



## Class 2 Permissive Change Report

<b>APPLICANT</b>	FIPLEX COMMUNICATIONS INC.
<b>ADDRESS</b>	2101 NW 79th Ave. MIAMI FL 33122 USA
<b>FCC ID</b>	P3TDH7SX
<b>MODEL NUMBER</b>	DH7SX
<b>PRODUCT DESCRIPTION</b>	700/800 MHZ DUAL BAND INDUSTRIAL BOOSTER
<b>DATE SAMPLE RECEIVED</b>	06/17/2019
<b>FINAL TEST DATE</b>	06/26/2019
<b>TESTED BY</b>	Franklin Rose
<b>APPROVED BY</b>	Tim Royer
<b>TEST RESULTS</b>	<input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL

Report Number	Report Version	Description	Issue Date
1537UT19_C2PC TestReport_	Rev1	Initial Issue	06/26/2019

**THE ATTACHED REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL WITHOUT THE WRITTEN APPROVAL OF TIMCO ENGINEERING, INC.**

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## GENERAL REMARKS

### Summary

The device under test does:

- ☒ Fulfill the general approval requirements as identified in this test report and was selected by the customer.
- ☐ Not fulfill the general approval requirements as identified in this test report

### Attestations

This equipment has been tested in accordance with the standards identified in this test report. To the best of my knowledge and belief, these tests were performed using the measurement procedures described in this report.

All instrumentation and accessories used to test products for compliance to the indicated standards are calibrated regularly in accordance with ISO 17025 requirements.

I attest that the necessary measurements were made at:

**Timco Engineering Inc.**  
**849 NW State Road 45**  
**Newberry, FL 32669**  
**Designation #: US1070**

**Tested by:**



<b>Name and Title</b>	Franklin Rose, Project Manager / EMC Specialist
<b>Date</b>	06/26/2019

**Reviewed and Approved by:**



<b>Name and Title</b>	Tim Royer, Project Manager / EMC Engineer
<b>Date</b>	06/28/2019

## GENERAL INFORMATION

**EUT Definition:** FCC 90.219(a)

*Signal booster.* A device or system that automatically receives, amplifies, and retransmits signals from wireless stations into and out of building interiors, tunnels, shielded outdoor areas and other locations where these signals would otherwise be too weak for reliable communications. Signal booster systems may contain both Class A and Class B signal boosters as components.

### EUT Technical Specifications:

<b>EUT Description</b>	700/800 MHZ DUAL BAND INDUSTRIAL BOOSTER		
<b>EUT Details</b>	Single Cabinet Bi-Directional Dual Band (700/800) Class A Signal Booster for Public Safety and Public Safety LTE Operations		
<b>FCC ID</b>	P3TDH7SX		
<b>Model Number</b>	DH7SX		
<b>Operating Frequency</b>	700 Band, Uplink: 788 – 805 MHz 700 Band, Downlink: 758 – 775 MHz 800 Band, Downlink: 851 – 869 MHz 800 Band, Uplink: 806 – 824 MHz		
<b>EUT Power Source</b>	<input checked="" type="checkbox"/> 110–120Vac, 50– 60Hz	<input type="checkbox"/> DC Power	<input type="checkbox"/> Battery Operated
<b>Test Item</b>	<input type="checkbox"/> Engineering Prototype	<input checked="" type="checkbox"/> Pre-Production	<input type="checkbox"/> Production
<b>Type of Equipment</b>	<input checked="" type="checkbox"/> Fixed	<input type="checkbox"/> Mobile	<input type="checkbox"/> Portable
<b>Antenna Connector</b>	3 external N Type		
<b>Test Conditions</b>	The temperature was 26°C Relative humidity of 50%.		
<b>Modification to the EUT</b>	The EUT has been fitted with a new input LNA. This is the subject of this C2PC application.		
<b>Test Exercise</b>	The EUT was operated in accordance with the service manual using software supplied by the manufacturer.		
<b>Applicable Standards</b>	TIA 603-E:2016, ANSI C63.26, FCC CFR 47 Part 2, Part 90, KDB 935210 D05 v01r02, section 4		
<b>Test Facility</b>	Timco Engineering Inc. at 849 NW State Road 45 Newberry, FL 32669 USA. Designation #: US1070		

## **TECHNICAL JUSTIFICATION**

### **The Change to the EUT**

The EUT has been outfitted with a new LNA component at the Uplink input of the device. After performing an engineering assessment, we find that this will directly affect the following tests:

1. Uplink Automatic Gain Control Level
2. Uplink Noise Figure
3. Uplink Noise Inside and Outside the Passband
4. Uplink Intermodulation

And this change will indirectly affect the following tests, primarily due to changes in the AGC level:

1. Uplink Out of Band Rejection
2. Uplink Input vs. Output Comparison
3. Uplink Adjacent Channel Power (700 Band only)
4. Uplink Spurious Conducted Emissions

### **The Scope of Testing**

This change has no bearing on the downlink, and the downlink will receive no re-testing.

We will perform full measurements of the primarily affected testing and include all results within this test report.

We will perform spot-checks of the secondarily affected testing, and include the pertinent results here to assess RF characteristics of the equipment, and to demonstrate any changes which may have occurred in the functioning of this EUT.

## SUMMARY OF RESULTS

Applied Rule Part(s)	Test	Result
KDB 935210 s.4, FCC Pt. 90.531(a)	Test Frequencies	For Reporting Only
KDB 935210 s.4.1	Input Signals	For Reporting Only
KDB 935210 s.4.2	AGC Threshold	For Reporting Only
KDB 935210 s.4.3, FCC Pt. 90.219(a), FCC Pt. 90.219(d)(7)	Out-of-Band Rejection	<b>CLASS A DEVICE</b>
KDB 935210 s.4.4, FCC Pt. 2.1049(c), FCC Pt. 90.219(e)(4)(ii), FCC Pt. 90.210(c)	Input vs. Output Signal Comparison	<b>PASS</b>
KDB 935210 s.4.4, FCC Pt. 90.543(a),(c),(e)	Adjacent Channel Power	<b>PASS</b>
KDB 935210 s.4.5, FCC Pt. 90.219(e)(1), FCC Pt. 90.219(e)(4)(iii)	RF Power Output (and Gain)	<b>PASS</b>
FCC Pt. 2.1033(c)(8)	Power Input to the Final Power Amplifier	For Reporting Only
KDB 935210 s.4.6, FCC Pt. 90.219(e)(2)	Noise Figure	<b>PASS</b>
FCC Pt. 90.219(d)(6)(ii), FCC Pt. 90.219(d)(6)(iii)	Passband Noise	For Reporting Only
KDB 935210 s.4.7.2 FCC Part 2.1051(a), FCC Pt. 90.219(d)(6)(i), FCC Pt. 90.219(e)(3)	Intermodulation Spurious Emissions	<b>PASS</b>
KDB 935210 s.4.7.3, FCC Part 2.1051(a), FCC Pt. 90.219(e)(3)	Spurious Emissions at Antenna Terminals	<b>PASS</b>

## EMISSION DESIGNATION

**Rule Part No.:** FCC Part 2.202(g)

**Note:** All signals used here are representative of the type of signals which will be passed through this EUT, as outlined in KDB 935210 s.4.1.

### Analog Signals

Emission Designator	Description	Modulation Type	M (modulation Freq., kHz)	R (rate, baud)	D (deviation, kHz)	K (numeric constant)	S (symbols)	Bandwidth Calculation	Necessary Bandwidth
4K00F3E	Narrowband Analog FM Voice	FM	1.0	-	1.0	1.0	-	$B_n = 2M + 2DK$	4.00
11K2F3E	Narrowband Analog FM Voice	FM	3.0	-	2.5	1.0	-		11.00
16K0F3E	Wideband Analog FM Voice	FM	3.0	-	5.0	1.0	-		16.00

### Digital Signals

Emission Designator	Description	Modulation Type	M (modulation Freq., kHz)	R (rate, baud)	D (deviation, kHz)	K (numeric constant)	S (symbols)	Bandwidth Calculation	B <sub>n</sub> (necessary bandwidth, kHz)
4K00F1E	Narrow NXDN Voice	4FSK	-	4800	1.55	0.516	4	$B_n = (R/\log_2 S) + 2DK$	4.00
4K00F1D	Narrow NXDN Data	4FSK	-	4800	1.55	0.516	4		4.00
4K00F1W	Narrow NXDN Voice/Data	4FSK	-	4800	1.55	0.516	4		4.00
8K30F1E	Wide NXDN Voice	4FSK	-	4800	3	0.984	4		8.30
8K30F1D	Wide NXDN Data	4FSK	-	4800	3	0.984	4		8.30
8K30F1W	Wide NXDN Voice & Data	4FSK	-	4800	3	0.984	4		8.30
4K00F2D	Narrow NXDN CW ID	4FSK	0.8	4800	1.2	1.0	4	$B_n = 2M + 2DK$	4.00
8K30F2D	Wide NXDN CW ID	4FSK	1.15	4800	3	1	4		8.30
7K60FXE	DMR Voice	4FSK	-	9600	1.8	0.778	4	$B_n = (R/\log_2 S) + 2DK$	7.60
7K60FXD	DMR Data	4FSK	-	9600	1.8	0.778	4		7.60
8K10F1E	P25 Phase I C4FM Voice	4FSK	-	9600	1.8	0.916	4	$B_n = (R/\log_2 S) + 2DK$	8.10
8K10F1D	P25 Phase I C4FM Data	4FSK	-	9600	1.8	0.916	4		8.10
8K10F1W	P25 Phase II H-CPM Voice/Data	4FSK	-	9600	1.8	0.916	4		8.10
9K80F1E	P25 Phase II H-DQPSK Voice	QPSK	-	12000	-	0.817	4	$B_n = 2RK/\log_2 S$	9.80
9K80F1D	P25 Phase II H-DQPSK Data	QPSK	-	12000	-	0.817	4		9.80
5M00G7D	Public Safety LTE	8PSK	-	5000	-	1	4		5000.00
10M0G7D	Public Safety LTE	8PSK	-	10000	-	1	4		10000.00
5M00D7W	Public Safety LTE	QAM	-	5000	-	-	4	$B_n = 2R/\log_2 S$	5000.00
10M0D7W	Public Safety LTE	QAM	-	10000	-	-	4		10000.00
5M00W7D	Public Safety LTE	OFDM	-	-	-	16	-	$B_n = 312.5 * K$	5000.00
10M0W7D	Public Safety LTE	OFDM	-	-	-	32	-	$B_n = 312.5 * K$	10000.00
5M00F9W	Public Safety LTE	QPSK	-	5000	-	1	4	$B_n = 2RK/\log_2 S$	5000.00
10M0F9W	Public Safety LTE	QPSK	-	10000	-	1	4		10000.00

## TEST FREQUENCIES

**Rule Part No.:** KDB 935210 s.4

All tests specified in KDB 935210 D05, Section 4 are intended for each band/block of operation. The bands/blocks of operation of this EUT are as follows:

**EUT Operational Band(s):** KDB 935210 D02, Appendix D, Table D.3

**Table D.3 – Various Part 90 PLMRS band allocations, rule parts/sections, and service types for Section 90.219 purposes (for info only – see rules for details, also KDB Publication 634817 [R14])**

F <sub>L</sub> (MHz)	–	F <sub>H</sub> (MHz)	Rule(s)	Misc. Notes
758	–	768	90-R, Public Safety (PS) Broadband (FirstNet)	B9B (LTE)
768	–	769	PS Guardband	
769	–	775	PS Narrowband	
788	–	798	90-R, Public Safety (PS) Broadband (FirstNet)	B9B (LTE)
798	–	799	PS Guardband	
799	–	805	PS Narrowband	
806	–	809	90 NPSPAC (PS) [90.617(a)(1)]	B9B/B9A
809	–	815	90 Interleaved PS; B/ILT; SMR [90.614(a); 90.613 ch. nos. 1-470] <sup>a</sup>	B9B/B9A
815	–	816	90 Expansion B/ILT; SMR [90.614(a); 90.613 ch. nos. 470-550] <sup>a</sup>	B9B/B9A
816	–	817	90 Guardband	B9B/B9A
817	–	824	CMRS 90 ESMR [90.614(b); 90.613 ch. nos. 551-830]	B2I 90-S
851	–	854	90 NPSPAC (PS) [90.617(a)(1)]	B9B/B9A
854	–	860	90 Interleaved PS; B/ILT; SMR [90.614(a); 90.613 ch. nos. 1-470] <sup>a</sup>	B9B/B9A
860	–	861	90 Expansion B/ILT; SMR [90.614(a); 90.613 ch. nos. 470-550] <sup>a</sup>	B9B/B9A
861	–	862	90 Guardband	B9B/B9A
862	–	869	CMRS 90 ESMR [90.614(b); 90.613 ch. nos. 551-830]	B2I 90-S

**Frequencies for Testing:** FCC Pt. 90.531(a)

This section sets forth the band plan for the 758-775 MHz and 788-805 MHz public safety bands.

(a) *Base and mobile use.* The 763-775 MHz band may be used for base, mobile or fixed (repeater) transmissions. The 793-805 MHz band may be used only for mobile or fixed (control) transmissions.

The EUT will utilize the bands:

Operation	Band	Test Frequencies	Notes
<b>700 Band, Uplink</b>			
Public Safety LTE	788 – 798 MHz	788.03125 MHz 797.96875 MHz	
PLMRS/PSRS	793 – 805 MHz	793.00000 MHz 804.96875 MHz	excludes operation in the 798 – 799 MHz Guardband
<b>800 Band, Uplink</b>			
PLMRS/PSRS	806 – 824 MHz	806.03125 MHz 816.96875 MHz 823.96875 MHz	



## INPUT SIGNALS

**Rule Part No.:** KDB 935210 s.4.1

The procedures in this clause are specific to EUTs intended for operating in the Private Land Mobile Radio Services (PLMRS) and Public Safety Radio Services (PSRS)<sup>5</sup>, which are governed under the provisions and requirements of the Part 90 rules (i.e., Section 90.219 applies).

Table 1 depicts signal types associated with PLMRS operations, which are to be considered as test signals to be used in performing compliance testing on PLMRS amplifiers, repeaters, and industrial boosters. Not all of the procedures in this clause will require using each of the signals listed in Table 1, because for many EUTs a CW tone can adequately model the narrowband signals typically encountered within these services. For EUTs supporting digitally modulated signals, the intended operating signal types should be tested (e.g., P25 Phase 1, P25 Phase 2, TETRA, etc.), especially for PSRS devices. Devices intended for use in 700 MHz Public Safety Broadband spectrum shall be tested using a representative band-limited AWGN signal (99 % OBW of 4.1 MHz) or the applicable signal type (e.g., LTE).

**Table 1—Test signals for PLMRS devices**

<b>Emission Designator</b>	<b>Modulation</b>	<b>Occupied Bandwidth</b>	<b>Channel Bandwidth</b>	<b>Audio Frequency</b>
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

## Input Signals

### 4K00F3E (Narrowband Analog FM Voice)

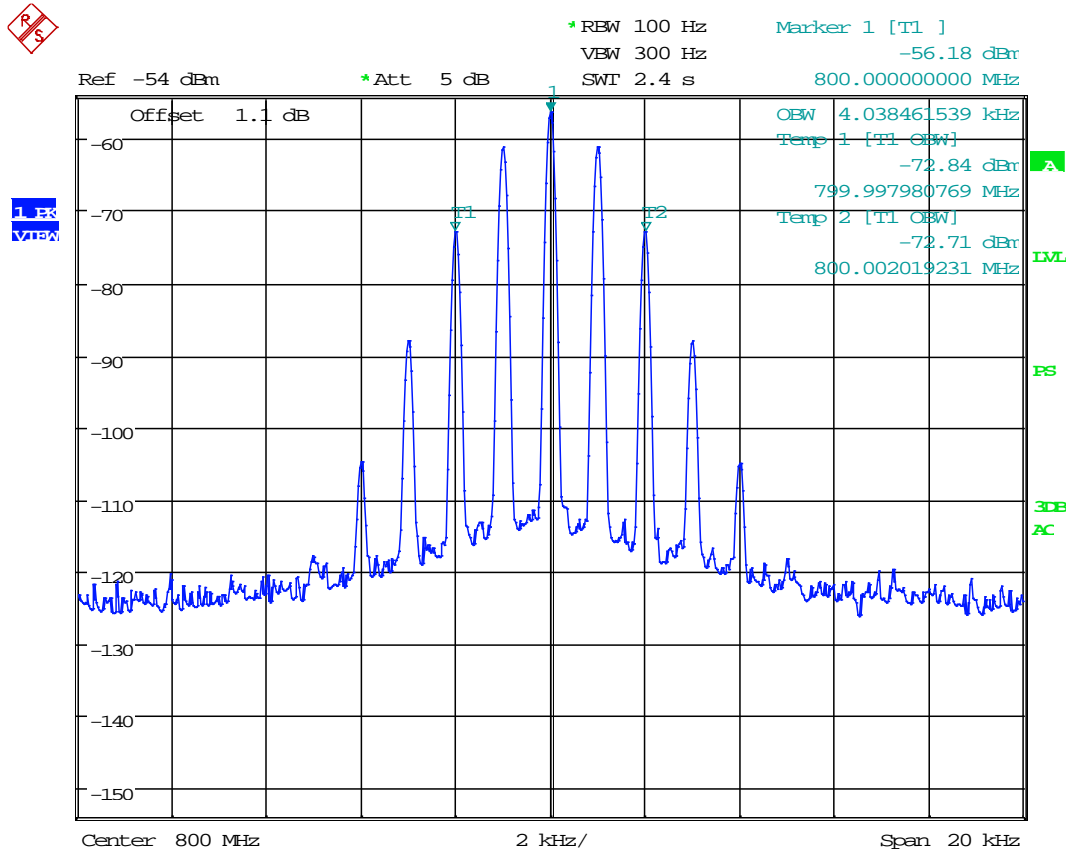
#### Substituted for signals:

4K00F1E (Narrow NXDN Voice)

4K00F1D (Narrow NXDN Data)

4K00F1W (Narrow NXDN Voice & Data)

4K00F2D (Narrow NXDN CW ID)

