



## FCC CFR 47 Part 90.219 Test Report

|                             |  |
|-----------------------------|--|
| <b>APPLICANT</b>            | RADIO SOLUTIONS, INC.  |
| <b>ADDRESS</b>              | 55 ACCORD PARK DRIVE<br>NORWELL, MA. 02061 USA                         |
| <b>FCC ID</b>               | 2AHVPSB700M2A  |
| <b>MODEL NUMBER</b>         | SB700M2A   |
| <b>PRODUCT DESCRIPTION</b>  | SIGNAL BOOSTER   |
| <b>DATE SAMPLE RECEIVED</b> | 05/09/2018   |
| <b>FINAL TEST DATE</b>      | 05/16/2018   |
| <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 |
|---------------------|----------------|--|------------|
| 652AUT18TestReport_ | Rev1           | Initial Issue                                  | 05/18/2018 |
| 652AUT18TestReport_ | Rev2           | Tested and Reported to updated frequency range | 05/25/2018 |

**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 Testing Technician |
| <b>Date</b>           | 05/18/2018  |

**Reviewed and Approved by:**



|                       |   |
|-----------------------|---|
| <b>Name and Title</b> | Tim Royer, Project Manager / EMC Testing Engineer |
| <b>Date</b>           | 05/18/2018  |

## 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.

|                                |  |  |   |
|--------------------------------|--|--|---|
| <b>EUT Description</b>         | SIGNAL BOOSTER   |  |   |
| <b>EUT Details</b>             | Single Cabinet Bi-Directional PS Signal Booster  |  |   |
| <b>FCC ID</b>                  | 2AHVP SB700M2A   |  |   |
| <b>Model Number</b>            | SB700M2A   |  |   |
| <b>Operating Frequency</b>     | Downlink: 763 – 775 MHz (except in 768–769 MHz guardband)<br>Uplink: 793 – 805 MHz (except in 798–799 MHz guardband)                                       |  |   |
| <b>Test Frequencies</b>        | Downlink: 770 MHz<br>Uplink: 802 MHz   |  |   |
| <b>Type of Emission</b>        | 11K2F3E (Narrowband Analog FM Voice),<br>8K10F1E (P25 Phase I C4FM Voice),<br>8K10F1D (P25 Phase I C4FM Data)<br>8K10F1W (P25 Phase II H-CPM Voice & Data) |  |   |
| <b>Modulation</b>              | FM   |  |   |
| <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"/> 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>       | N Type   |  |   |
| <b>Test Conditions</b>         | The temperature was 26°C<br>Relative humidity of 50%.  |  |   |
| <b>Modification to the EUT</b> | No Modification to EUT.  |  |   |
| <b>Test Exercise</b>           | The EUT was operated in accordance with the service manual.  |  |   |
| <b>Applicable Standards</b>    | TIA 603-E:2016, ANSI C63.26 (by way of incorporation in KDB 935210), 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   |  |   |

## RESULTS SUMMARY

| Applied Rule Part(s)  | Test                                     | Result                |
|---|--|-----------------------|
| KDB 935210 s.4,<br>FCC Pt. 90.531(a)  | Test Frequencies                         | For Reporting Only    |
| KDB 935210 s.4.1  | Test Signals                             | For Reporting Only    |
| KDB 935210 s.4.2  | AGC Threshold                            | For Reporting Only    |
| KDB 935210 s.4.3,<br>FCC Pt. 90.219(a),<br>FCC Pt. 90.219(d)(7)                               | Out-of-Band Rejection                    | <b>CLASS B DEVICE</b> |
| KDB 935210 s.4.4,<br>FCC Pt. 2.1049(c),<br>FCC Pt. 90.219(e)(4)(ii),<br>FCC Pt. 90.210(c)     | Input vs. Output Signal Comparison       | <b>PASS</b>           |
| KDB 935210 s.4.5,<br>FCC Pt. 90.219(e)(1),<br>FCC Pt. 90.219(e)(4)(iii)                       | Input/Output Power 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,<br>FCC Pt. 90.219(e)(2)   | Noise Figure                             | <b>PASS</b>           |
| FCC Pt. 90.219(d)(6)(ii),<br>FCC Pt. 90.219(d)(6)(iii)  | Passband Noise                           | For Reporting Only    |
| KDB 935210 s.4.7.2<br>FCC Part 2.1051(a),<br>FCC Pt. 90.219(d)(6)(i),<br>FCC Pt. 90.219(e)(3) | Intermodulation Spurious Emissions       | <b>PASS</b>           |
| KDB 935210 s.4.7.3,<br>FCC Part 2.1051(a),<br>FCC Pt. 90.219(e)(3)                            | Spurious Emissions at Antenna Terminals  | <b>PASS</b>           |
| KDB 935210 s.4.8,<br>FCC Part 2.1055(a)(1),<br>FCC Part 2.1055(b),<br>FCC Pt. 90.219(e)(4)(i) | Frequency Stability                      | n/a                   |
| KDB 935210 s.4.9,<br>FCC Part 2.1053(a),<br>FCC Pt. 90.219(e)(3)                              | Field Strength of Spurious Emissions     | <b>PASS</b>           |

## 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>L</sub> (MHz) | Rule(s)                                       | Misc. Notes |
|----------------------|---|----------------------|---|-------------|
| 758                  | – | 768                  | 90-R, Public Safety (PS) Broadband (FirstNet) | LTE         |
| 768                  | – | 769                  | PS Guardband                                  |             |
| 769                  | – | 775                  | PS Narrowband                                 |             |
| 788                  | – | 798                  | 90-R, Public Safety (PS) Broadband (FirstNet) | LTE         |
| 798                  | – | 799                  | PS Guardband                                  |             |
| 799                  | – | 805                  | PS Narrowband                                 |             |

**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: 763 – 775 MHz, except for the 768 – 769 MHz Guardband; and 793 – 805 MHz, except for the 798 – 799 MHz Guardband

Therefore, the test frequency of each band shall be:

**Downlink Band: 770 MHz**

**Uplink Band: 802 MHz**

## TEST 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**

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

**EUT Intended Band:**

**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 |
|----------------------|---|----------------------|---------------|-------------|
| 769                  | – | 775                  | PS Narrowband |             |
| 799                  | – | 805                  | PS Narrowband |             |

**Input Signals for testing:**

**11K3F3E (Narrowband Analog FM Voice)**

**Covering signals:**

8K10F1E (P25 Phase I C4FM Voice)

**8K10F1D (P25 Phase I C4FM Data)**

**8K10F1W (P25 Phase II H-CPM Voice/Data)**



## 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>

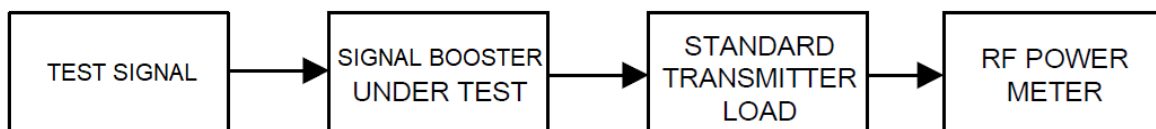
In the case of fiber-optic distribution systems, the RF input port of the equipment under test (EUT) refers to the RF input of the supporting equipment RF to optical convertor; see also descriptions and diagrams for typical DAS booster systems in KDB Publication 935210 D02 [R7].

