block of operation.

Plot data of Out-of-band/out-of-block emissions

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


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


+3 dB above Out-of-band (two adjacent test signals) / VHF / Downlink


+3 dB above Out-of-band (two adjacent test signals) / UHF / Downlink


Plot data of Spurious Emissions

Spurious / VHF / Downlink


Spurious / UHF / Downlink


4.8. RADIATED SPURIOUS EMISSIONS

Test Requirements:

§ 2.1053 Measurements required: Field strength of spurious radiation.

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

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

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

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

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

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

Test Procedures:

Because KDB 935210 D05 procedure does not provide this requirement, measurements were in accordance with the test methods section 5.5 of ANSI C63.26-2015

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

b) Each emission under consideration shall be evaluated:

1) Raise and lower the measurement antenna in accordance 5.5.2, as necessary to enable detection of the maximum emission amplitude relative to measurement antenna height.

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

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

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

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

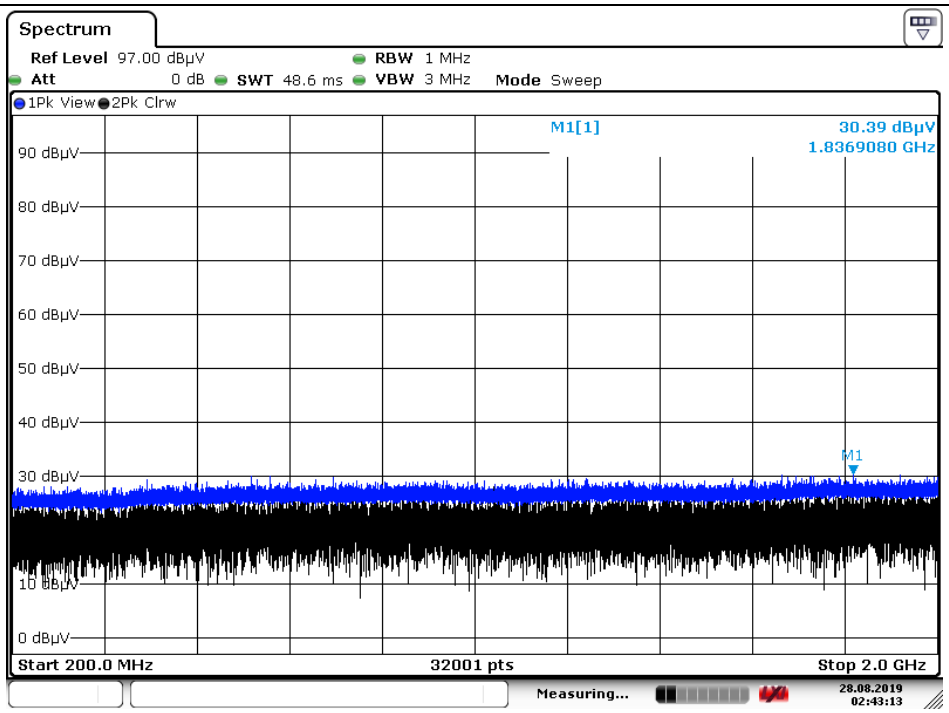
c) Repeat step b) for each emission frequency with the measurement antenna oriented in both the horizontal and vertical polarizations to determine the orientation that gives the maximum emissions amplitude.

Notes:

1. We have done horizontal and vertical polarization in detecting antenna.

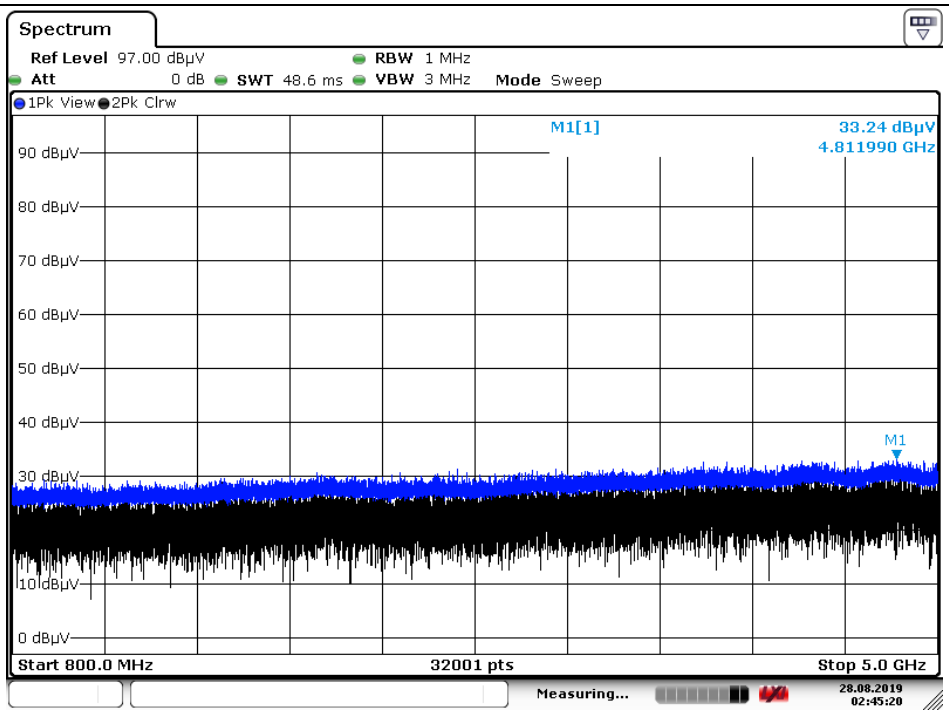
Plot data of radiated spurious emissions

Radiated Spurious Emission / VHF / Downlink



Date: 28.AUG.2019 02:43:13

Radiated Spurious Emission / UHF / Downlink



Date: 28.AUG.2019 02:45:20

Note : Only the worst case plots for Radiated Spurious Emissions.

5. Annex A_EUT AND TEST SETUP PHOTO

Please refer to test setup photo file no. as follows;

No.	Description
1	HCT-RF-1909-FC005-P