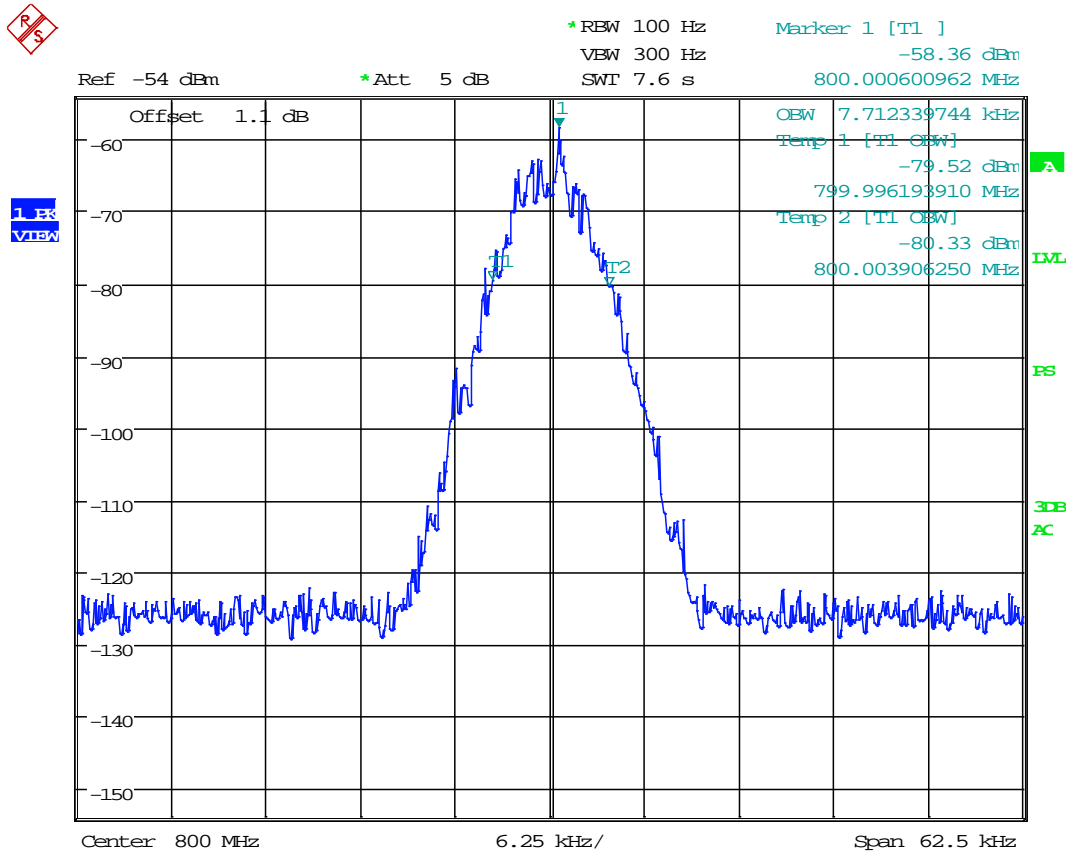


Date: 30.JAN.2019 13:10:11

**Occupied Bandwidth: 4.04 kHz**

## Input Signals

### 8K10F1E/F1D (P25 Phase I C4FM Voice, Data)

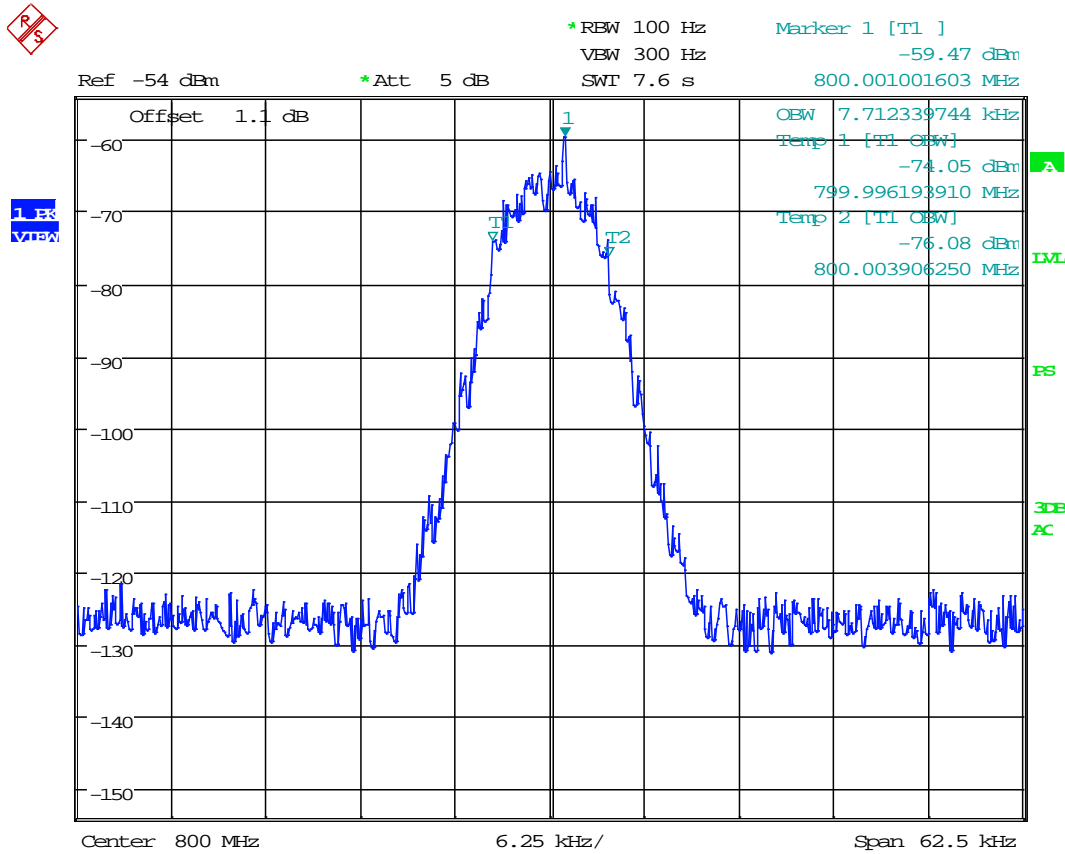


Date: 30.JAN.2019 14:28:58

**Occupied Bandwidth: 7.71 kHz**

## Input Signals

### 8K10F1W (P25 Phase II H-CPM Voice & Data)

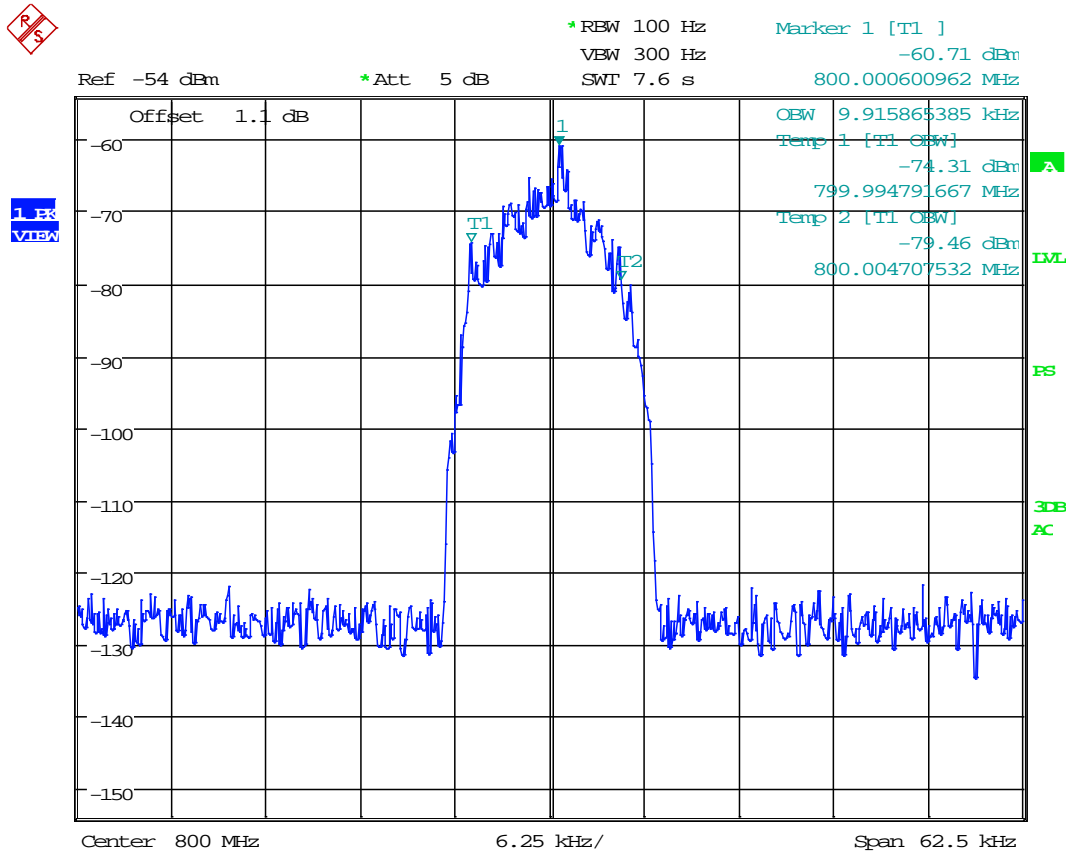


Date: 30.JAN.2019 14:30:47

**Occupied Bandwidth: 7.71 kHz**

## Input Signals

### 9K80F1E/F1D (P25 Phase II H-DQPSK Voice, Data)



Date: 30.JAN.2019 14:32:35

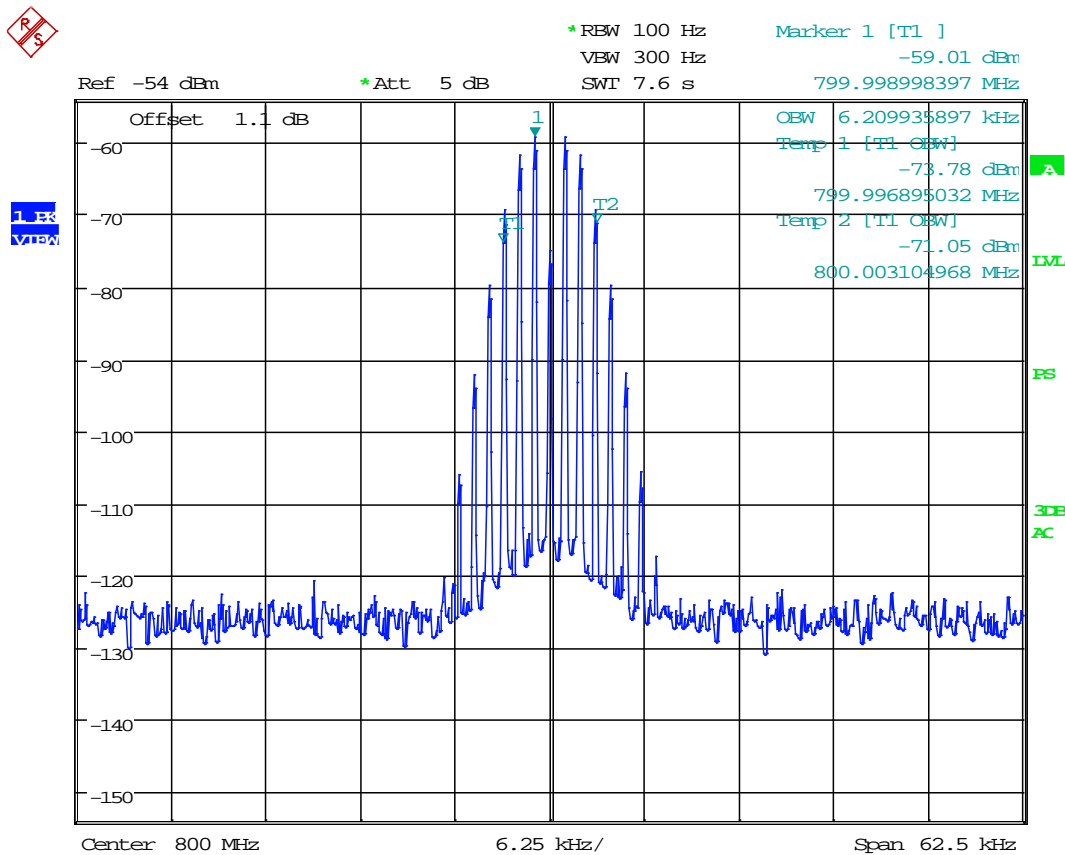
**Occupied Bandwidth: 9.92 kHz**

## Input Signals

### 11K3F3E (Narrowband Analog FM Voice)

#### Substituted for signals:

7K60FXE (2-Slot DMR TDMA Voice)  
 7K60FXD (2-Slot DMR TDMA Data)  
 8K30F1E (Wide NXDN Voice)  
 8K30F1D (Wide NXDN Data)  
 8K30F1W (Wide NXDN Voice & Data)  
 8K30F2D (Wide NXDN CW ID)

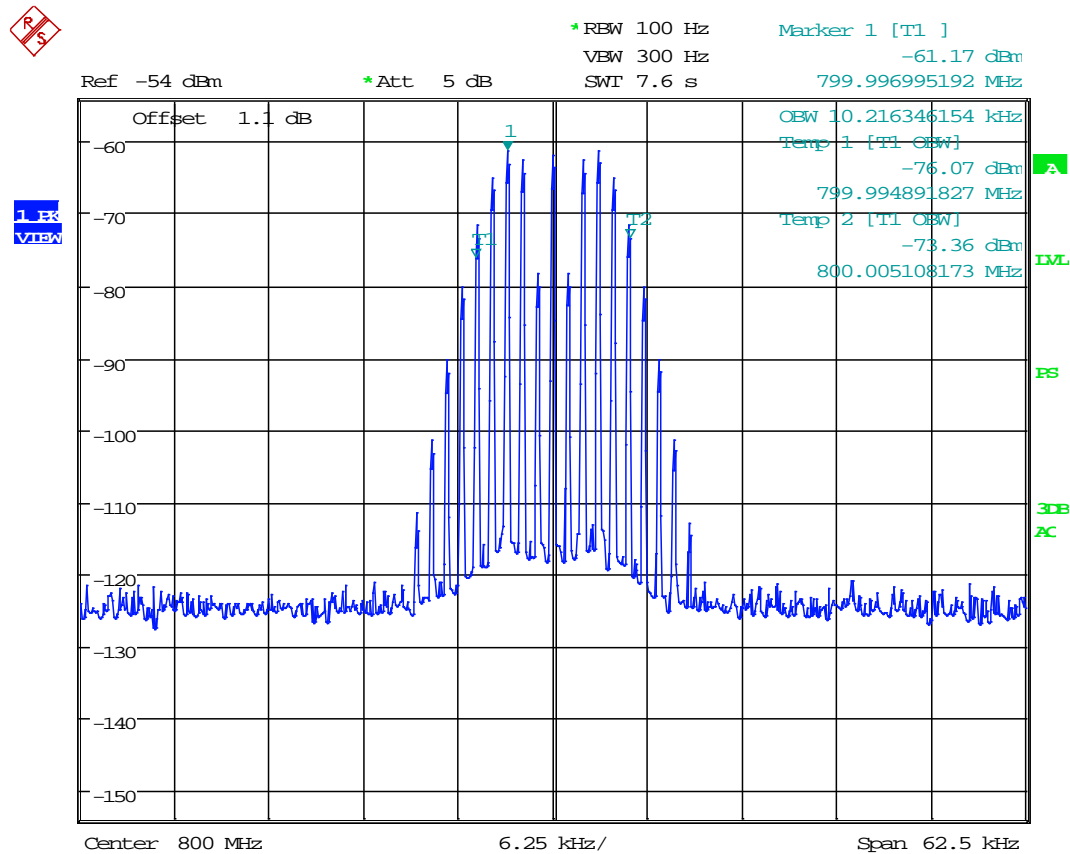


Date: 30.JAN.2019 14:19:45

**Occupied Bandwidth: 6.21 kHz**

## Input Signals

### 16K0F3E (Wideband Analog FM Voice)



Date: 30.JAN.2019 14:23:14

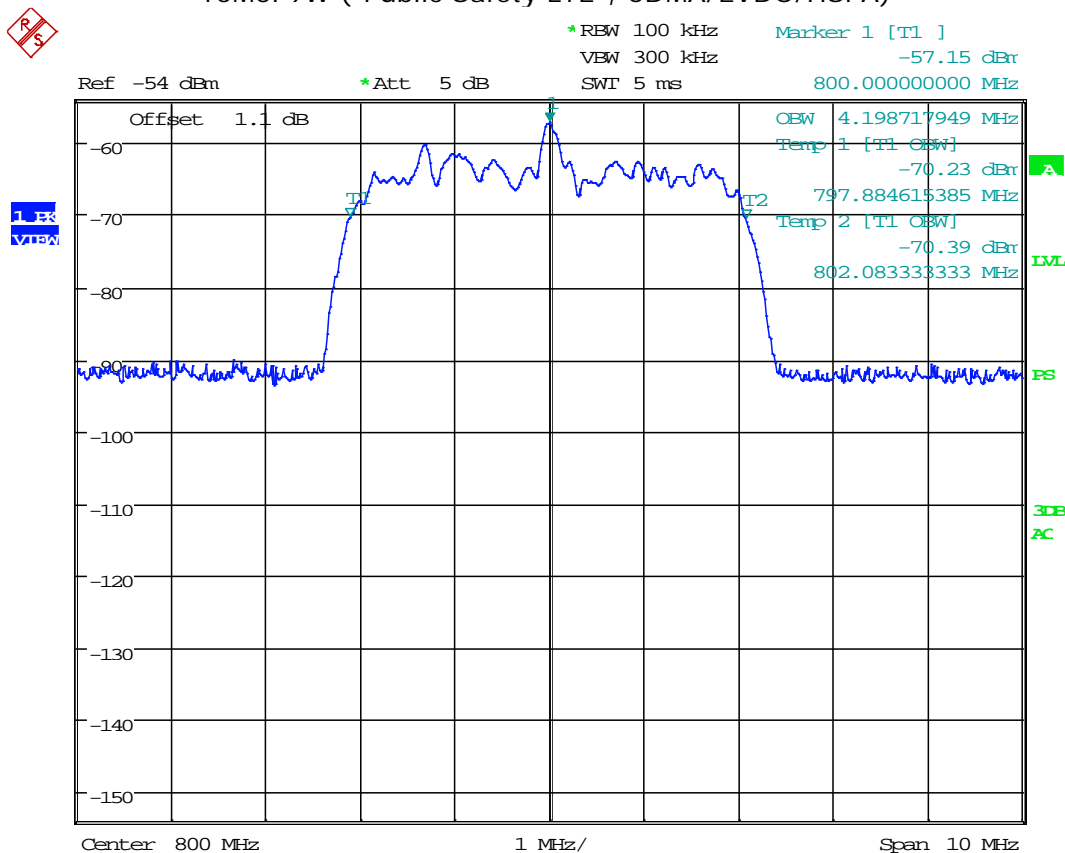
Occupied Bandwidth: 10.22 kHz

## Input Signals

### AWGN Signal ("4.1 MHz" Bandwidth-Limited Additive Gaussian White Noise)

#### Substituted for signals:

5M00G7D ("Public Safety LTE", GSM/EDGE)  
 5M00D7W ("Public Safety LTE", QAM)  
 5M00W7D ("Public Safety LTE", OFDM)  
 5M00F9W ("Public Safety LTE", CDMA/EVDO/HSPA)  
 10M0G7D ("Public Safety LTE", GSM/EDGE)  
 10M0D7W ("Public Safety LTE", QAM)  
 10M0W7D ("Public Safety LTE", OFDM)  
 10M0F9W ("Public Safety LTE", CDMA/EVDO/HSPA)



Date: 30.JAN.2019 14:36:46

### Occupied Bandwidth: 4.20 MHz



## AGC THRESHOLD

**Rule Part No.:** KDB 935210 s.4.2

### Requirements:

Testing at and above the AGC threshold will be required.<sup>6</sup> 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.