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: Downlink Measurement Table

|            | Gen Freq<br>(MHz) | Gen Output<br>(dBm) | Insertion Loss<br>(dB) | Booster Input<br>(dBm) | Booster Output<br>(dBm) |
|------------|-------------------|---------------------|------------------------|------------------------|-------------------------|
|            | 770.00            | -43.7               | -20.84                 | -64.54                 | 26.97                   |
|            | 770.00            | -42.7               | -20.84                 | -63.54                 | 27.98                   |
|            | 770.00            | -41.7               | -20.84                 | -62.54                 | 29.00                   |
| AGC        | 770.00            | -40.7               | -20.84                 | -61.54                 | 30.00                   |
|            | 770.00            | -39.7               | -20.84                 | -60.54                 | 30.00                   |
|            | 770.00            | -38.7               | -20.84                 | -59.54                 | 30.00                   |
| AGC +3 dBm | 770.00            | -37.7               | -20.84                 | -58.54                 | 30.00                   |

**AGC LEVEL: -61.54 dBm**

### Test Data: Uplink Measurement Table

|            | Gen Freq<br>(MHz) | Gen Output<br>(dBm) | Insertion Loss<br>(dB) | Booster Input<br>(dBm) | Booster Output<br>(dBm) |
|------------|-------------------|---------------------|------------------------|------------------------|-------------------------|
|            | 802.00            | -43.7               | -20.84                 | -64.54                 | 27.09                   |
|            | 802.00            | -42.7               | -20.84                 | -63.54                 | 28.05                   |
|            | 802.00            | -41.7               | -20.84                 | -62.54                 | 29.04                   |
| AGC        | 802.00            | -40.7               | -20.84                 | -61.54                 | 30.04                   |
|            | 770.00            | -39.7               | -20.84                 | -60.54                 | 30.04                   |
|            | 770.00            | -38.7               | -20.84                 | -59.54                 | 30.04                   |
| AGC +3 dBm | 770.00            | -37.7               | -20.84                 | -58.54                 | 30.04                   |

**AGC LEVEL: -61.54 dBm**

## 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:

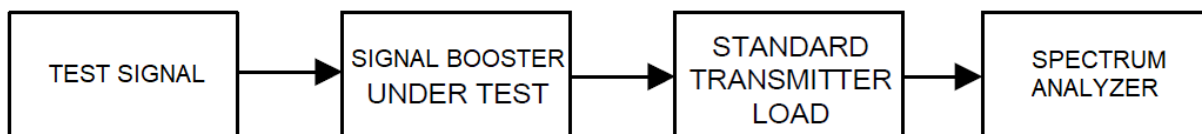
(7) Signal booster passbands are limited to the service band or bands for which the operator is authorized. In general, signal boosters should utilize the minimum passband that is sufficient to accomplish the purpose. Except for distributed antenna systems (DAS) installed in buildings, the passband of 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.

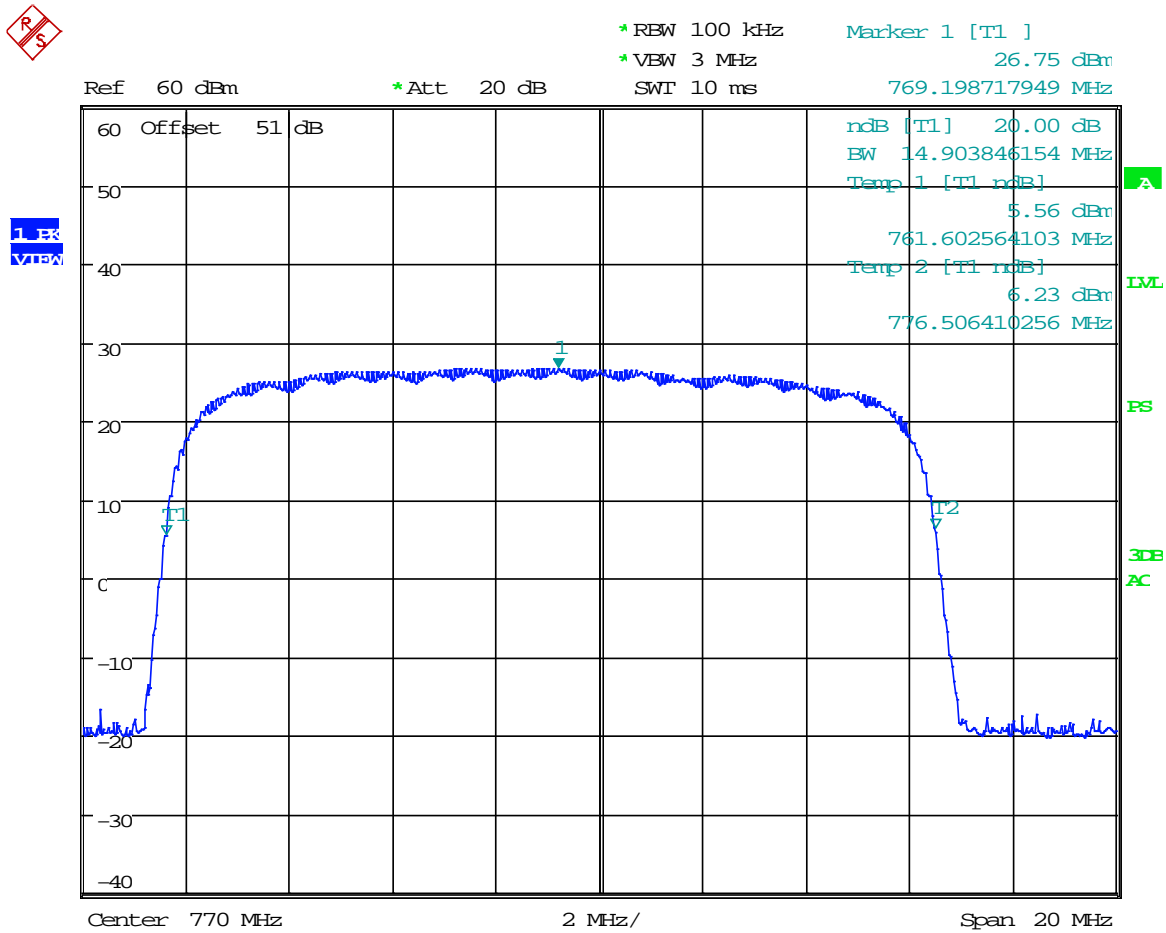
- a) Connect a signal generator to the input of the EUT.
- b) Configure a swept CW signal with the following parameters:
  - 1) Frequency range =  $\pm 250\%$  of the manufacturer's specified pass band.
  - 2) The CW amplitude shall be 3 dB below the AGC threshold (see 4.2), and shall not activate the 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: Downlink Passband