<sup>6</sup> See footnote 1 about the terms and concepts AGC, ALC, OLC.

**Test Procedure:** KDB 935210 s.3.2

The AGC threshold is to be determined as follows.<sup>3</sup>

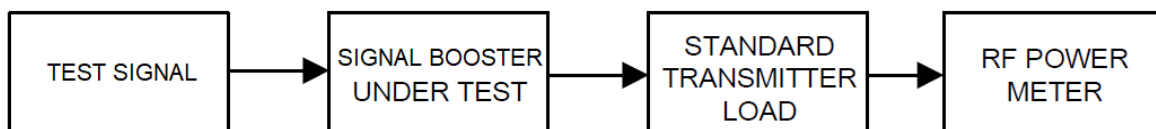
In the case of fiber-optic distribution systems, the RF input port of the equipment under test (EUT) refers to the RF input of the supporting equipment RF to optical convertor; see also descriptions and diagrams for typical DAS booster systems in KDB Publication 935210 D02 [R7].

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 (i.e., broadband or narrowband).
- 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 3.5.3 or 3.5.4, 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.

<sup>3</sup> Consistent with for example TIA-156 [R10], for compliance testing purposes the terms automatic gain control (AGC), automatic level control (ALC), and output level control (OLC) are generally taken to be synonyms, which refer to a means by which gain or output power is electronically adjusted as a function of voltage or some other specified parameter(s).

**Test Setup Block Diagram:** KDB 935210 s.3.2



## AGC THRESHOLD

### Test Data: AGC Threshold Table

#### 700 Band, Uplink

	Gen Freq (MHz)	Gen Output (dBm)	Insertion Loss (dB)	Booster Input (dBm)	Booster Output (dBm)	Gain (dB)
AGC -3 dBm	797.96875	-59	-0.59	-59.59	20.91	80.50
	797.96875	-58	-0.59	-58.59	21.89	80.48
	797.96875	-57	-0.59	-57.59	22.88	80.47
AGC	797.96875	-56	-0.59	-56.59	23.80	80.39
	797.96875	-55	-0.59	-55.59	23.80	79.39
	797.96875	-54	-0.59	-54.59	23.80	78.39
AGC +3 dBm	797.96875	-53	-0.59	-53.59	23.69	77.28
Saturation	797.96875	0	-0.59	-0.59	23.80	24.39

#### 800 Band, Uplink

	Gen Freq (MHz)	Gen Output (dBm)	Insertion Loss (dB)	Booster Input (dBm)	Booster Output (dBm)	Booster Output (dBm)
AGC -3 dBm	816.96875	-59	-0.59	-59.59	22.39	81.98
	816.96875	-58	-0.59	-58.59	23.38	81.97
	816.96875	-57	-0.59	-57.59	24.38	81.97
AGC	816.96875	-56	-0.59	-56.59	24.92	81.51
	816.96875	-55	-0.59	-55.59	24.94	80.53
	816.96875	-54	-0.59	-54.59	24.88	79.47
AGC +3 dBm	816.96875	-53	-0.59	-53.59	24.88	78.47
Saturation	816.96875	0	-0.59	-0.59	24.96	25.55

## OUT OF BAND REJECTION

**Rule Part No.:** KDB 935210 s.4.3, FCC Pt. 90.219(a), FCC Pt. 90.219(d)(7)

(a) *Definitions.* The definitions in this paragraph apply only to the rules in this section.

*Class A signal booster.* A signal booster designed to retransmit signals on one or more specific channels. A signal booster is deemed to be a Class A signal booster if none of its passbands exceed 75 kHz.

*Class B signal booster.* A signal booster designed to retransmit any signals within a wide frequency band. A signal booster is deemed to be a Class B signal booster if it has a passband that exceeds 75 kHz.

### Requirements:

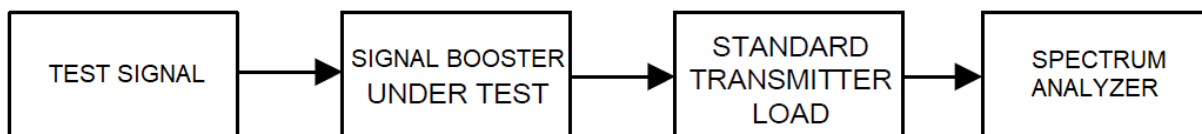
(7) Signal booster passbands are limited to the service band or bands for which the operator is authorized. In general, signal boosters should utilize the minimum passband that is sufficient to accomplish the purpose. Except for distributed antenna systems (DAS) installed in buildings, the passband of a Class B booster should not encompass both commercial services (such as ESMR and Cellular Radiotelephone) and part 90 Land Mobile and Public Safety Services.

**Test Procedure:** KDB 935210 s.4.3

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

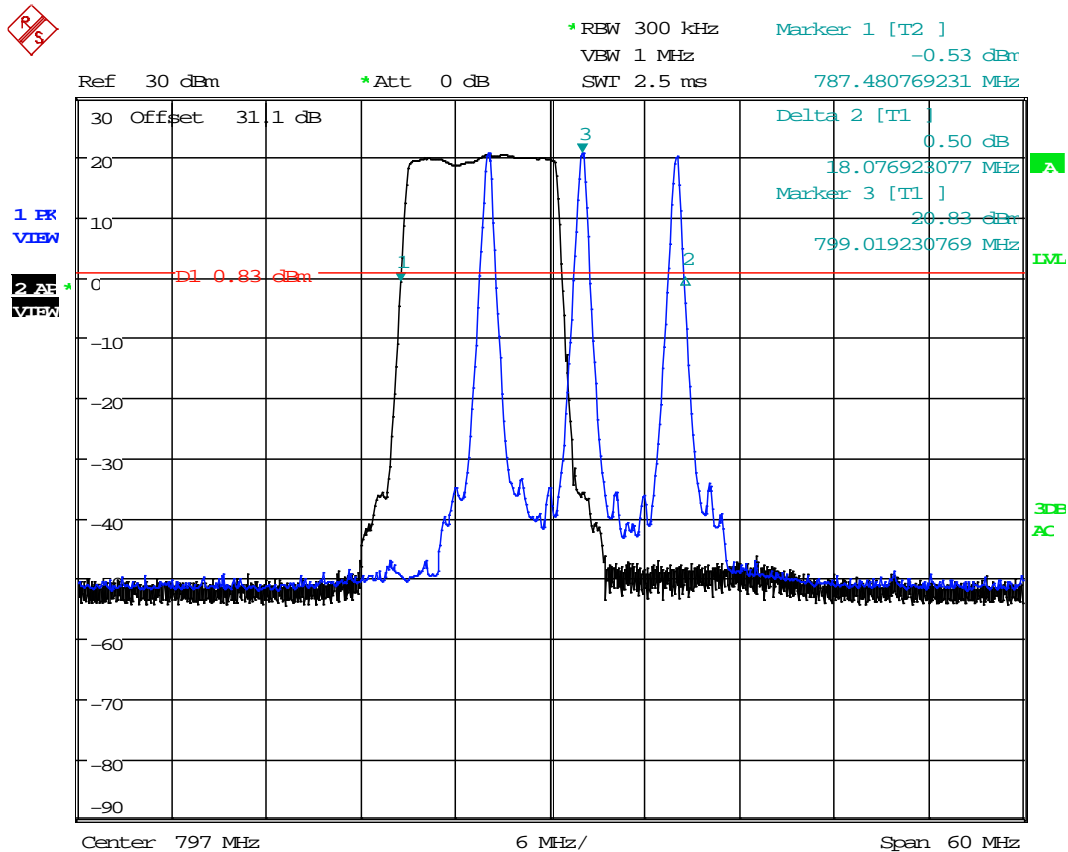
- a) Connect a signal generator to the input of the EUT.
- b) Configure a swept CW signal with the following parameters:
  - 1) Frequency range =  $\pm 250\%$  of the manufacturer's specified pass band.
  - 2) The CW amplitude shall be 3 dB below the AGC threshold (see 4.2), and shall not activate the AGC threshold throughout the test.
  - 3) Dwell time = approximately 10 ms.
  - 4) Frequency step = 50 kHz.
- c) Connect a spectrum analyzer to the output of the EUT using appropriate attenuation.
- d) Set the RBW of the spectrum analyzer to between 1 % and 5 % of the manufacturer's rated passband, and  $VBW = 3 \times RBW$ .
- e) Set the detector to Peak and the trace to Max-Hold.
- f) After the trace is completely filled, place a marker at the peak amplitude, which is designated as  $f_0$ , and with two additional markers (use the marker-delta method) at the 20 dB bandwidth (i.e., at the points where the level has fallen by 20 dB).
- g) Capture the frequency response plot for inclusion in the test report.

**Test Setup Block Diagram:** KDB 935210 s.4.3



## OUT OF BAND REJECTION

Test Data: 700 Band Uplink Passband



Date: 24.JUN.2019 15:14:19

Trace 1 (Blue): PLMRS/PSRS Sub-Block  
Trace 2 (Black): Public Safety LTE Sub-Block

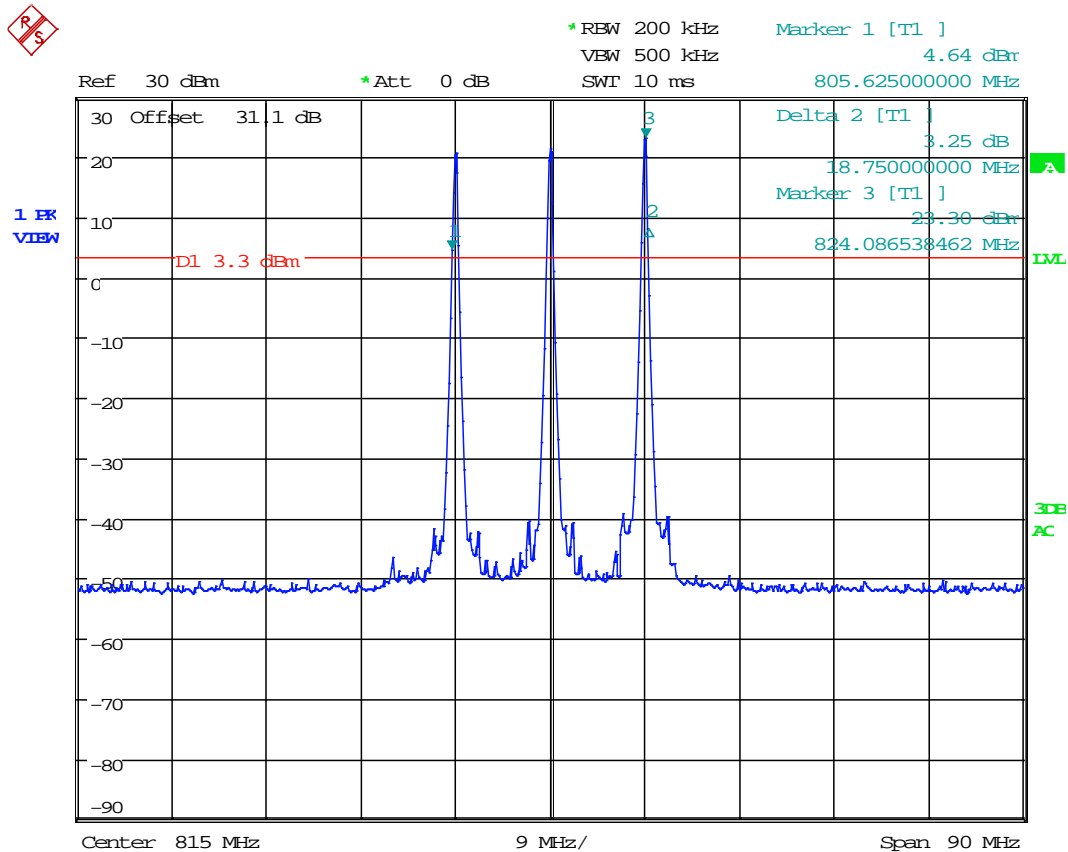
## RESULT:

**CLASS A DEVICE, Channelized Equipment with  $\leq 75$  kHz Passband**

**OPERATING FREQUENCY RANGE = 18.88 MHz**

## OUT OF BAND REJECTION

Test Data: 800 Band Uplink Passband



Date: 24.JUN.2019 14:54:02

## RESULT:

**CLASS A DEVICE, Channelized Equipment with  $\leq 75$  kHz Passband**

**OPERATING FREQUENCY RANGE = 18.75 MHz**

## INPUT VS OUTPUT COMPARISON

**Rule Part No.:** KDB 935210 s.4.4, FCC Pt. 2.1049(h), FCC Pt. 90.219(e)(4)(ii),  
FCC Pt. 90.219(e)(4)(iii), FCC Pt. 90.210(c)

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.

### Requirements:

(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.

(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).

#### APPLICABLE EMISSION MASKS

Frequency band (MHz)	Mask for equipment with audio low pass filter	Mask for equipment without audio low pass filter
806-809/851-854 <sup>6</sup>	B	H

Frequency band (MHz)	Mask for equipment with audio low pass filter	Mask for equipment without audio low pass filter
809-824/854-869 <sup>35</sup>	B, D	D, G.

<sup>3</sup>Equipment used in this licensed to EA or non-EA systems shall comply with the emission mask provisions of §90.691 of this chapter.

<sup>5</sup>Equipment designed to operate on 25 kilohertz bandwidth channels must meet the requirements of either Emission Mask B or G, whichever is applicable, while equipment designed to operate on 12.5 kilohertz bandwidth channels must meet the requirements of Emission Mask D. Equipment designed to operate on 25 kilohertz bandwidth channels may alternatively meet the Adjacent Channel Power limits of §90.221.

<sup>6</sup>Transmitters utilizing analog emissions that are equipped with an audio low-pass filter must meet Emission Mask B. All transmitters utilizing digital emissions and those transmitters using analog emissions without an audio low-pass filter must meet Emission Mask H.

Frequency band (MHz)	Mask for equipment with audio low pass filter	Mask for equipment without audio low pass filter
All other bands	B	C

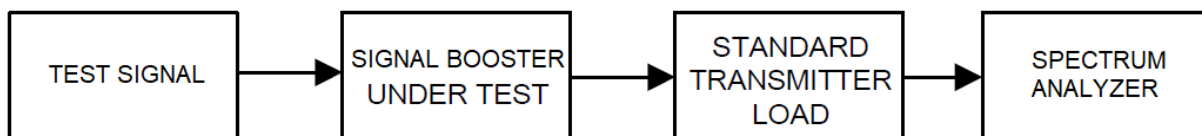


## INPUT VS OUTPUT COMPARISON

**Test Procedure:** KDB 935210 s.4.4

- 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 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 4.2.
- 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 as  $f_0$ .
- 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 Setup Block Diagram:** KDB 935210 s.4.4



## INPUT VS OUTPUT COMPARISON

**Emission Mask Calculation:** FCC Pt. 90.219(e)(4)(ii), FCC Pt. 90.219(e)(4)(iii),  
FCC Pt. 90.210(c)

### 700 Band Emission Mask

MASK C, Uplink, 12.5 kHz BW		
Displacement Frequency (kHz)	Level (dBc)	UL Level (dBm)
0	0.00	24.0
≥ 5	0.00	24.0
< 10	25.0	-0.99
≥ 10	27.8	-3.80
< 31.25	50.0	-26.0
≥ 31.25	37.0	-13.0

### 800 Band Emission Mask

MASK D, Uplink		
Displacement Frequency (kHz)	Level (dBc)	UL Level (dBm)
0	0.00	24.0
> 5.625	20.0	4.04
< 12.5	69.9	-45.9
≥ 12.5	44.0	-20.0