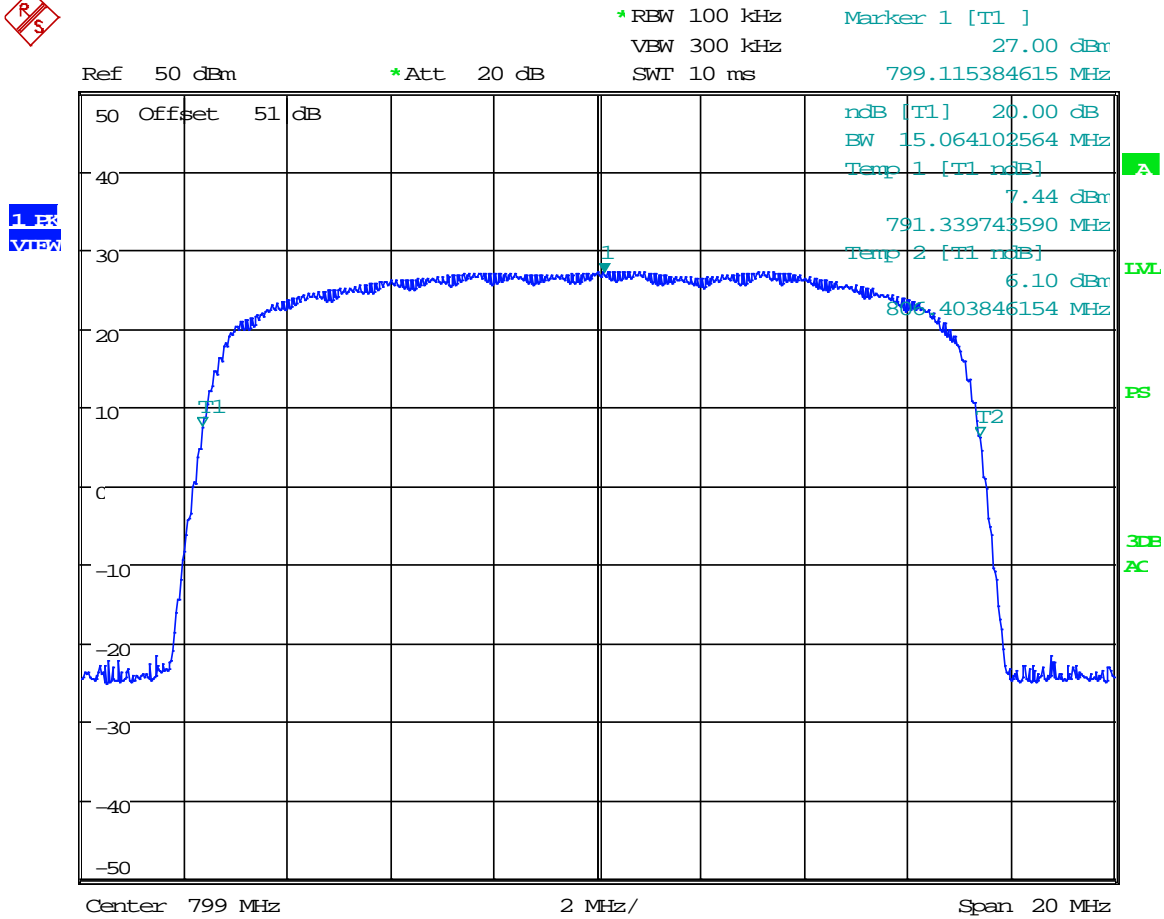
Date: 14.MAY.2018 14:52:03

**OPERATIONAL PASSBAND = 14.90 MHz**

**RESULT: CLASS B DEVICE ( $\geq 75$  kHz Passband)**

## OUT OF BAND REJECTION

Test Data: Uplink Passband



Date: 15.MAY.2018 14:26:45

**OPERATIONAL PASSBAND = 15.06 MHz**

**RESULT: CLASS B DEVICE ( $\geq 75$  kHz Passband)**

## 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:

APPLICABLE EMISSION MASKS

| Frequency band (MHz)           | Mask for equipment with audio low pass filter | Mask for equipment without audio low pass filter |
|--------------------------------|---|--|
| Below 25 <sup>1</sup>          | A or B  | A or C   |
| 25-50                          | B   | C  |
| 72-76                          | B   | C  |
| 150-174 <sup>2</sup>           | B, D, or E                                    | C, D or E  |
| 150 paging only                | B   | C  |
| 220-222                        | F   | F  |
| 421-512 <sup>2 5</sup>         | B, D, or E                                    | C, D, or E                                       |
| 450 paging only                | B   | G  |
| 806-809/851-854 <sup>6</sup>   | B   | H  |
| 809-824/854-869 <sup>3 5</sup> | B   | 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 <sup>4</sup>         |   |  |
| 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 ( $f_d$  in kHz) of more than 5 kHz, but not more than 10 kHz: At least  $83 \log(f_d/5)$  dB;

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

(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).

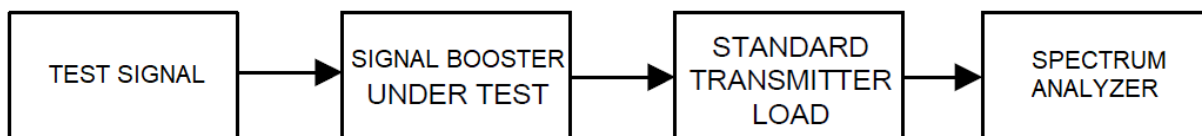


## INPUT VS OUTPUT COMPARISON

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

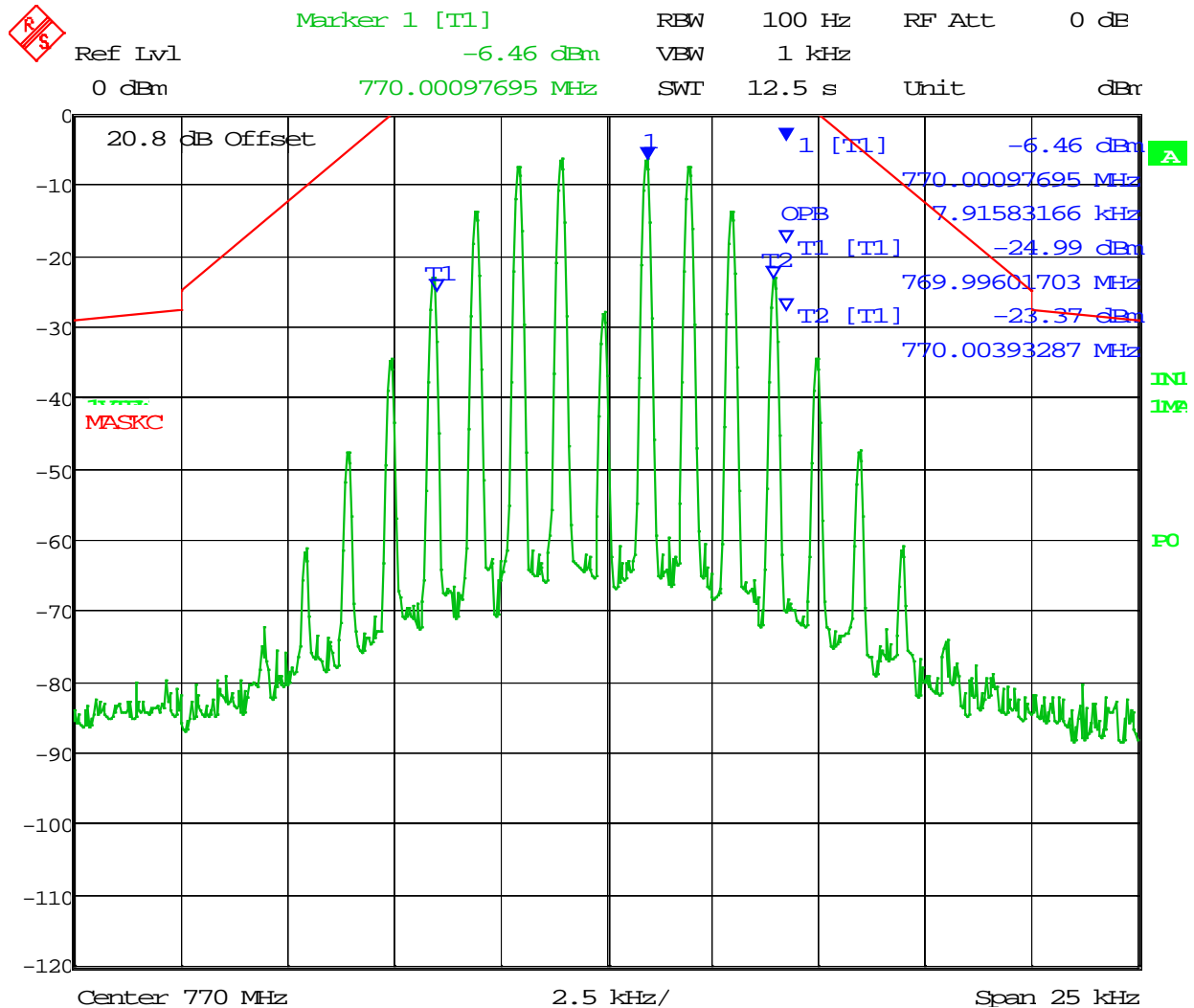
- a) Connect a signal generator to the input of the EUT.
- b) Configure the signal generator to transmit the appropriate test signal associated with the public safety emission designation (see Table 1).
- c) Configure the signal level to be just below the AGC threshold (see results from 4.2).
- d) Connect 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

Test Data: Downlink (770 MHz), 11K3F3E Input Signal



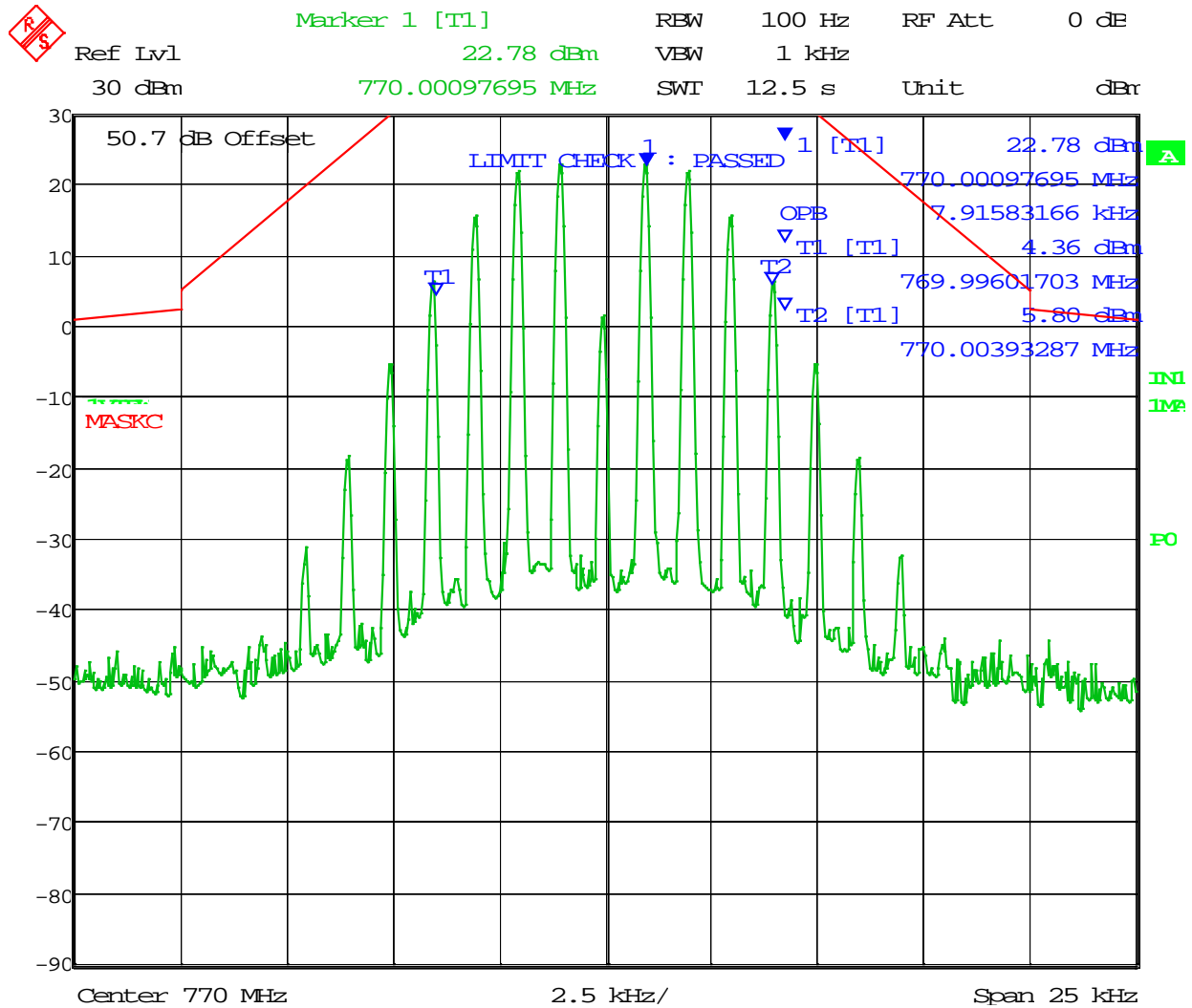
Date: 1.JAN.1997 02:32:19

**RESULT: Input Signal 99% OBW = 7.92 kHz**



## INPUT VS OUTPUT COMPARISON

Test Data: Downlink (770 MHz), 11K3F3E Output Signal, @ AGC

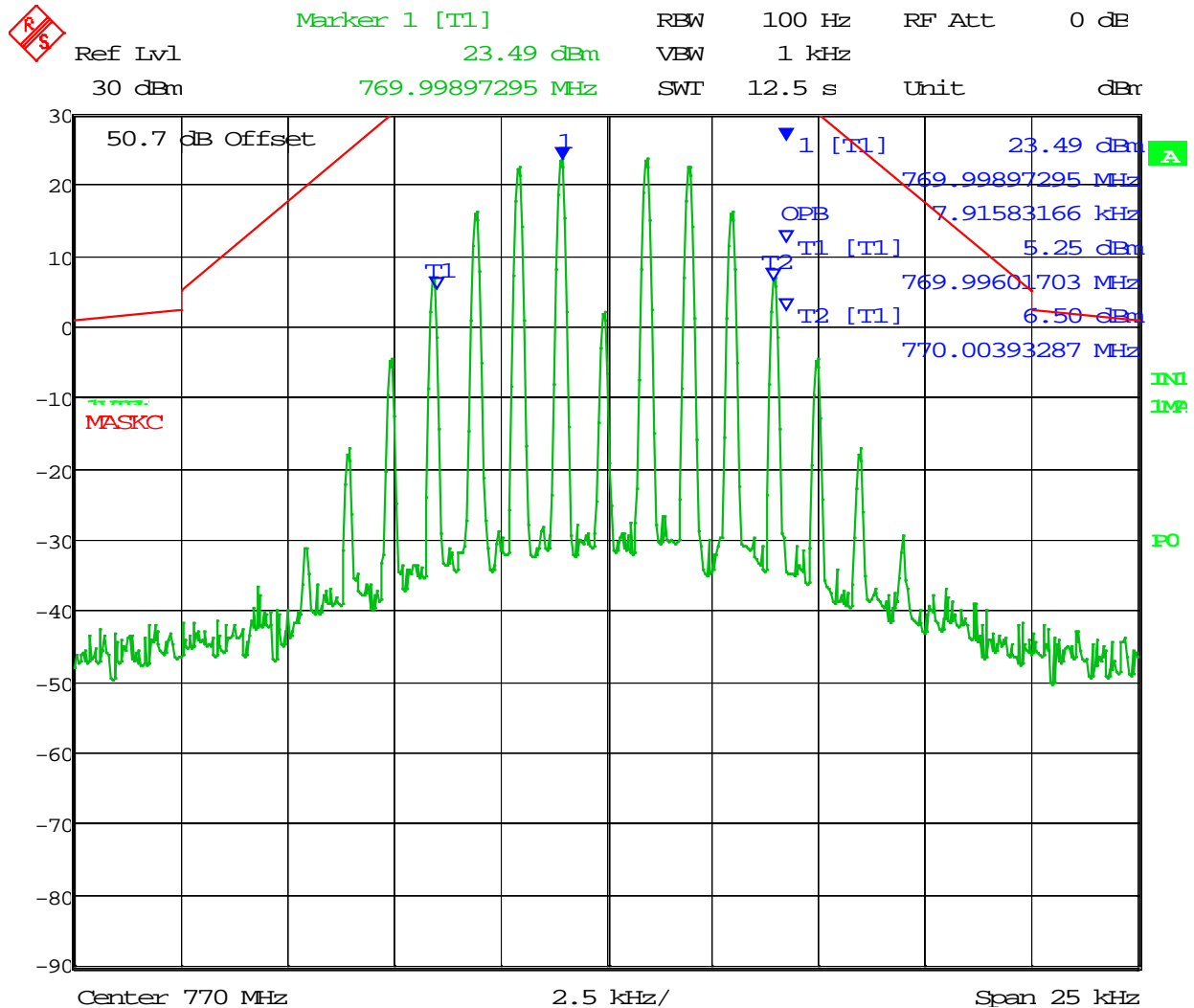


Date: 1.JAN.1997 02:38:04

**RESULT: AGC Output Signal 99% OBW = 7.92 kHz**

## INPUT VS OUTPUT COMPARISON