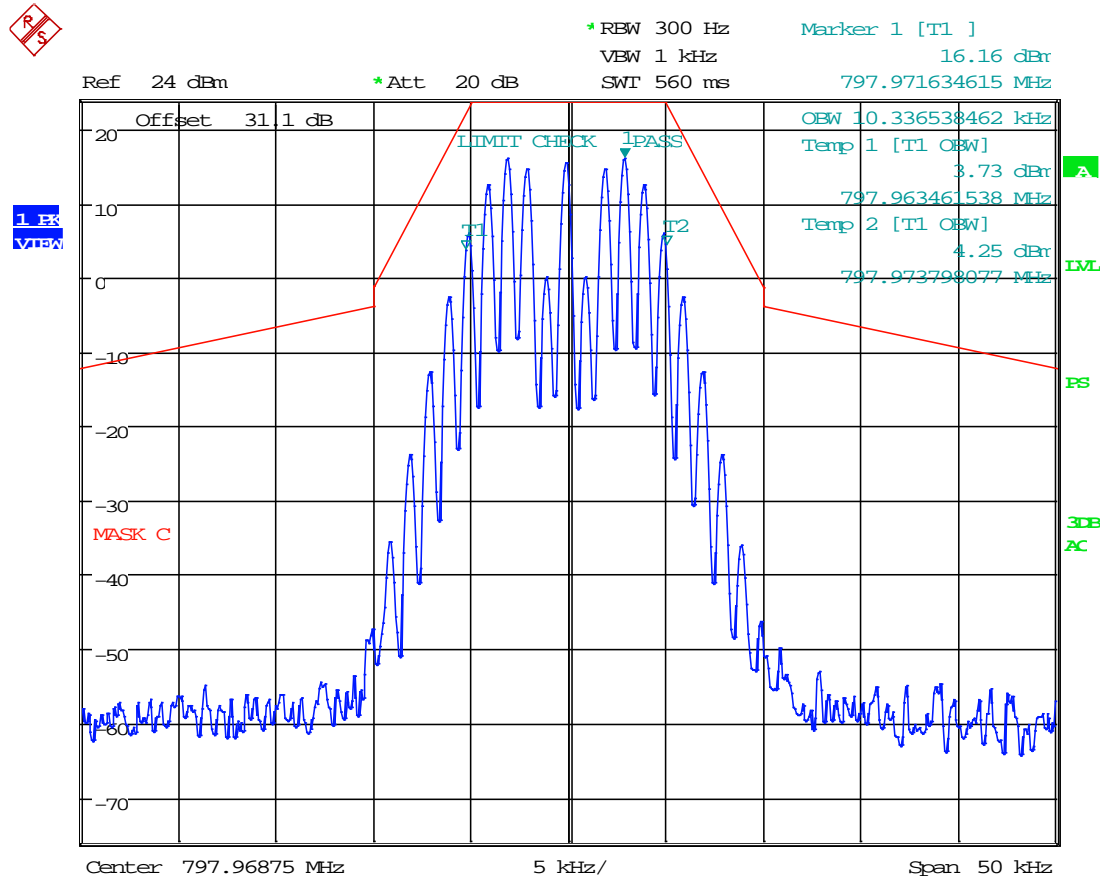
MASK G, Uplink, 12.5 kHz BW		
Displacement Frequency (kHz)	Level (dBc)	UL Level (dBm)
0	0.00	24.0
> 10	24.9	-0.90
< 31.25	44.0	-20.0
≥ 31.25	37.0	-13.0



## INPUT VS OUTPUT COMPARISON

### 700 Band Uplink

Test Data: Uplink, 16K0F3E Output Signal, @ AGC

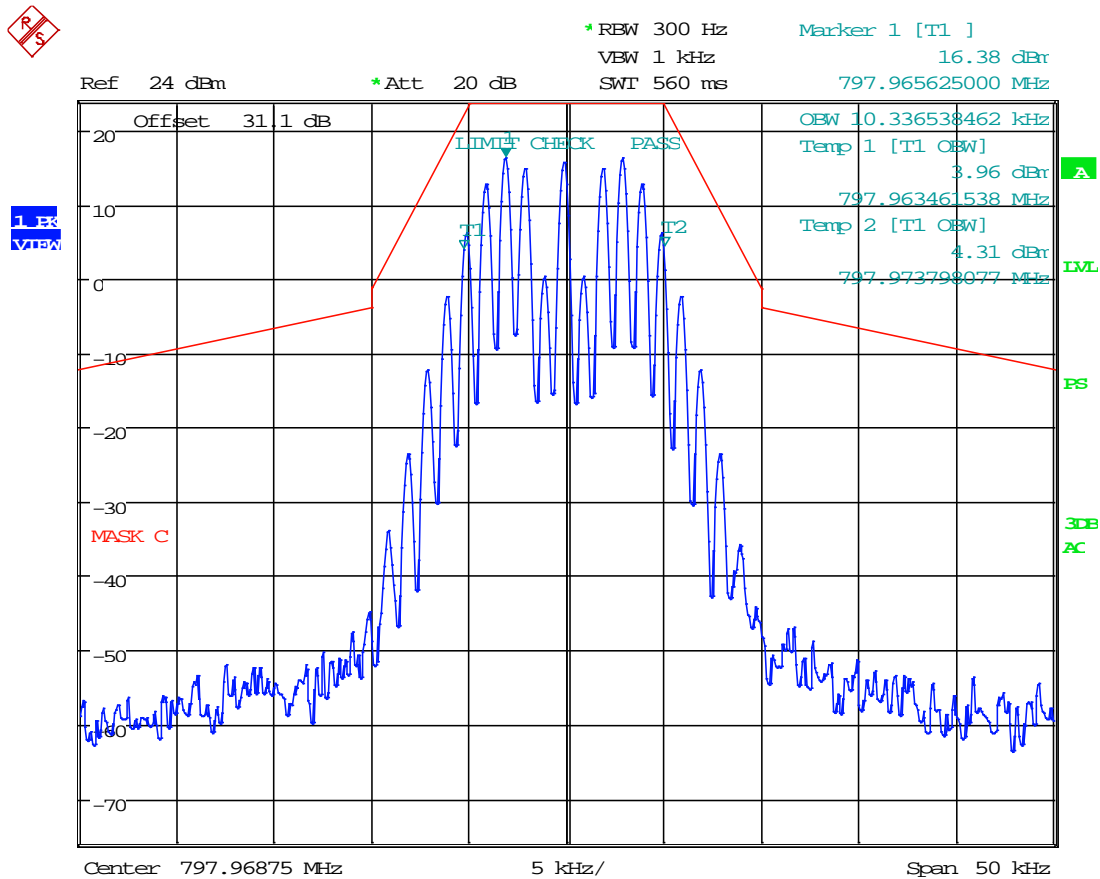


Date: 24.JUN.2019 13:31:06

**RESULT: AGC Output Signal 99% OBW = 10.34 kHz**

## INPUT VS OUTPUT COMPARISON

Test Data: Uplink, 16K0F3E Output Signal, @ AGC +3 dBm



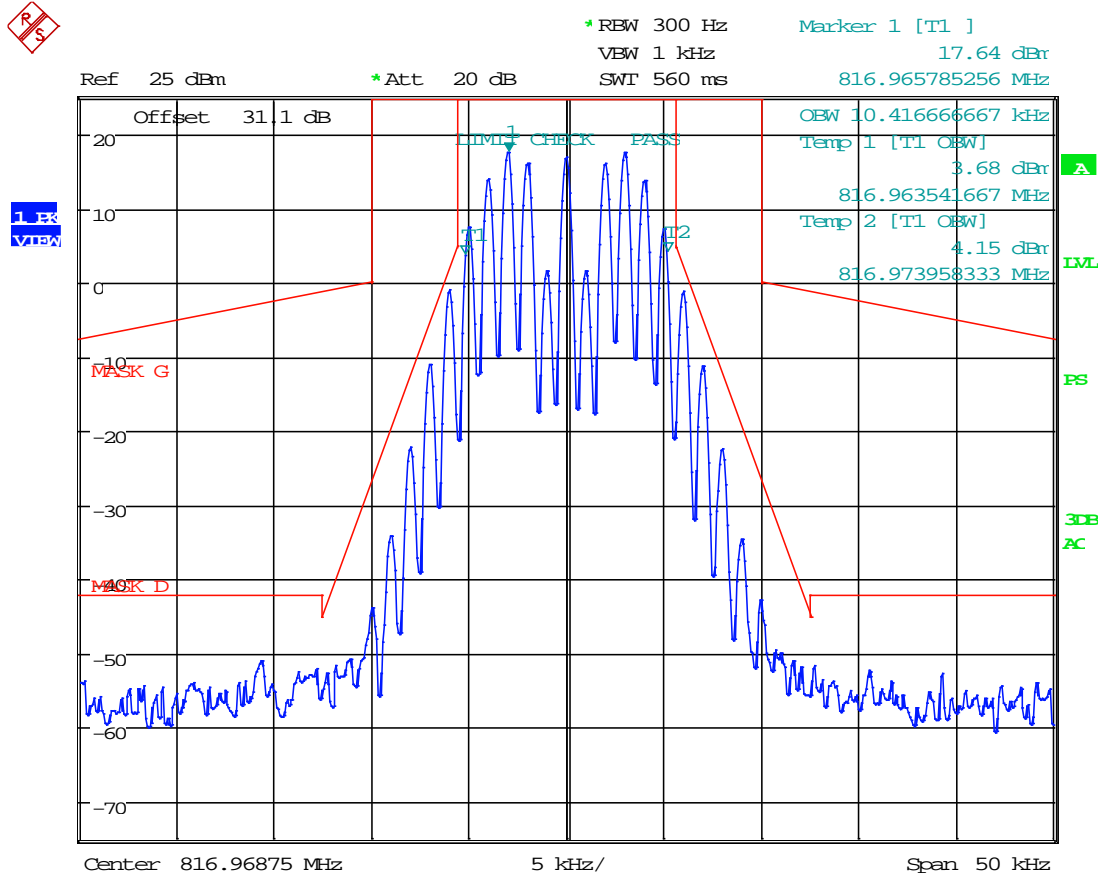
Date: 24.JUN.2019 13:33:03

**RESULT: AGC+3 Output Signal 99% OBW = 10.34 kHz**

## INPUT VS OUTPUT COMPARISON

### 800 Band Uplink

Test Data: Uplink, 16K0F3E Output Signal, @ AGC

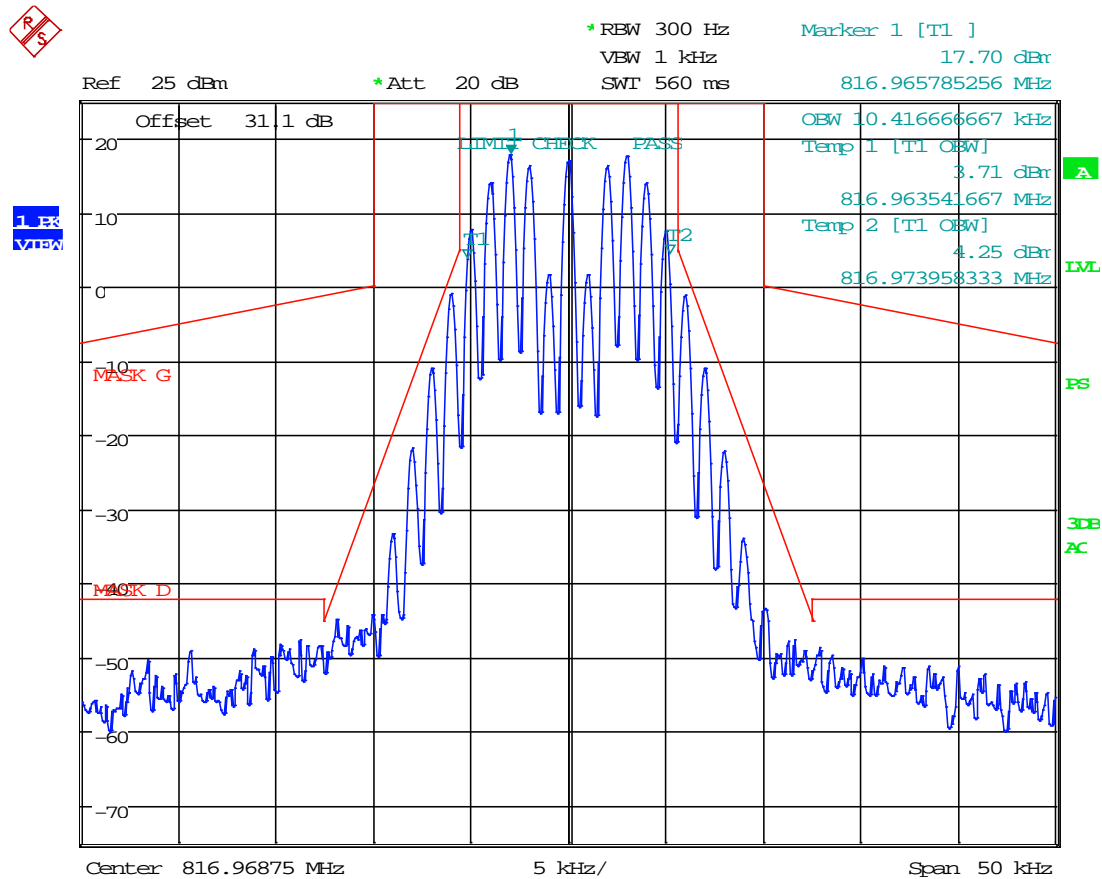


Date: 24.JUN.2019 14:33:36

**RESULT: AGC Output Signal 99% OBW = 10.42 kHz**

## INPUT VS OUTPUT COMPARISON

Test Data: Uplink, 16K0F3E Output Signal, @ AGC +3 dBm



Date: 24.JUN.2019 14:34:14

**RESULT: AGC+3 Output Signal 99% OBW = 10.42 kHz**

## INPUT VS OUTPUT COMPARISON

### ADJACENT CHANNEL POWER

**Rule Part No.:** KDB 935210 s.4.4, FCC Pt. 2.1049(h), FCC Pt. 90.543(a),(c),(e)

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.

**Note:** This EUT meets the “simultaneous retransmitting of multiple signals” exemption in Part 90.543, deferring to paragraphs (c) and (e). However, the EUT has been evaluated for ACP requirements in part (a), below:

**Requirements:** Part 90.453(a)

#### **§90.543 Emission limitations.**

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

(a) The adjacent channel power (ACP) requirements for transmitters designed for various channel sizes are shown in the following tables. Mobile station requirements apply to handheld, car mounted and control station units. The tables specify a value for the ACP as a function of the displacement from the channel center frequency and measurement bandwidth. In the following tables, “(s)” indicates a swept measurement may be used.

#### **6.25 kHz BASE TRANSMITTER ACP REQUIREMENTS**

Offset from center frequency (kHz)	Measurement bandwidth (kHz)	Maximum ACP (dBc)
6.25	6.25	-40
12.50	6.25	-60
18.75	6.25	-60
25.00	6.25	-65
37.50	25	-65
62.50	25	-65
87.50	25	-65
150.00	100	-65
250.00	100	-65
350.00	100	-65
>400 to 12 MHz	30 (s)	-80
12 MHz to paired receive band	30 (s)	-80
In the paired receive band	30 (s)	<sup>1</sup> -85

## ADJACENT CHANNEL POWER

FCC Part 90.543(a), con't.

### 12.5 kHz BASE TRANSMITTER ACP REQUIREMENTS

Offset from center frequency (kHz)	Measurement bandwidth (kHz)	Maximum ACP (dBc)
9.375	6.25	-40
15.625	6.25	-60
21.875	6.25	-60
37.5	25	-60
62.5	25	-65
87.5	25	-65
150	100	-65
250	100	-65
350.00	100	-65
>400 kHz to 12 MHz	30 (s)	-80
12 MHz to paired receive band	30 (s)	-80
In the paired receive band	30 (s)	<sup>1</sup> -85

### 25 kHz BASE TRANSMITTER ACP REQUIREMENTS

Offset from center frequency (kHz)	Measurement bandwidth (kHz)	Maximum ACP (dBc)
15.625	6.25	-40
21.875	6.25	-60
37.5	25	-60
62.5	25	-65
87.5	25	-65
150	100	-65
250	100	-65
350	100.00	-65
>400 kHz to 12 MHz	30 (s)	-80
12 MHz to paired receive band	30 (s)	-80
In the paired receive band	30 (s)	<sup>1</sup> -85

## ADJACENT CHANNEL POWER

**Requirements:** Part 90.543(c)

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

**Requirements:** Part 90.543(e)

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

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

(2) On all frequencies between 769-775 MHz and 799-805 MHz, by a factor not less than  $65 + 10\log(P)$  dB in a 6.25 kHz band segment, for mobile and portable stations.

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

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

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

**Note:** Part 90.543(c) and (e)(3) are satisfied by testing performed to meet attenuation of unwanted spurious emissions level to at least  $43 + 10\log(P)$  dB for all emissions outside the fundamental.



## ADJACENT CHANNEL POWER

**Test Procedure:** FCC Part 90.543(b)

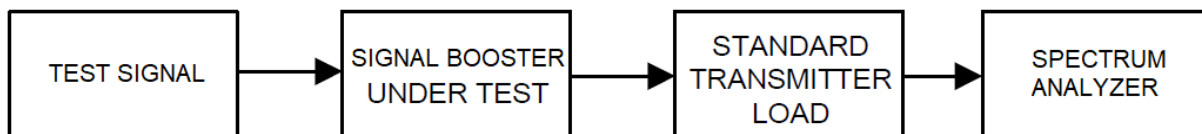
(b) *ACP measurement procedure.* The following are the procedures for making the transmitter ACP measurements. For all measurements modulate the transmitter as it would be modulated in normal operating conditions. For time division multiple access (TDMA) systems, the measurements are to be made under TDMA operation only during time slots when the transmitter is active. All measurements are made at the transmitter's output port. If a transmitter has an integral antenna, a suitable power coupling device shall be used to couple the RF signal to the measurement instrument. The coupling device shall substantially maintain the proper transmitter load impedance. The ACP measurements may be made with a spectrum analyzer capable of making direct ACP measurements. "Measurement bandwidth", as used for non-swept measurements, implies an instrument that measures the power in many narrow bandwidths equal to the nominal resolution bandwidth and integrates these powers to determine the total power in the specified measurement bandwidth.

(1) *Setting reference level.* Set transmitter to maximum output power. Using a spectrum analyzer capable of ACP measurements, set the measurement bandwidth to the channel size. For example, for a 6.25 kHz transmitter set the measurement bandwidth to 6.25 kHz. Set the frequency offset of the measurement bandwidth to zero and adjust the center frequency of the instrument to the assigned center frequency to measure the average power level of the transmitter. Record this power level in dBm as the "reference power level."

(2) *Non-swept power measurement.* Using a spectrum analyzer capable of ACP measurements, set the measurement bandwidth and frequency offset from the assigned center frequency as shown in the tables in §90.543 (a) above. Any value of resolution bandwidth may be used as long as it does not exceed 2 percent of the specified measurement bandwidth. Measure the power level in dBm. These measurements should be made at maximum power. Calculate ACP by subtracting the reference power level measured in (b)(1) from the measurements made in this step. The absolute value of the calculated ACP must be greater than or equal to the absolute value of the ACP given in the table for each condition above.