Test Data: Downlink (770 MHz), 11K3F3E Output Signal, @ AGC +3 dBm

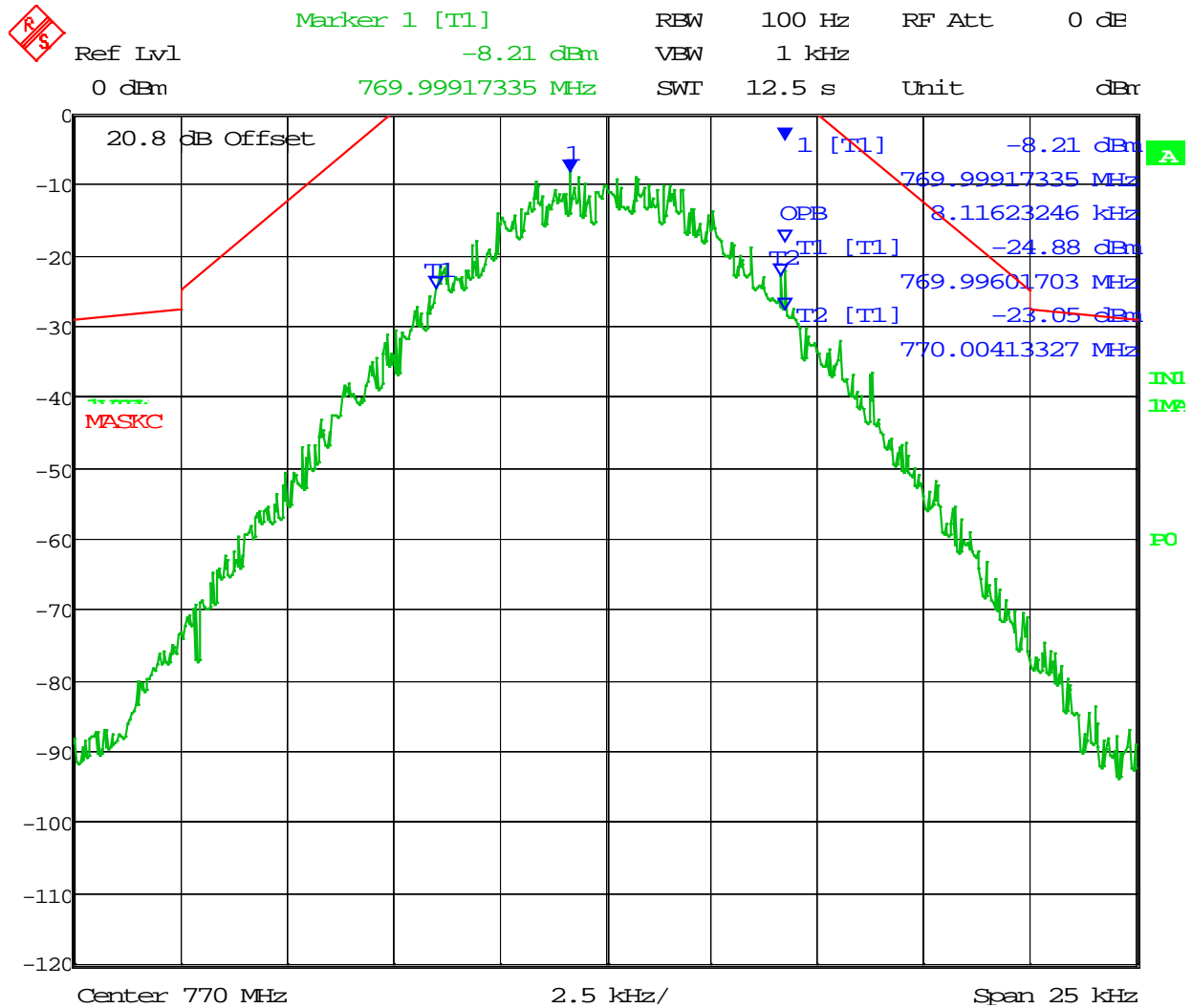


Date: 1.JAN.1997 02:40:38

**RESULT: AGC+3 Output Signal 99% OBW = 7.92 kHz**

## INPUT VS OUTPUT COMPARISON

Test Data: Downlink (770 MHz), 8K10F1D Input Signal

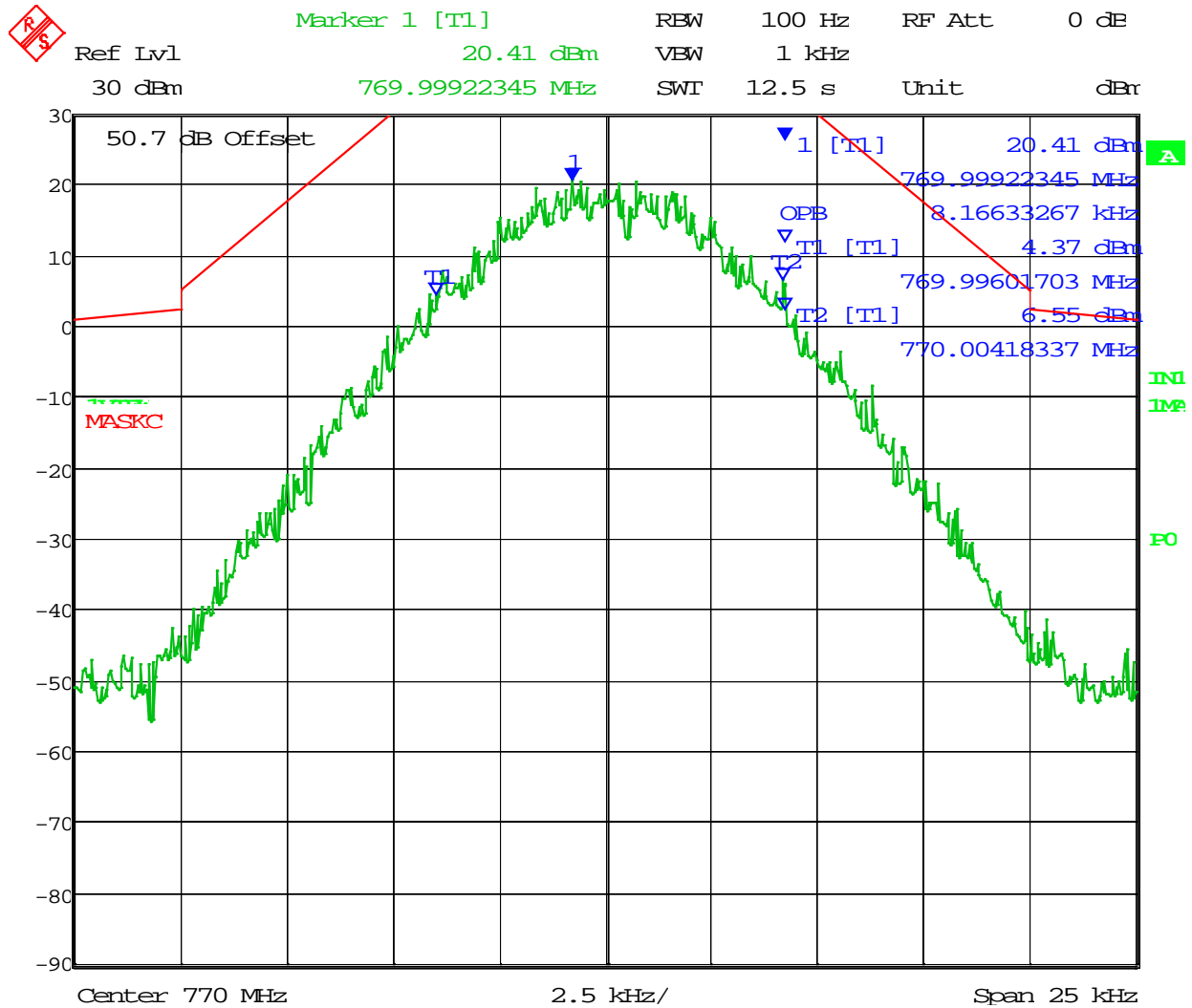


Date: 1.JAN.1997 02:29:15

**RESULT: Input Signal 99% OBW = 8.12 kHz**

## INPUT VS OUTPUT