(3) *Swept power measurement.* Set a spectrum analyzer to 30 kHz resolution bandwidth, 1 MHz video bandwidth and average, sample, or RMS detection. Set the reference level of the spectrum analyzer to the RMS value of the transmitter power. Sweep above and below the carrier frequency to the limits defined in the tables. Calculate ACP by subtracting the reference power level measured in (b)(1) from the measurements made in this step. The absolute value of the calculated ACP must be greater than or equal to the absolute value of the ACP given in the table for each condition above.

**Test Setup Block Diagram:** KDB 935210 s.4.4



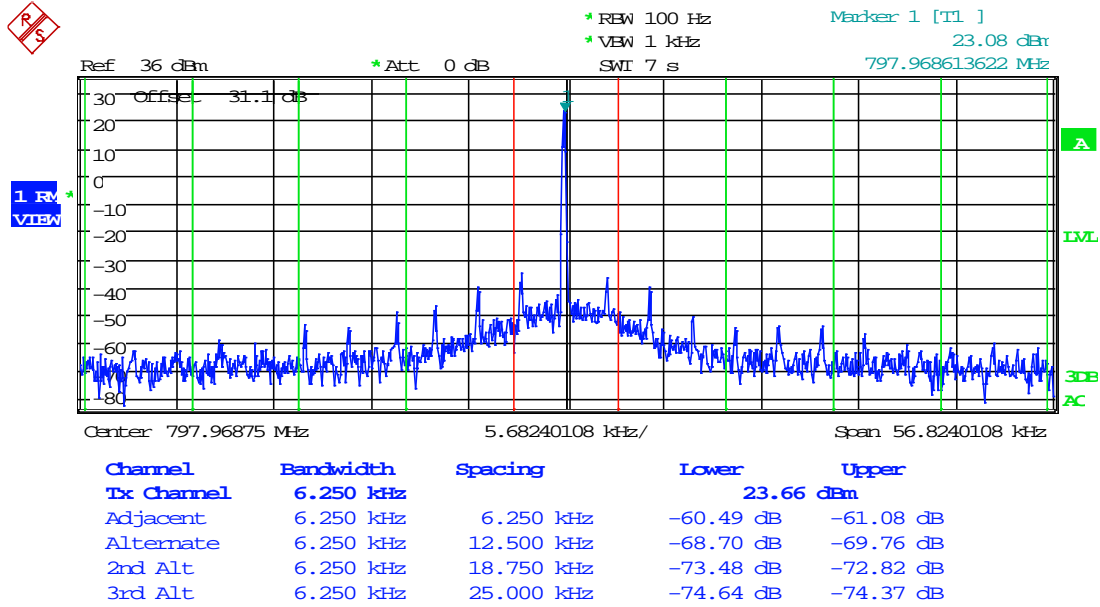
**Note:** The spectrum analyzer was set to ACP measurement mode, and operated in accordance with the measurement procedures in Part 90.543(b)



## ADJACENT CHANNEL POWER

### 700 Band Uplink, 6.25 kHz Signal

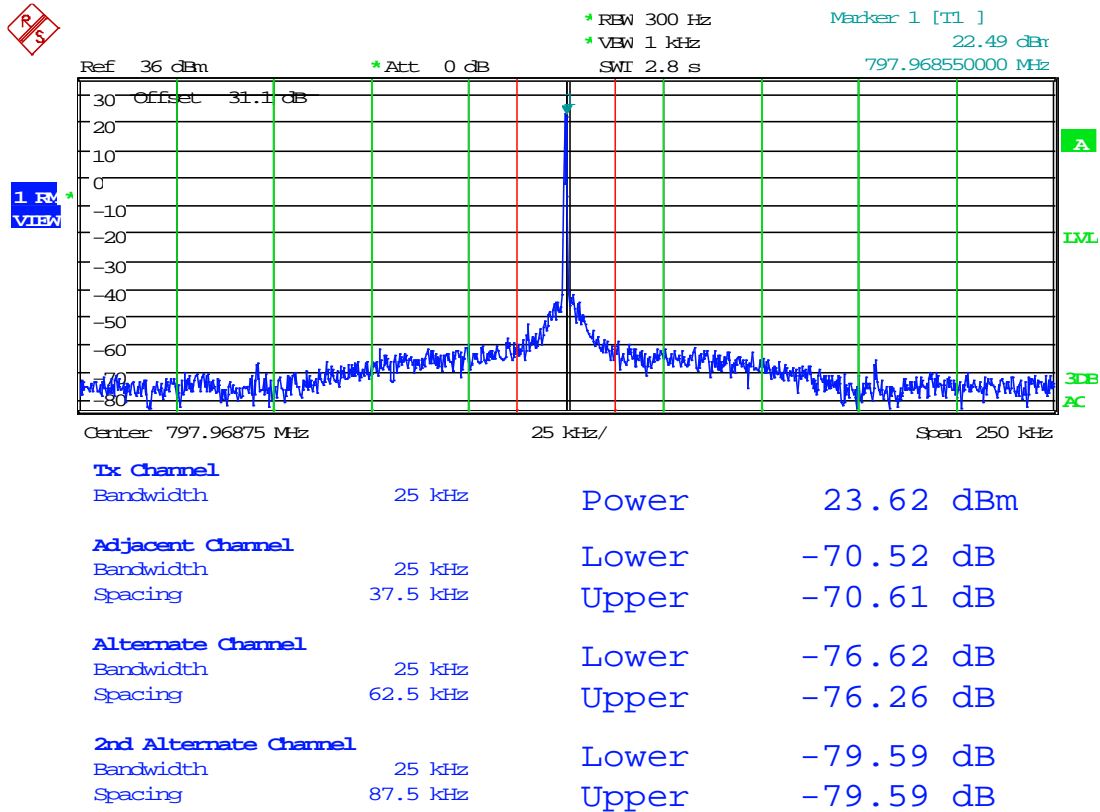
Test Data: Uplink, 6.25 kHz Bandwidth



Date: 24.JUN.2019 15:23:38

## ADJACENT CHANNEL POWER

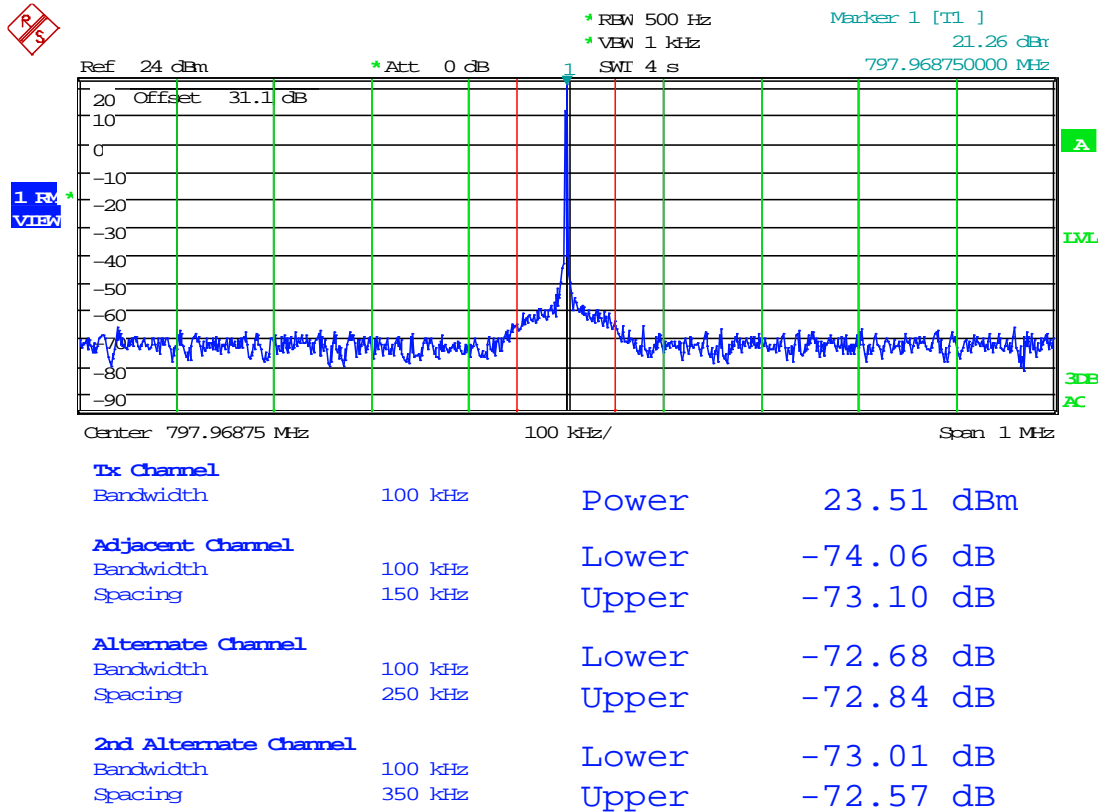
Test Data: Uplink, 25 kHz Bandwidth



Date: 24.JUN.2019 15:27:09

## ADJACENT CHANNEL POWER

Test Data: Uplink, 100 kHz Bandwidth



Date: 24.JUN.2019 15:28:52

## RF POWER OUTPUT

**Rule Part No.:** KDB 935210 s.4.5, 4.5.5, FCC Pt. 2.1046(a), FCC Pt. 2.1033(c)(8), FCC Pt. 90.219(d)(3), FCC Pt. 90.219(e)(1), FCC Pt. 90.219(e)(4)(iii)

### Requirements:

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

(3) Signal boosters must be deployed such that the radiated power of the each retransmitted channel, on the forward link and on the reverse link, does not exceed 5 Watts effective radiated power (ERP).

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

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

**Test Procedure:** KDB 935210 s.4.5, & 4.5.3, TIA 603-E

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

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

#### 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  $\geq 3 \times$  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.

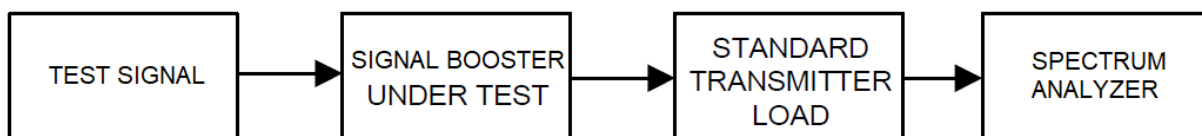
NOTE—Sections 90.219 and 2.1033(c) do not require gain test data; inclusion of industrial booster gain test data in test reports submitted for FCC equipment authorization is optional.

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.

**Test Setup Block Diagram:** KDB 935210 s.4.5



## RF POWER OUTPUT

### Test Data: 700 Band Measurement Table

#### 700 Band, Uplink

	Gen Freq (MHz)	Input Power (dBm)	Output (dBm)	Gain (dB)	Antenna Gain (dBi)	Cable Loss (dB)	ERP (dBm)	ERP (W)	Limit ERP (W)	Margin (W)
AGC	793.00000	-56.59	23.8	80.39	0.00	0.00	23.80	0.24	5.00	4.76
AGC +3 dBm	793.00000	-53.59	23.69	77.28	0.00	0.00	23.69	0.23	5.00	4.77
Saturation	793.00000	0	23.8	23.80	0.00	0.00	23.80	0.24	5.00	4.76

### Test Data: 800 Band Measurement Table

#### 800 Band, Uplink

	Gen Freq (MHz)	Input Power (dBm)	Output (dBm)	Gain (dB)	Antenna Gain (dBi)	Cable Loss (dB)	ERP (dBm)	ERP (W)	Limit ERP (W)	Margin (W)
AGC	816.96875	-56.59	24.92	81.51	0.00	0.00	24.92	0.31	5.00	4.69
AGC +3 dBm	816.96875	-53.59	24.94	78.53	0.00	0.00	24.94	0.31	5.00	4.69
Saturation	816.96875	0	24.96	24.96	0.00	0.00	24.96	0.31	5.00	4.69

**Maximum Power Output: 34.01 dBm (2.52 W)**

**Note:** The Downlink power output remains unchanged. The EUT maximum output power was measured in the Downlink.

## POWER TO FINAL AMPLIFIER

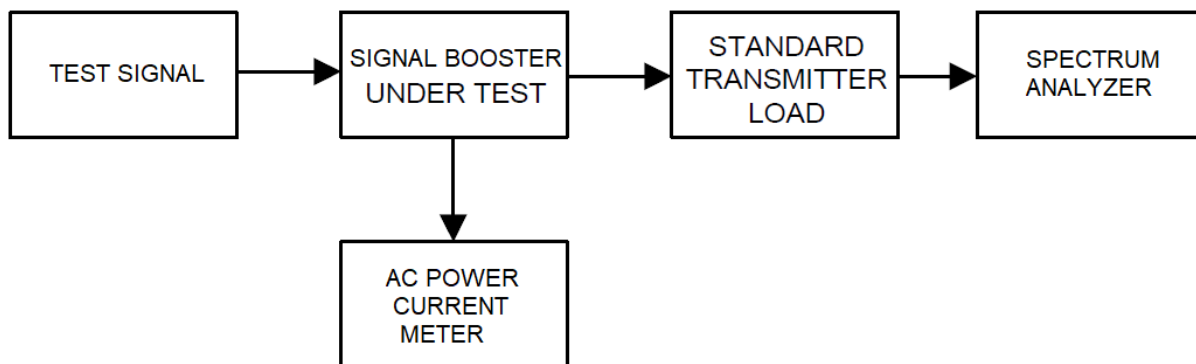
**Rule Part No.:** FCC Pt. 2.1033(c)(8)

### Requirements:

(c) Applications for equipment other than that operating under parts 15, 11 and 18 of this chapter shall be accompanied by a technical report containing the following information:

(8) The dc voltages applied to and dc currents into the several elements of the final radio frequency amplifying device for normal operation over the power range.

### Test Setup Block Diagram:



### Test Data: Power to Final Amplifier Calculation

INPUT POWER: (110 VAC) (2.73 A) = **300 Watts Maximum**

## NOISE FIGURE

**Rule Part No.:** KDB 935210 s.4.6, FCC Pt. 90.219(e)(2)

Section 90.219(e)(2) limits the noise figure of a signal booster to  $\leq 9$  dB in either direction. The following discussion provides guidance for demonstrating compliance with this requirement.

Several widely recognized methods for performing noise figure measurements are available. Some require the use of specialized equipment, such as a noise figure analyzer and/or an excess noise ratio (ENR) calibrated noise source, while others involve the use of conventional measurement instrumentation such as a spectrum analyzer. Methods that require use of a noise figure analyzer are generally accepted as producing the most accurate results, and are considered to be the reference method within this document, while others are considered to be acceptable alternative methods. Consult the relevant instrumentation application notes for detailed guidance regarding the selection and application of an appropriate methodology for performing noise figure measurements. Note also that noise figure measurements require that any AGC circuitry be disabled over the duration of the measurement.

### Requirements:

(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.

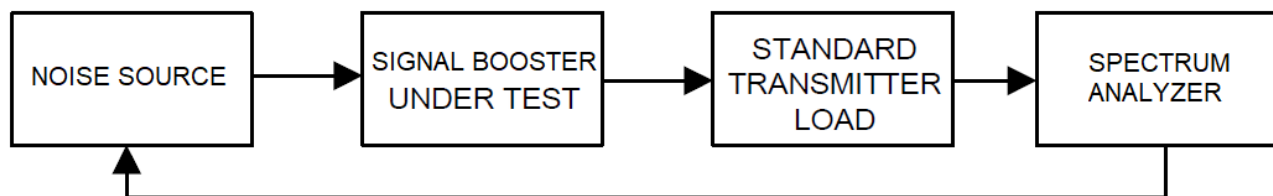
(2) The noise figure of a signal booster must not exceed 9 dB in either direction.

**Test Procedure:** 1MA178\_2e R&S Application Note the Y Factor Technique Noise Figure Sections 2 Background Theory and Equations & 3 Detailed Measurement Steps

Setup using an RBW of 10 kHz, VBW  $\geq 3 \times$  RBW, Span  $> 2 \times$  Passband, Max Hold, Peak Detector. "Noise Source off" and "Noise Source on" traces were taken.

**Note:** EUT's AGC method(s) and/or squelch function should be disabled for this test.

### Test Setup Block Diagram:



## NOISE FIGURE

### 700 Band Noise Figure

Test Data: 700 Band Uplink Noise Calculation

UPLINK OUT, 700 BAND	
FCC KDB 935210 S. 4.6, ISSED RSS-131 S. 6.4 - NOISE FIGURE	
Measurement Freq. (MHz)	<b>797.96875</b>
Noise Source ENR (dB)	15.0647
Noise Source $T_s^{\text{OFF}}, T_o$ (K)	290
Noise Source $T_s^{\text{ON}}$ (K)	9598.2335
Noise Source Cal $N_2^{\text{off}}$ (dB)	<b>-117.09</b>
Noise Source Cal $N_2^{\text{off}}$ (pW)	0.00195
Noise Source Cal $N_2^{\text{on}}$ (dB)	<b>-107.24</b>
Noise Source Cal $N_2^{\text{on}}$ (pW)	0.01888
Calibration Ratio $Y_2$	9.6605
Calibration $T_2$	784.7906
Noise + EUT $N_{12}^{\text{off}}$ (dB)	<b>-46.06</b>
Noise + EUT $N_{12}^{\text{off}}$ (pW)	24774.22
Noise + EUT $N_{12}^{\text{on}}$ (dB)	<b>-27.44</b>
Noise + EUT $N_{12}^{\text{on}}$ (pW)	1803017.74
Noise + EUT Ratio $Y_{12}$	72.7780
Noise + EUT $T_{12}$	-160.3191
Gain (Ratio)	105062523.5272
Gain (dB)	80.2145
2nd Stage Correction $T_1$	-160.319102102162
Noise Factor F	0.44718
Noise Figure (dB)	-3.50
Limit (dB)	9.00
Margin (dB)	<b>12.50</b>



## NOISE FIGURE

### 800 Band Noise Figure

Test Data: 800 Band Uplink Noise Calculation

UPLINK OUT, 800 BAND	
FCC KDB 935210 S. 4.6, ISSED RSS-131 S. 6.4 - NOISE FIGURE	
Measurement Freq. (MHz)	816.96875
Noise Source ENR (dB)	15.0624
Noise Source $T_s^{\text{OFF}}, T_0$ (K)	290
Noise Source $T_s^{\text{ON}}$ (K)	9593.2576
Noise Source Cal $N_2^{\text{off}}$ (dB)	-116.63
Noise Source Cal $N_2^{\text{off}}$ (pW)	0.00217
Noise Source Cal $N_2^{\text{on}}$ (dB)	-107.7
Noise Source Cal $N_2^{\text{on}}$ (pW)	0.01698
Calibration Ratio $Y_2$	7.8163
Calibration $T_2$	1074.8589
Noise + EUT $N_{12}^{\text{off}}$ (dB)	-38.4
Noise + EUT $N_{12}^{\text{off}}$ (pW)	144543.98
Noise + EUT $N_{12}^{\text{on}}$ (dB)	-24.00
Noise + EUT $N_{12}^{\text{on}}$ (pW)	3981071.71
Noise + EUT Ratio $Y_{12}$	27.5423
Noise + EUT $T_{12}$	60.5070
Gain (Ratio)	259054442.1552
Gain (dB)	84.1339
2nd Stage Correction $T_1$	60.507003428090
Noise Factor F	1.20864
Noise Figure (dB)	0.82
Limit (dB)	9.00
Margin (dB)	8.18

## PASSBAND NOISE

**Rule Part No.:** FCC Pt. 90.219(d)(6)(ii), FCC Pt. 90.219(d)(6)(iii)

**Requirements:** Reporting only.

(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.