COMPARISON

Test Data: Downlink (770 MHz), 8K10F1D Output Signal, @ AGC

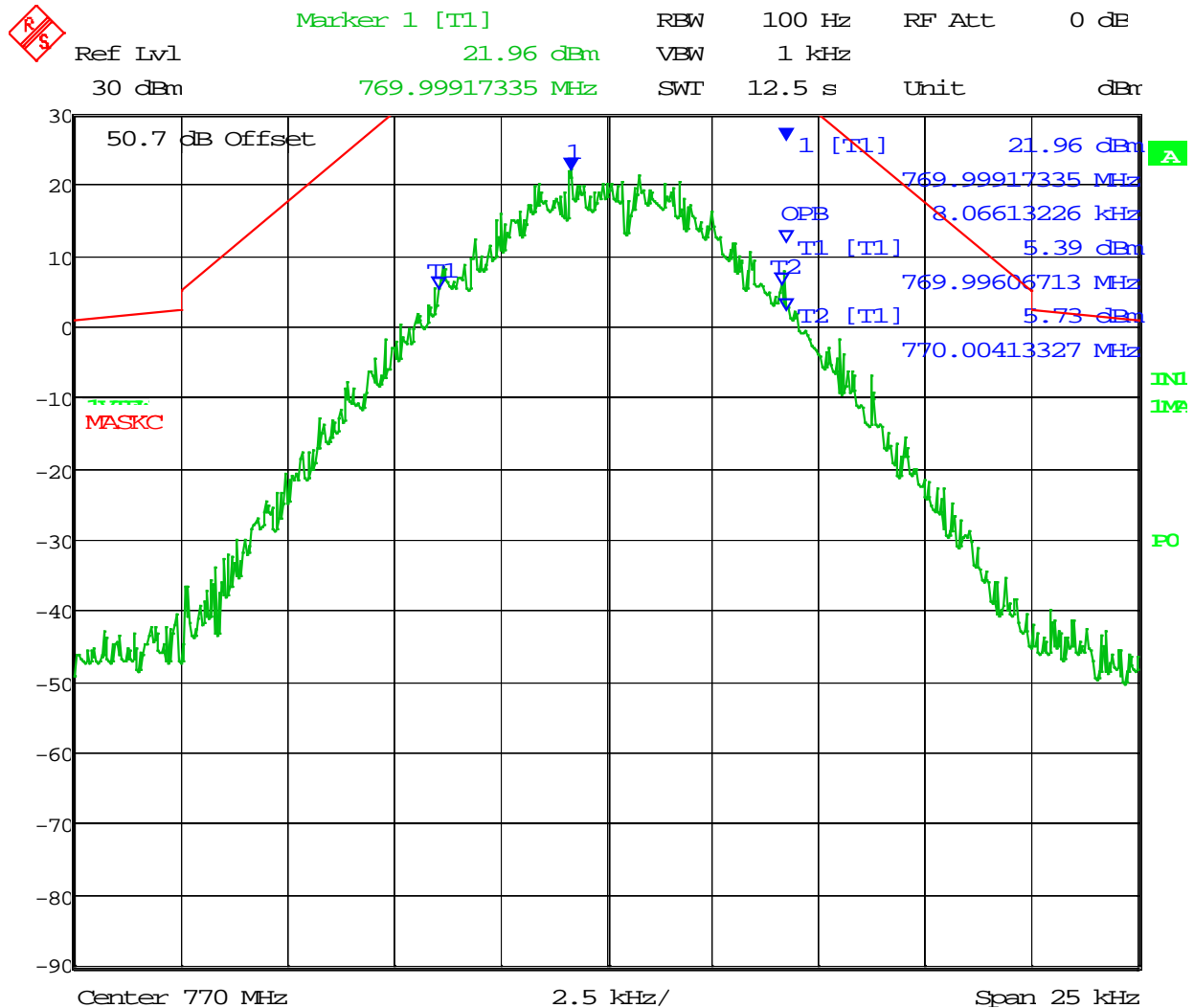


Date: 1.JAN.1997 02:42:44

**RESULT: AGC Output Signal 99% OBW = 8.17 kHz**

## INPUT VS OUTPUT COMPARISON

Test Data: Downlink (770 MHz), 8K10F1D Output Signal, @ AGC +3 dBm

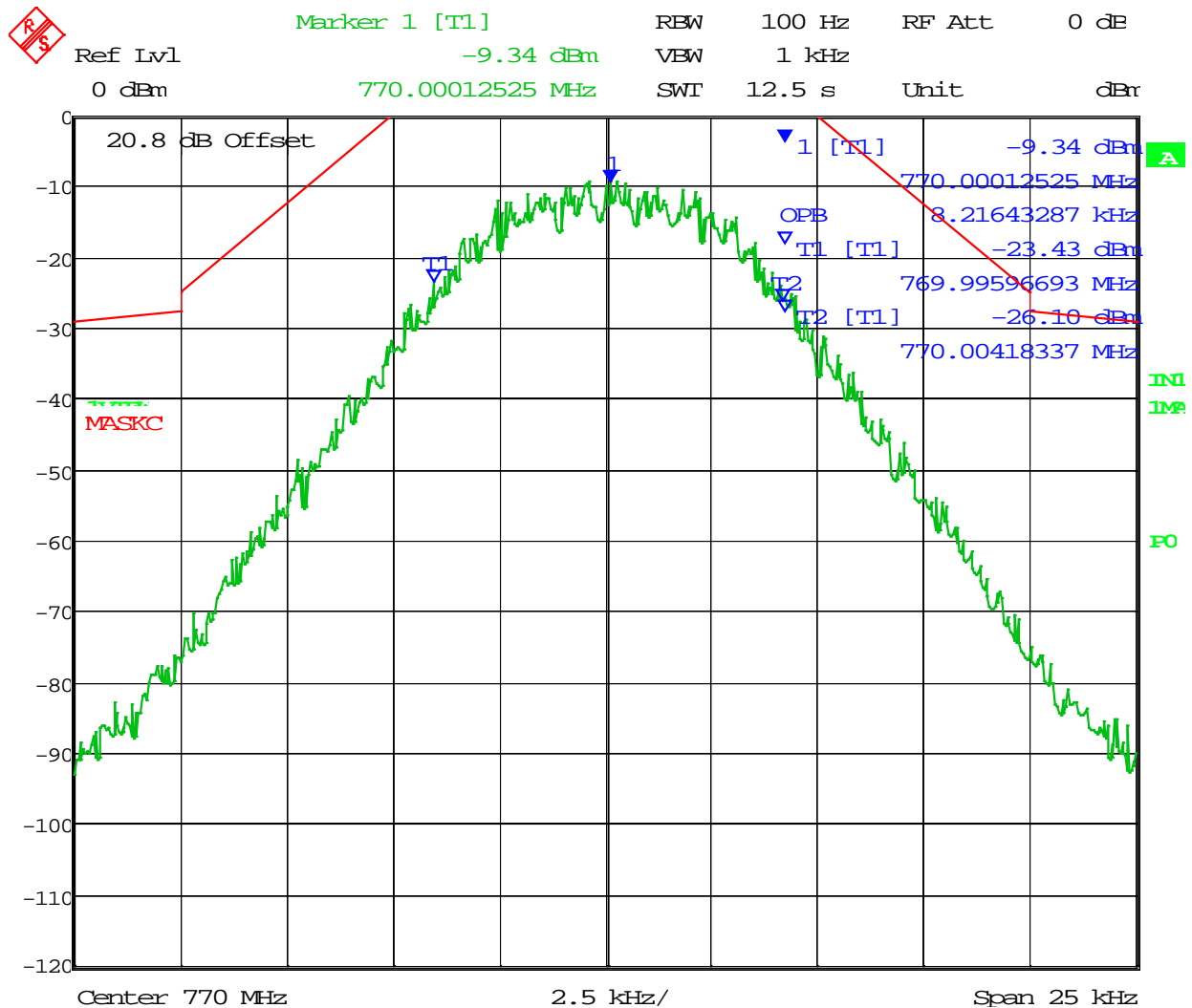


Date: 1.JAN.1997 02:48:54