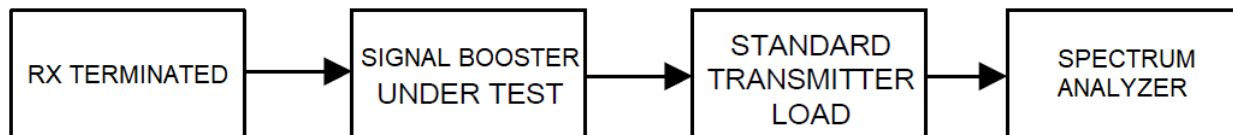
(ii) In general, the ERP of noise within the passband should not exceed  $-43$  dBm in 10 kHz measurement bandwidth.

(iii) In general, the ERP of noise on spectrum more than 1 MHz outside of the passband should not exceed  $-70$  dBm in a 10 kHz measurement bandwidth.

**Test Procedure:** With the Rx Port terminated, setup using an RBW of 10 kHz, VBW  $\geq 3\times$  RBW, Span  $> 2\times$  Passband, Max Hold, Peak Detector. Markers were placed in and  $>1$  MHz outside Passband.

**Note:** EUT's AGC method(s) and/or squelch function should be disabled for this test.

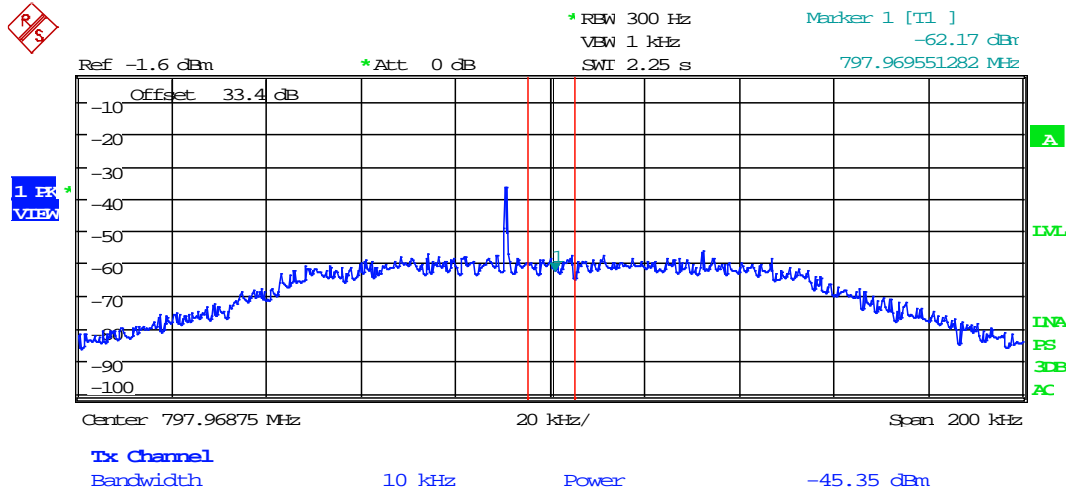
### Test Setup Block Diagram:



## PASSBAND NOISE

### 700 Band Passband Noise

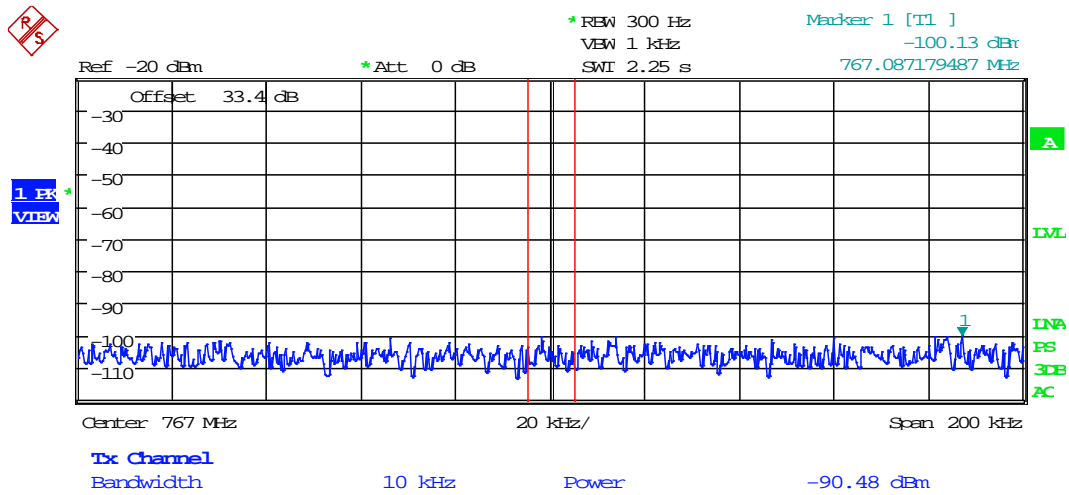
Test Data: 700 Band Uplink Noise Inside Passband



Date: 25.JUN.2019 12:23:12

## PASSBAND NOISE

Test Data: 700 Band Uplink Noise Outside Passband

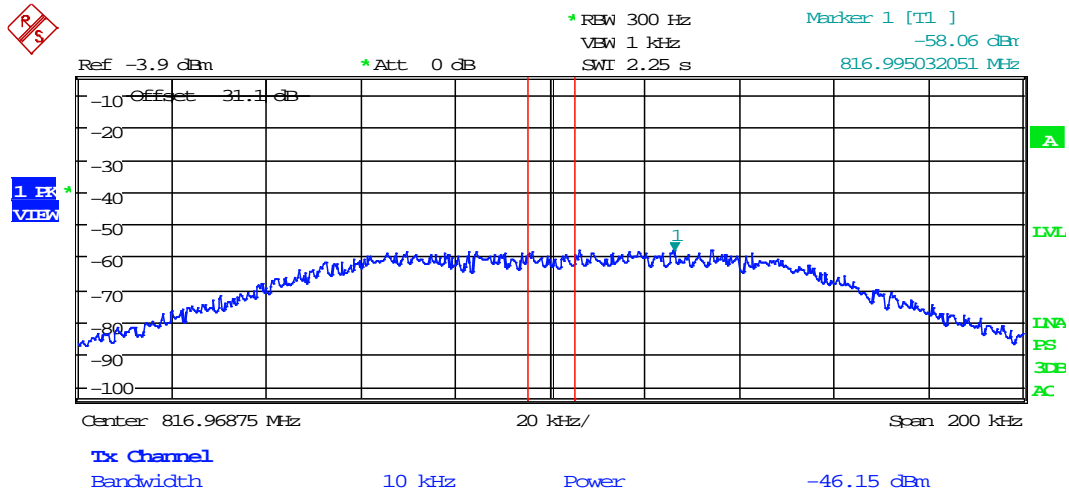


Date: 25.JUN.2019 12:24:23

## PASSBAND NOISE

### 800 Band Passband Noise

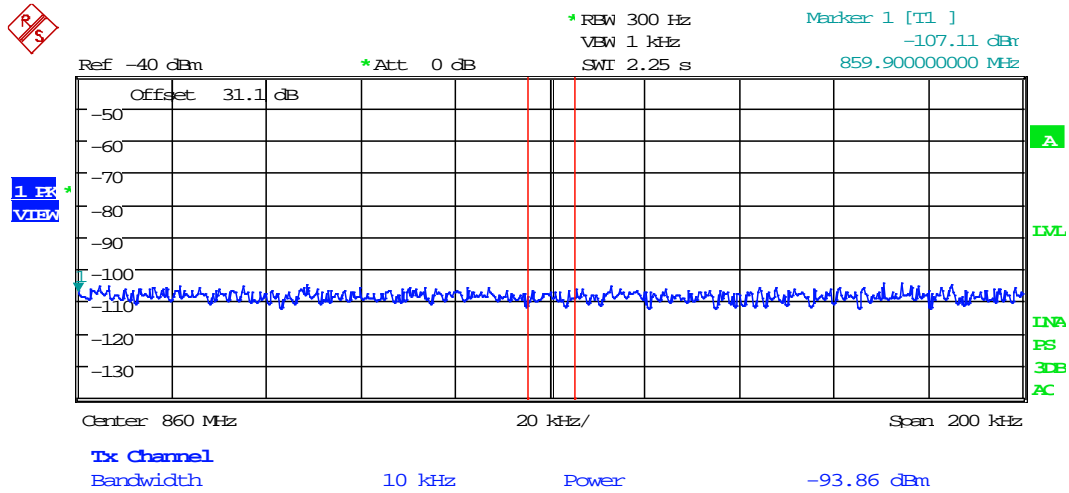
Test Data: 800 Band Uplink Noise Inside Passband



Date: 25.JUN.2019 12:04:36

## PASSBAND NOISE

Test Data: 800 Band Uplink Noise Outside Passband



Date: 25.JUN.2019 12:07:52

## INTERMODULATION SPURIOUS EMISSIONS

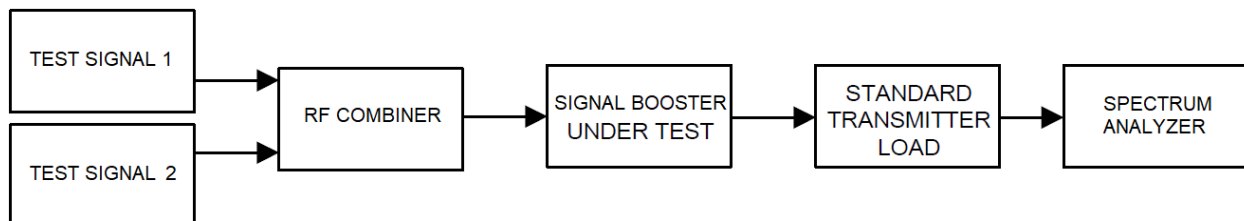
**Test Procedure:** KDB 935210 s.4.7.2, TIA 603-E

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  $f_0$  as determined from 4.4.

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

- 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).
- c) Connect a spectrum analyzer to the EUT output.
- d) Set the span to 100 kHz.
- e) Set RBW = 300 Hz with VBW  $\geq 3 \times$  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.

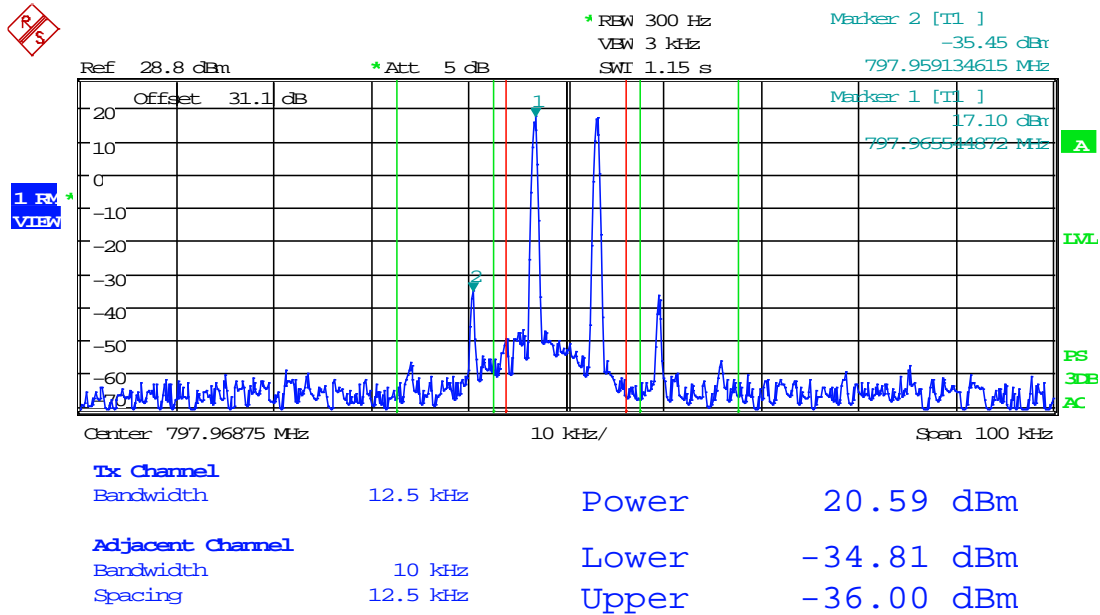
**Test Setup Block Diagram:** KDB 935210 s.4.7.2



## INTERMODULATION SPURIOUS EMISSIONS

### 700 Band Uplink

Test Data: Uplink , 6.25 kHz Channel Spacing, @ AGC

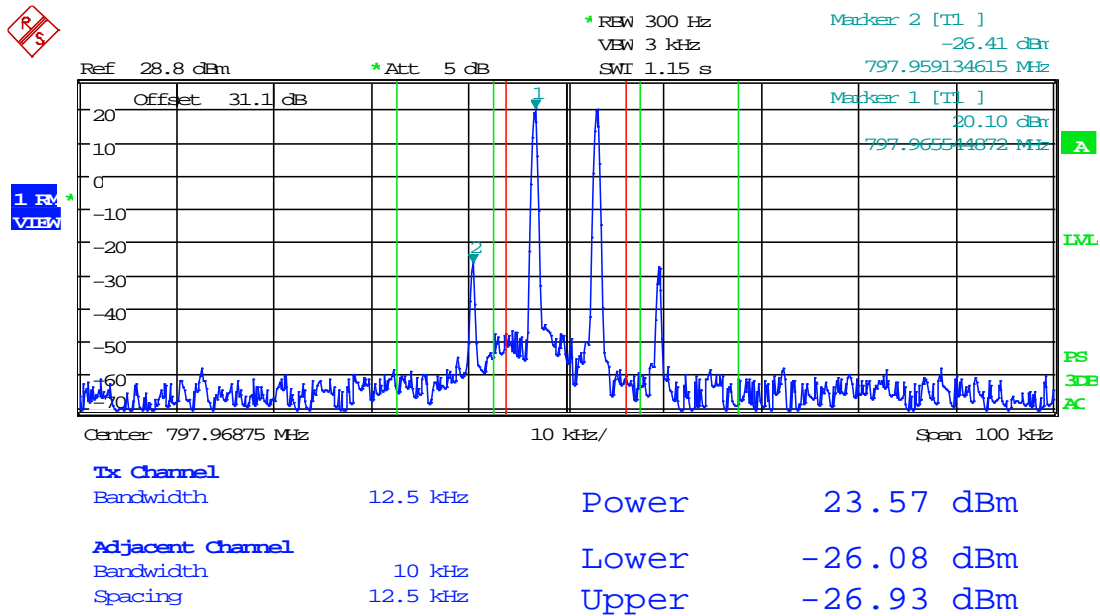


Date: 25.JUN.2019 12:35:15



## INTERMODULATION

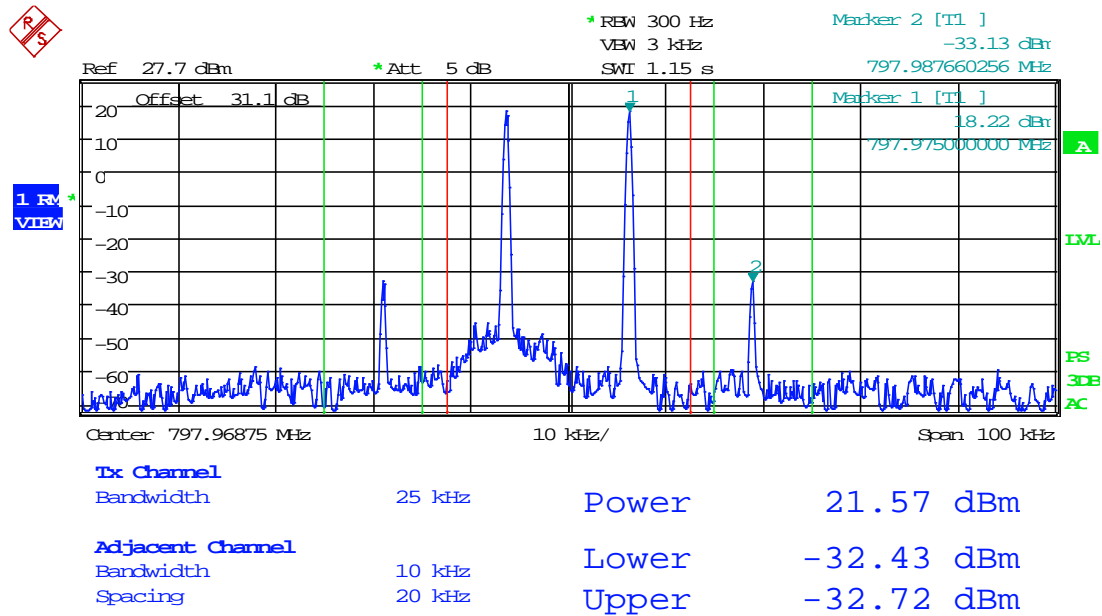
Test Data: Uplink , 6.25 kHz Channel Spacing, @ AGC +3 dBm