**RESULT: AGC+3 Output Signal 99% OBW = 8.07 kHz**

## INPUT VS OUTPUT COMPARISON

Test Data: Downlink (770 MHz), 8K10F1W Input Signal

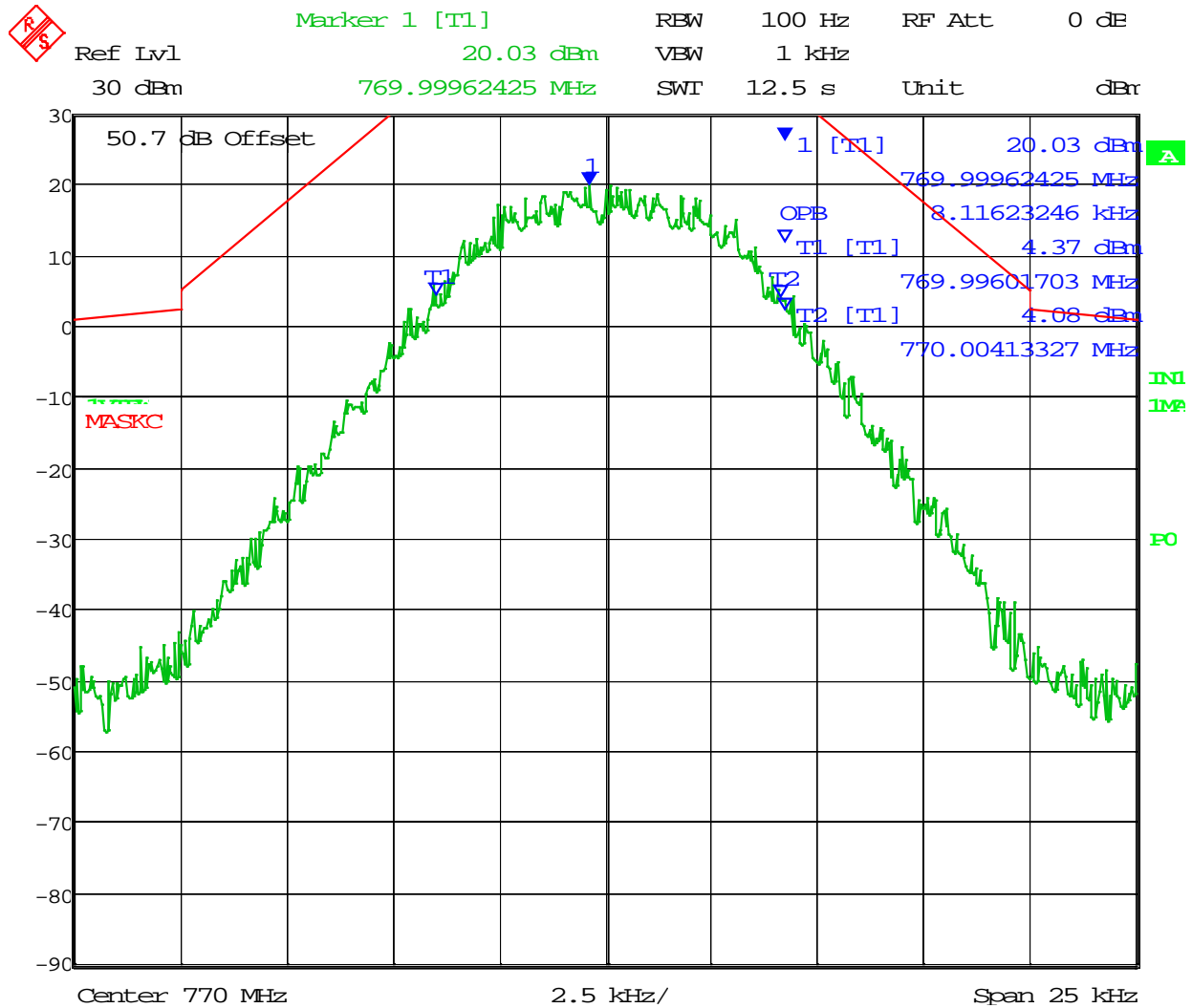


Date: 1.JAN.1997 02:30:36

**RESULT: Input Signal 99% OBW = 8.23 kHz**

## INPUT VS OUTPUT COMPARISON

Test Data: Downlink (770 MHz), 8K10F1W Output Signal, @ AGC

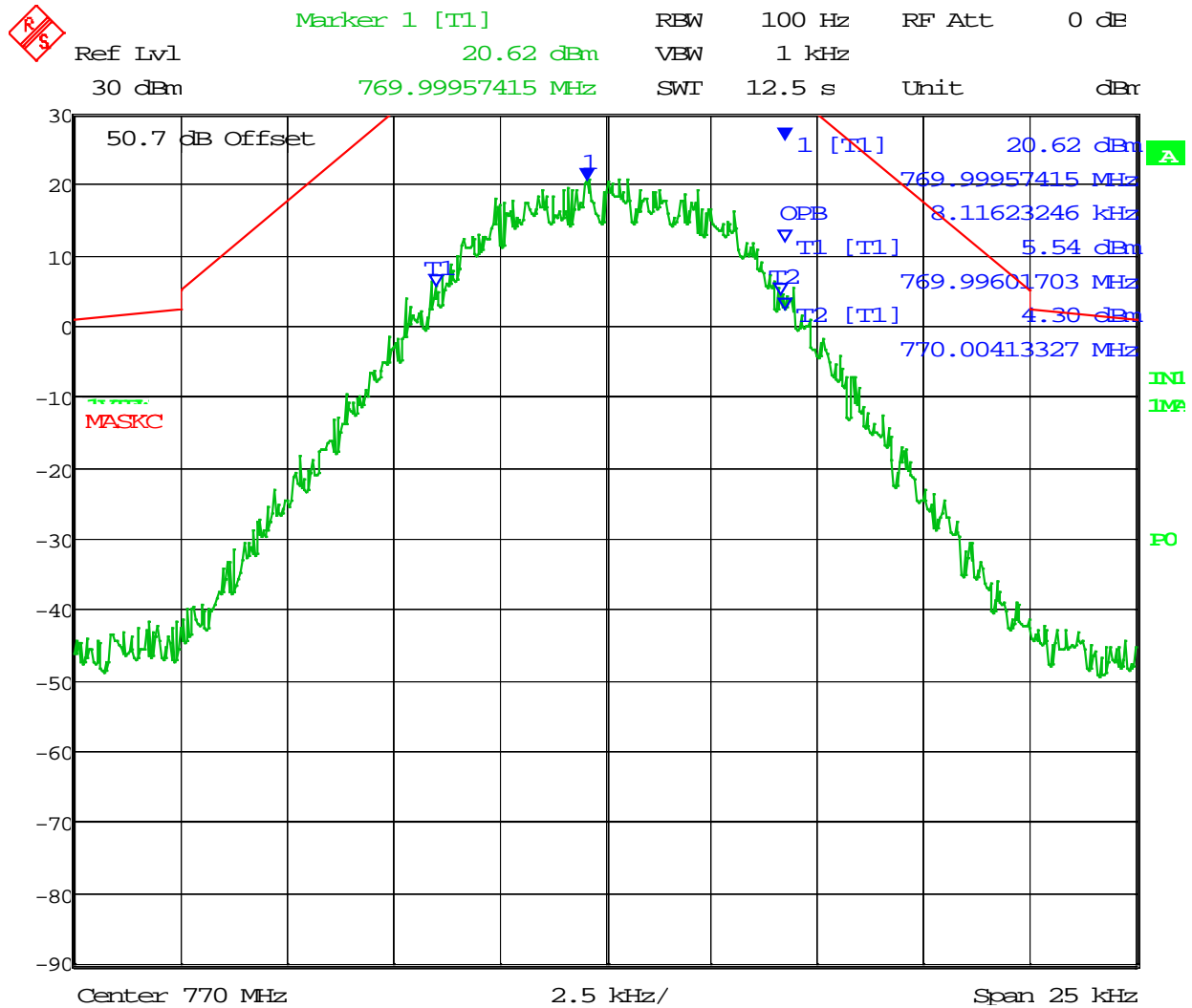


Date: 1.JAN.1997 02:46:32