Date: 25.JUN.2019 12:34:43

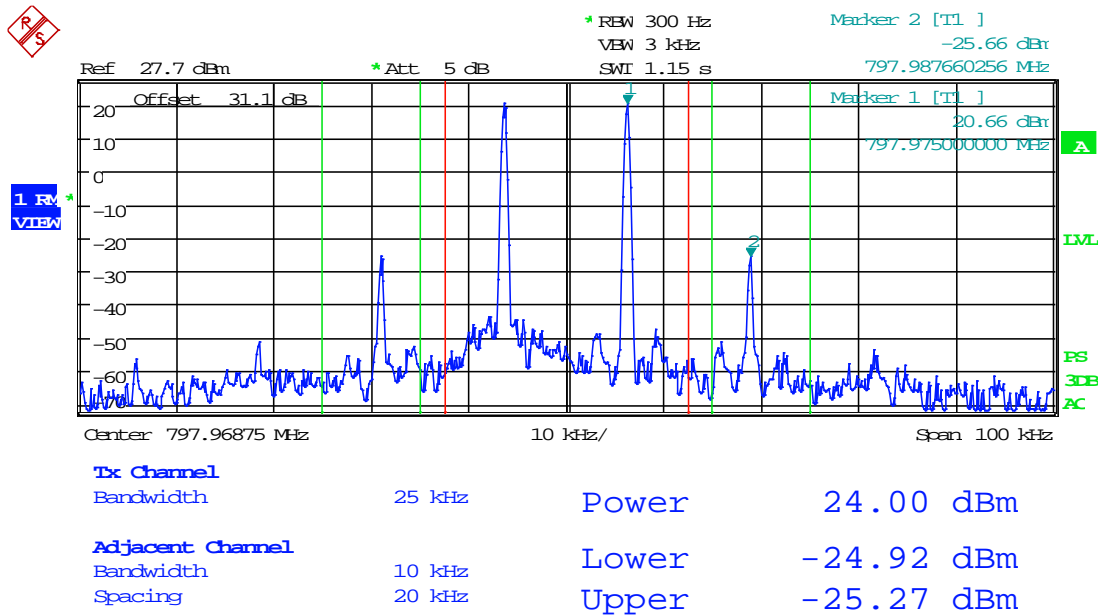
## INTERMODULATION

Test Data: Uplink , 12.5 kHz Channel Spacing, @ AGC



## INTERMODULATION

Test Data: Uplink , 12.5 kHz Channel Spacing, @ AGC +3 dBm

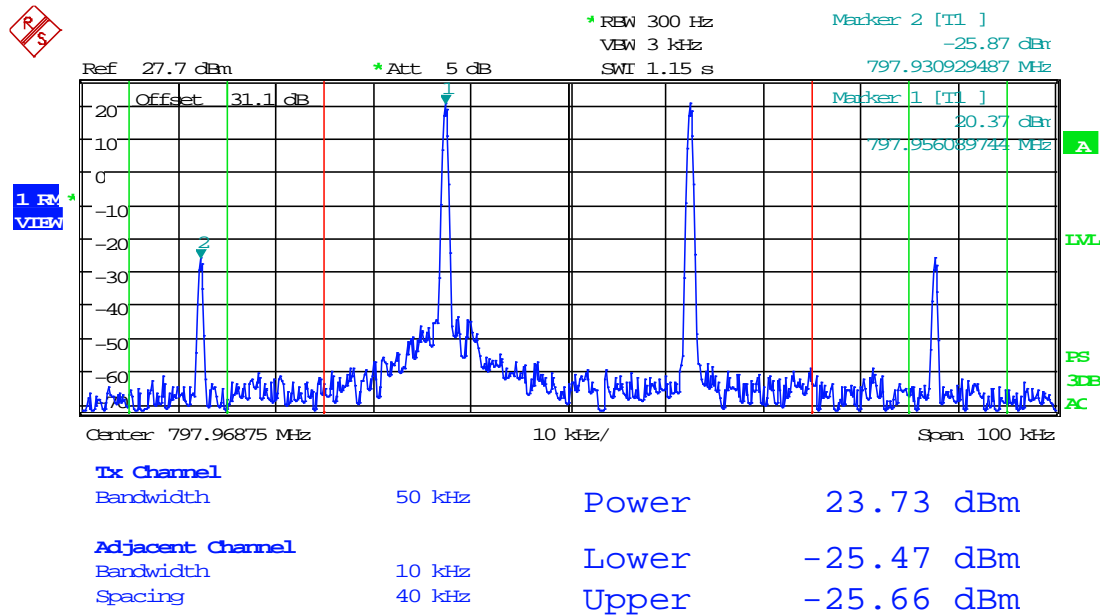


Date: 25.JUN.2019 12:38:23



## INTERMODULATION

Test Data: Uplink , 25 kHz Channel Spacing, @ AGC +3 dBm

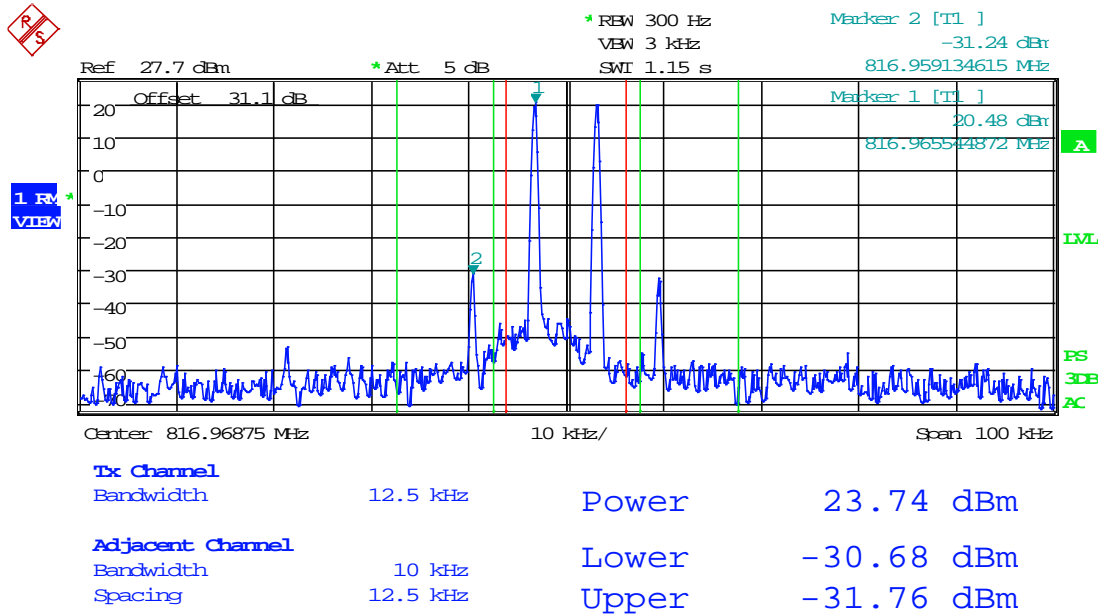


Date: 25.JUN.2019 12:40:12

## INTERMODULATION

### 800 Band Uplink

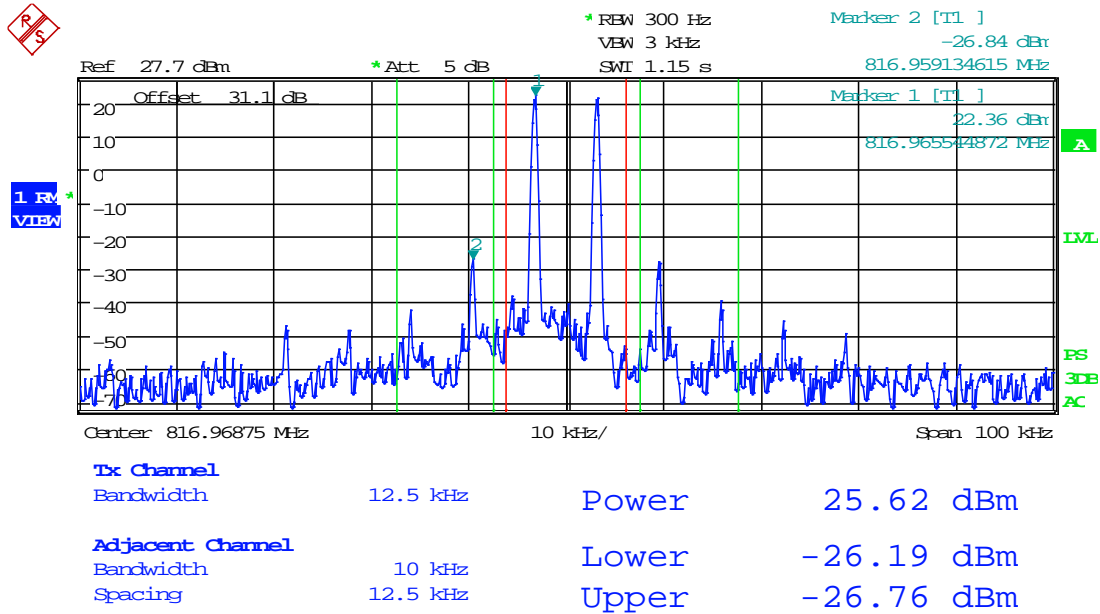
Test Data: Uplink (816.96875 MHz), 6.25 kHz Channel Spacing, @ AGC



Date: 25.JUN.2019 12:58:52

## INTERMODULATION

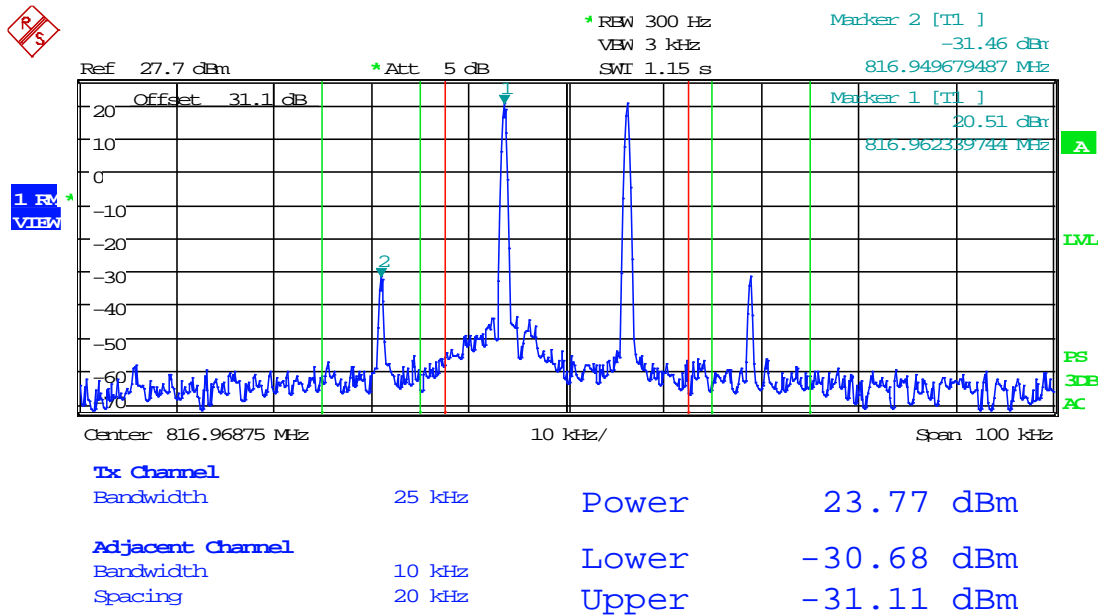
Test Data: Uplink (816.96875 MHz), 6.25 kHz Channel Spacing, @ AGC +3 dBm



Date: 25.JUN.2019 12:59:34

## INTERMODULATION

Test Data: Uplink (816.96875 MHz), 12.5 kHz Channel Spacing, @ AGC

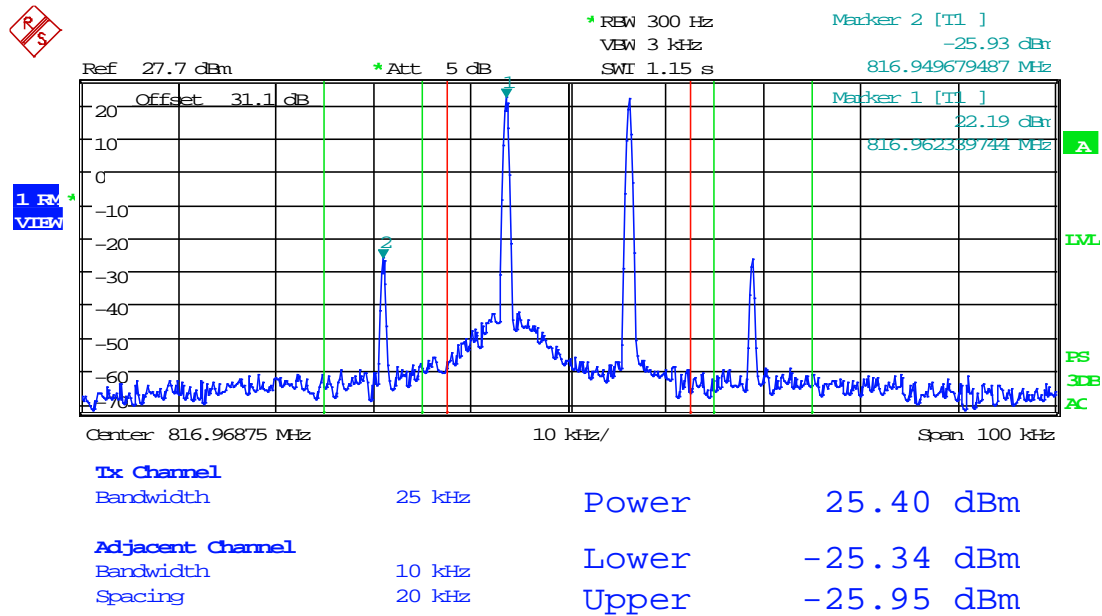


Date: 25.JUN.2019 12:44:55



## INTERMODULATION

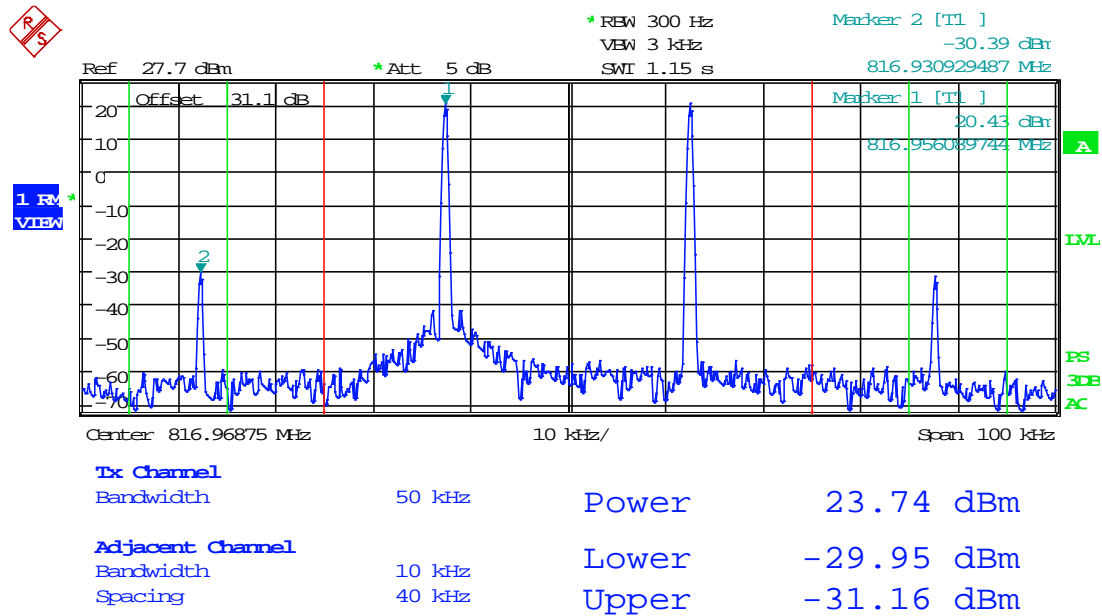
Test Data: Uplink (816.96875 MHz), 12.5 kHz Channel Spacing, @ AGC +3 dBm



Date: 25.JUN.2019 12:46:11

## INTERMODULATION

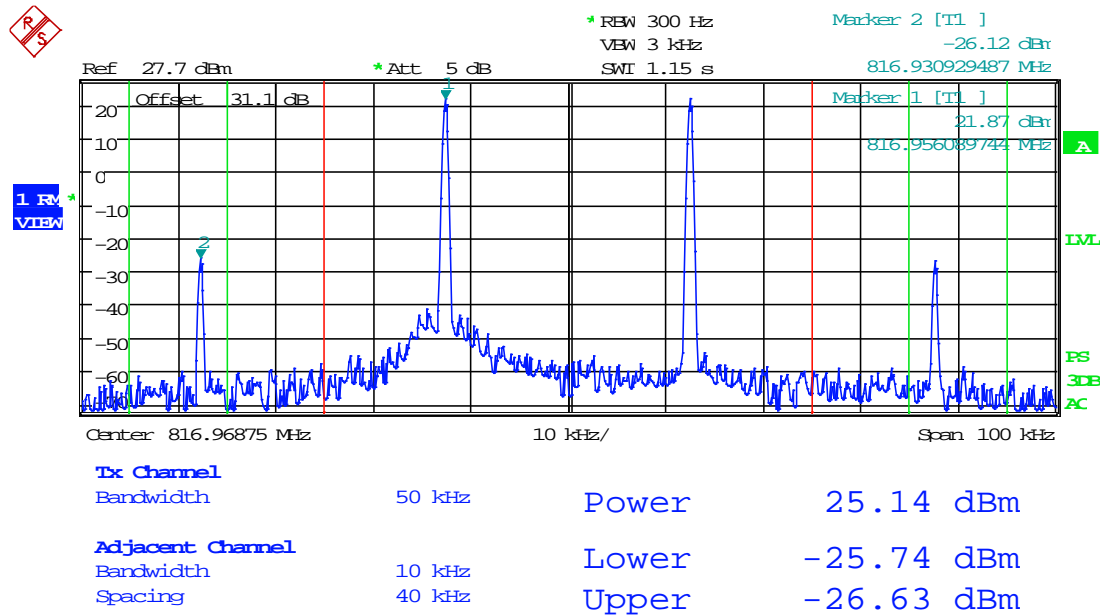
Test Data: Uplink (816.96875 MHz), 25 kHz Channel Spacing, @ AGC



Date: 25.JUN.2019 12:42:46

## INTERMODULATION

Test Data: Uplink (816.96875 MHz), 25 kHz Channel Spacing, @ AGC +3 dBm



Date: 25.JUN.2019 12:42:11

## INTERMODULATION

### SPURIOUS EMISSIONS AT ANTENNA TERMINALS

**Rule Part No.:** KDB 935210 s.4.7.3, FCC Part 2.1051(a), FCC Pt. 90.219(e)(3)

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).

#### Requirements:

(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.

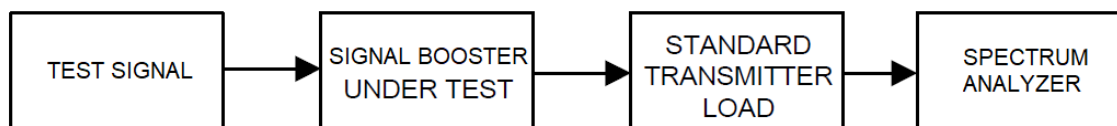
(3) Spurious emissions from a signal booster must not exceed -13 dBm within any 100 kHz measurement bandwidth.

**Test Procedure:** KDB 935210 s.4.7.3, TIA 603-E

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.

- 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 =  $3 \times \text{RBW}$ .
- h) Set the Sweep time = auto-couple.
- i) Set the detector to PEAK.
- j) Set the spectrum analyzer start frequency to 30 MHz (or the lowest radio frequency signal generated in the EUT, without going below 9 kHz if the EUT has additional internal clock frequencies), and the stop frequency to 10 times the highest allowable frequency of the EUT passband.
- k) Select MAX HOLD, and use the marker peak function to find the highest emission(s) outside the passband. (This could be either at a frequency lesser or greater than the passband frequencies.)
- l) Capture a plot for inclusion in the test report.
- m) Repeat steps c) to l) for each authorized frequency band/block of operation.

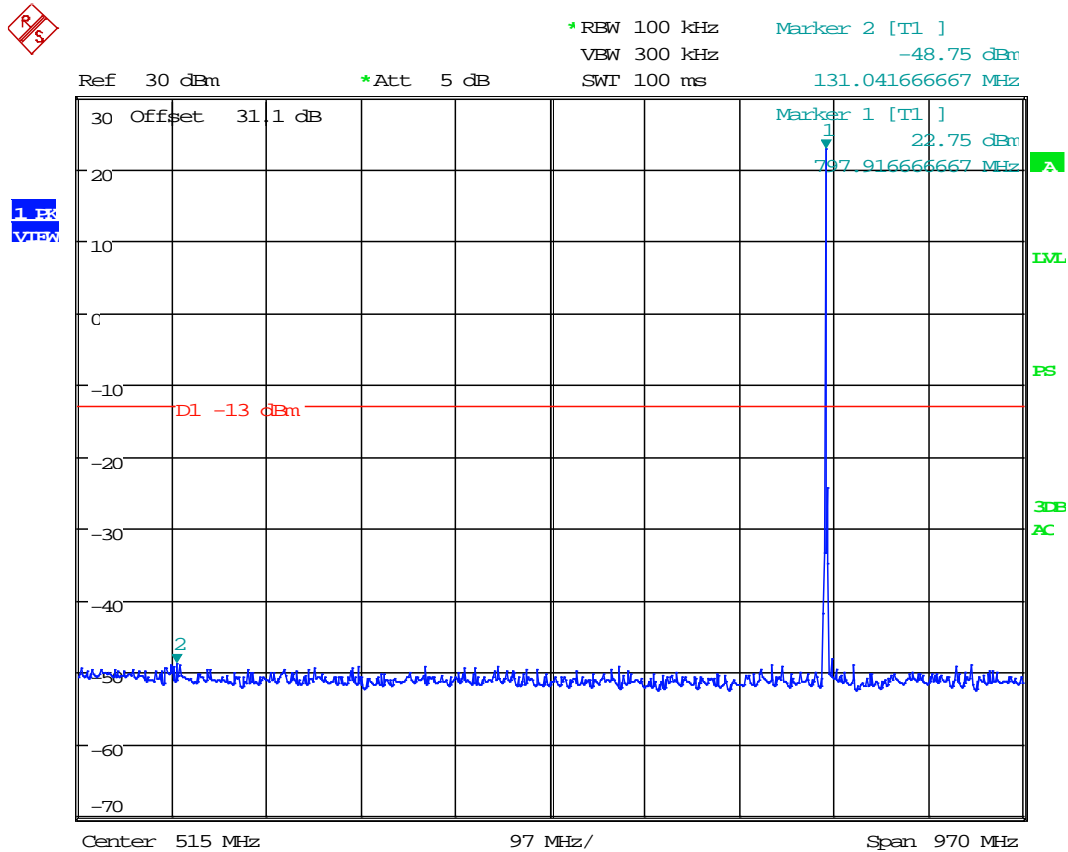
**Test Setup Block Diagram:** KDB 935210 s.4.7.3



## SPURIOUS EMISSIONS AT ANTENNA TERMINALS

### 700 Band Conducted Spurious Emissions

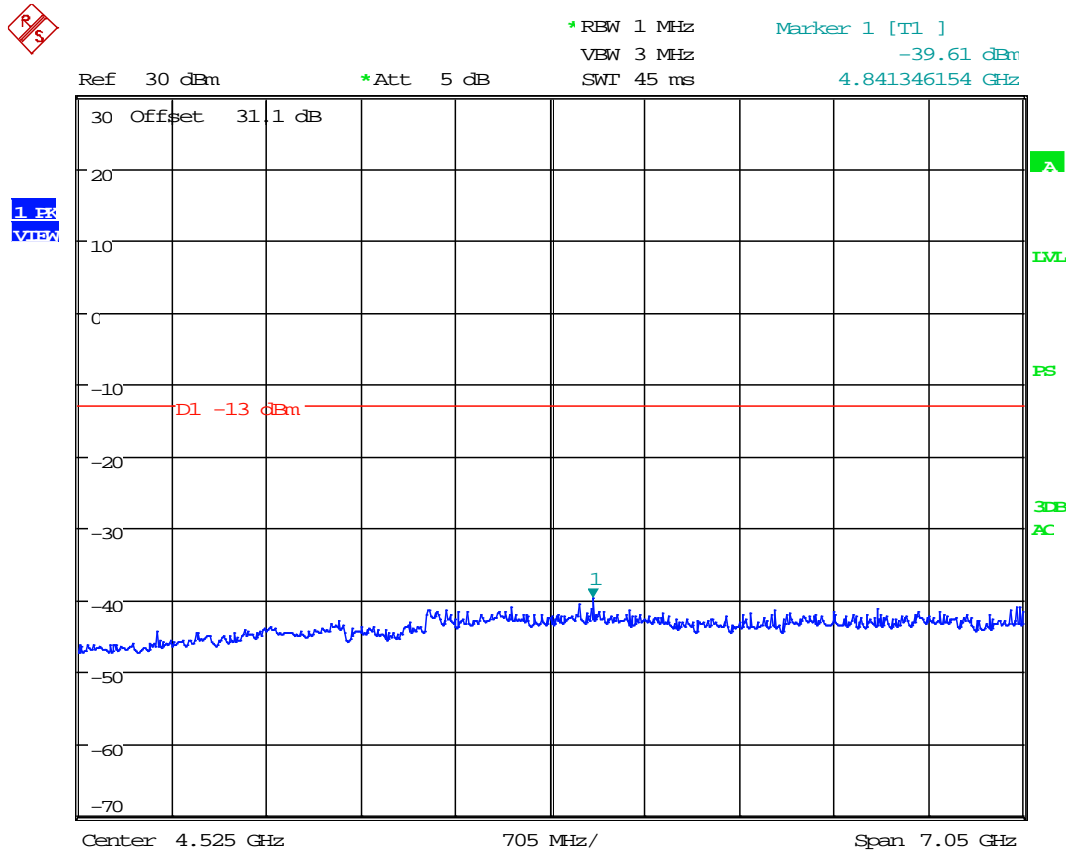
Test Data: 700 Band Uplink Spurious Emissions Plot, 30 MHz – 1 GHz



Date: 25.JUN.2019 15:28:13

## SPURIOUS EMISSIONS AT ANTENNA TERMINALS

Test Data: 700 Band Uplink Spurious Emissions Plot, > 1 GHz

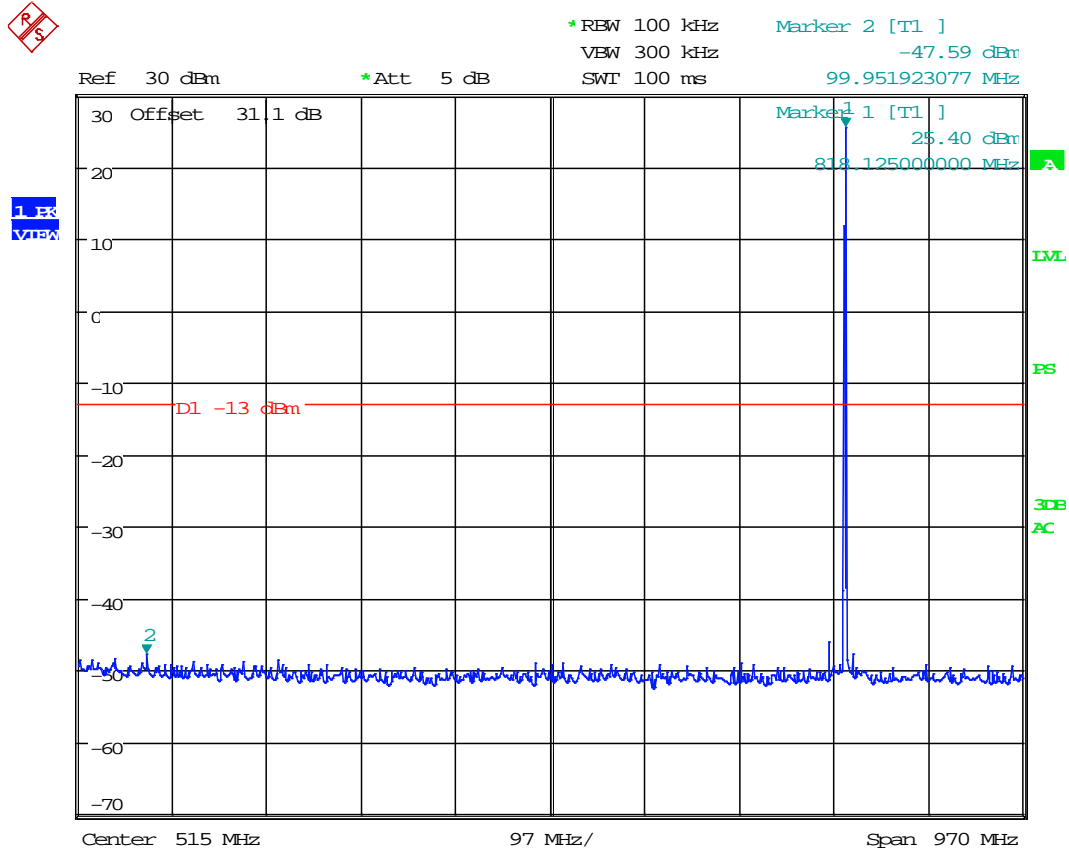


Date: 25.JUN.2019 15:27:04

## SPURIOUS EMISSIONS AT ANTENNA TERMINALS

### 800 Band Conducted Spurious Emissions

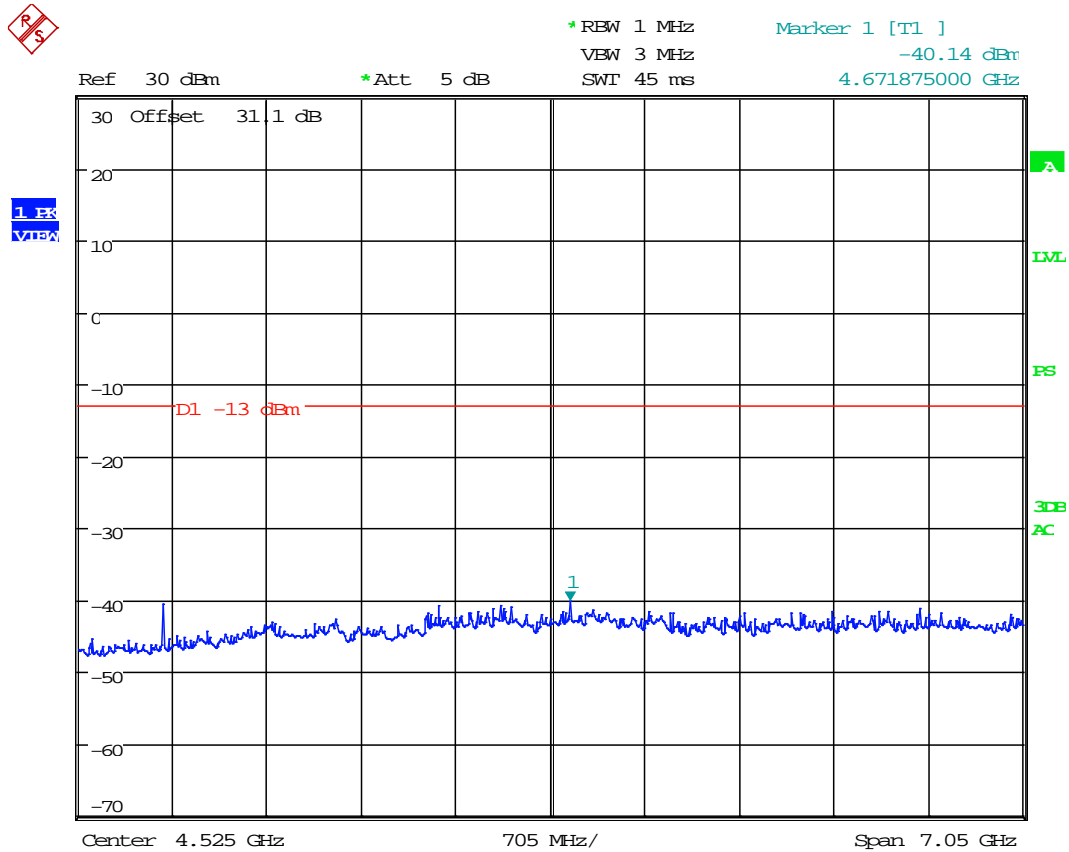
Test Data: 800 Band Uplink Spurious Emissions Plot, 30 MHz – 1 GHz



Date: 25.JUN.2019 13:03:38

## SPURIOUS EMISSIONS AT ANTENNA TERMINALS

Test Data: 800 Band Uplink Spurious Emissions Plot, > 1 GHz



Date: 25.JUN.2019 13:06:34



## STATEMENT OF MEASUREMENT UNCERTAINTY

The data and results referenced in this document are true and accurate. The measurement uncertainty was calculated for all measurements listed in this test report according To CISPR 16-4 or ENTR 100-028 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: “Uncertainty in EMC Measurements” and is documented in the Timco Engineering, Inc. quality system according to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Hereafter the best measurement capability for Timco Engineering, Inc. is reported:

Test Items	Measurement Uncertainty	Notes
RF Frequency Accuracy	$\pm 49.5 \text{ Hz}$	(1)
RF Conducted Power	$\pm 0.93 \text{ dB}$	(1)
Conducted spurious emission of transmitter valid up to 40GHz	$\pm 1.86 \text{ dB}$	
Occupied Bandwidth	$\pm 2.65\%$	
Radiated RF Power	$\pm 1.4 \text{ dB}$	
Rad Emissions Sub Meth up to 26.5GHz	$\pm 2.14 \text{ dB}$	
Adjacent channel power	$\pm 0.93 \text{ dB}$	(1)

**Notes:** (1) This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of  $k=1.96$ .

## EMC EQUIPMENT LIST

Device	Manufacturer	Model	Serial Number	Cal/Char Date	Due Date
Antenna: Biconical 1096	Eaton	94455-1	1096	08/01/17	08/01/19
Antenna: Log-Periodic 1122	Electro-Metrics	LPA-25	1122	07/26/17	07/26/19
Coaxial Cable - Chamber 3 cable set (backup)	Micro-Coax	Chamber 3 cable set (backup)	KMKM-0244-02 KMKM-0670-01 KFKF-0197-00	N/A	N/A
CHAMBER	Panashield	3M	N/A	03/12/19	03/12/21
Ant: Double-Ridged Horn/ETS Horn 1	ETS-Lindgren	3117	00035923	01/30/17	01/30/20
Software: Field Strength Program	Timco	N/A	Version 4.10.7.0	N/A	N/A
EMI Test Receiver R & S ESU 40	Rohde & Schwarz	ESU 40	100320	08/28/18	08/28/20
Bore-sight Antenna Positioning Tower	Sunol Sciences	TLT2	N/A	N/A	N/A
Attenuator N 30dB 20W DC-6G	Narda	PE7015-3	#21	06/22/17	06/22/20
Attenuator N 3dB 20W DC-4G	Narda	766-3	#5	07/10/17	07/10/20
Splitter 1 – 1000 MHz	MiniCircuits	ZFSC-4-1-BNC+	U115700825	N/A	N/A
Coaxial Cable – NMNM-0180-00 Aqua	Micro-Coax	UFB311A-0-0720-50U50U	225362-001 (#100)	07/14/2016	07/14/19
Coaxial Cable – NMNM-0180-01 Aqua	Micro-Coax	UFB311A-0-0720-50U50U	225362-002 (#101)	07/14/2016	07/14/19
Coaxial Cable - BMBM-0122-01 RG400	Pasternack	PE3582LF-48	BMBM-0122-01	01/31/2017	01/31/20
Coaxial Cable - BMBM-0122-02 RG400	Pasternack	PE3582LF-48	BMBM-0122-02	01/31/2017	01/31/20
Coaxial Cable - BMBM-0183-01 RG400	Pasternack	PE3582LF-72	BMBM-0183-01	01/31/2017	01/31/20
Terminator N 20W DC-18G	Narda	8205	#14	N/A	N/A
Noise Source 10MHz - 18GHz	Agilent	346B	MY44421884	N/A	N/A

### \*EMI RECEIVER SOFTWARE VERSION

The receiver firmware used was version 4.43 Service Pack 3

## END OF TEST REPORT