**RESULT: AGC Output Signal 99% OBW = 8.12 kHz**

## INPUT VS OUTPUT COMPARISON

Test Data: Downlink (770 MHz), 8K10F1W Output Signal, @ AGC +3 dBm



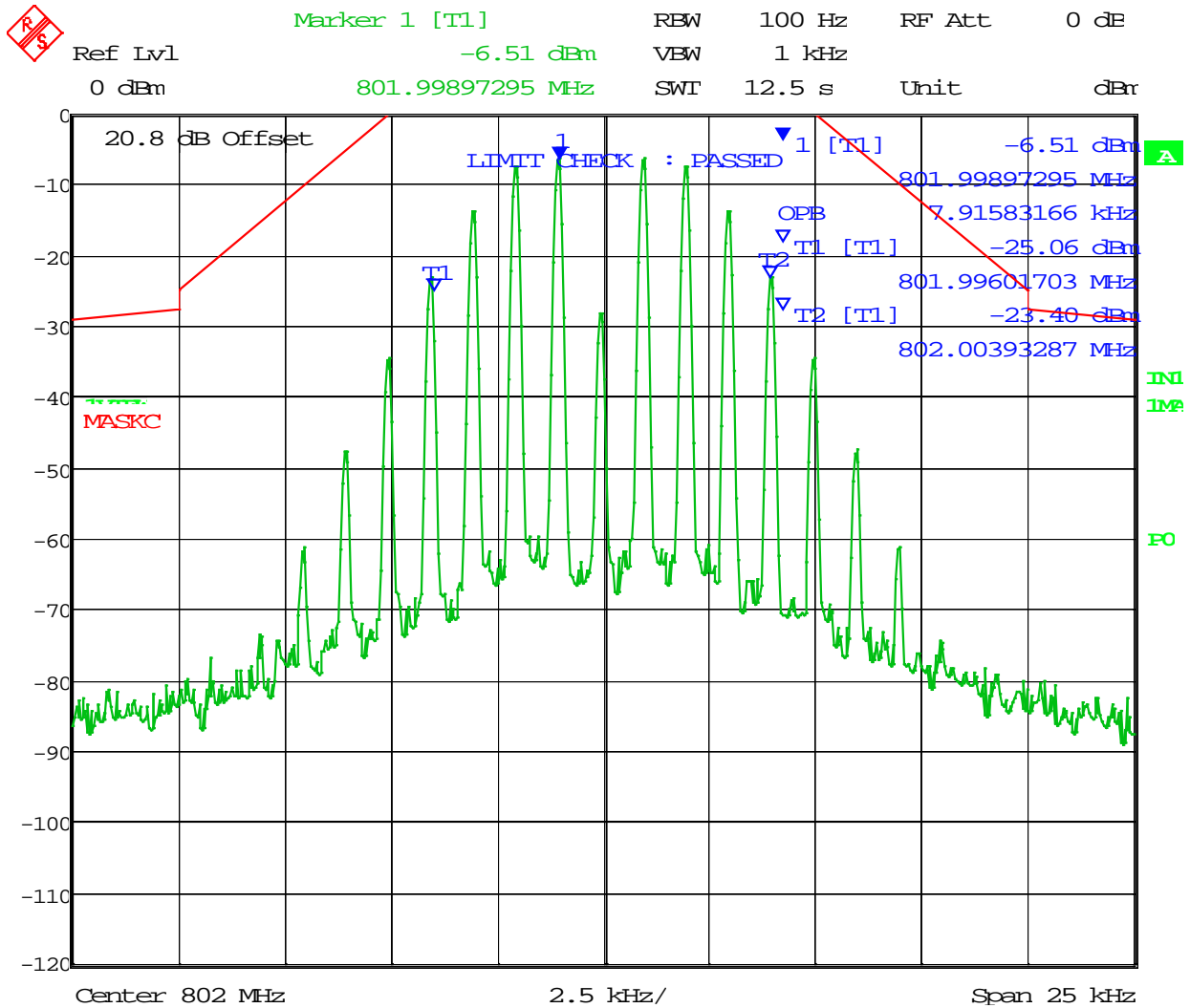
Date: 1.JAN.1997 02:47:52

**RESULT: AGC+3 Output Signal 99% OBW = 8.12 kHz**



## INPUT VS OUTPUT COMPARISON

Test Data: Uplink (802 MHz), 11K3F3E Input Signal

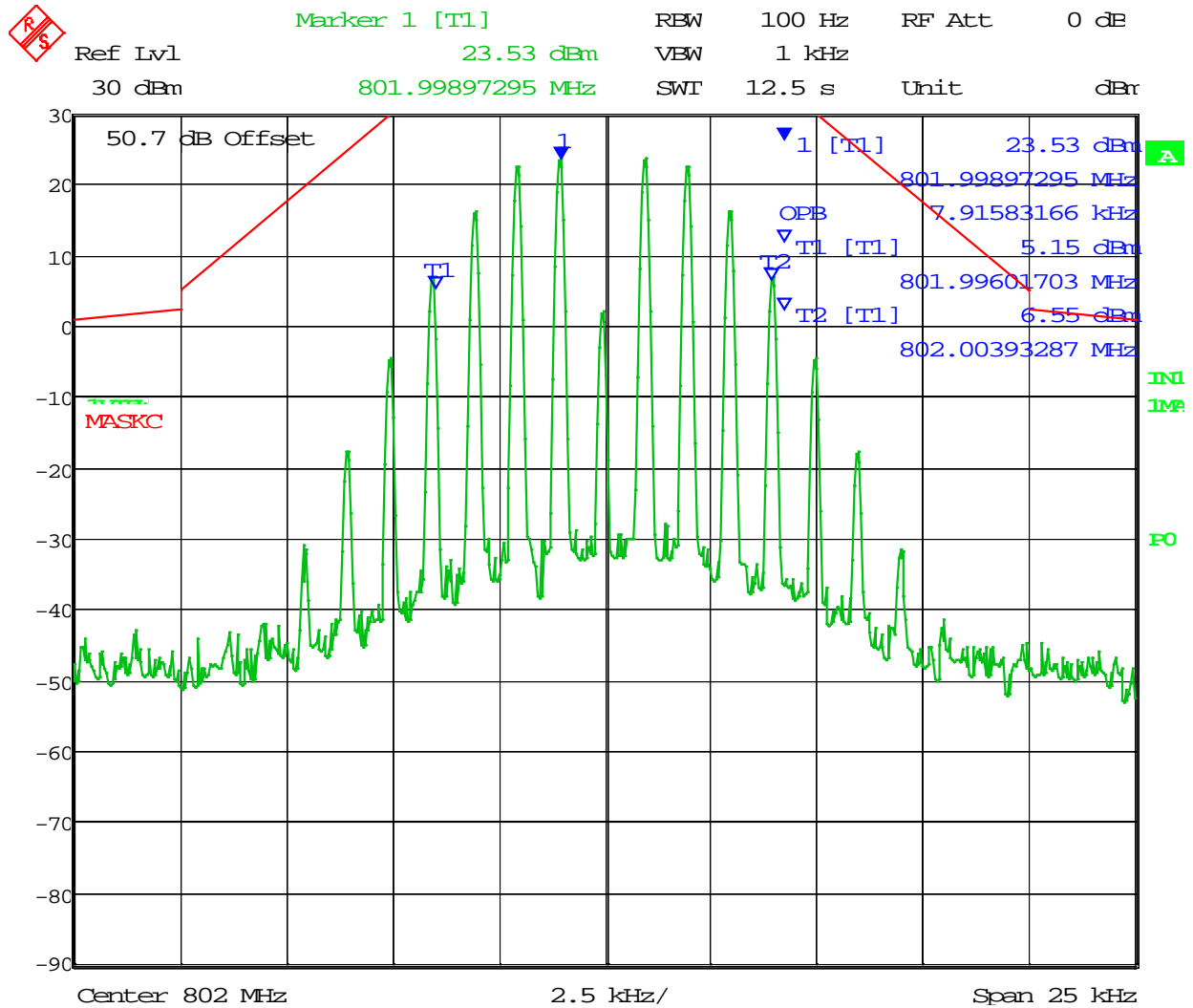


Date: 1.JAN.1997 03:06:46

**RESULT: Input Signal 99% OBW = 7.92 kHz**

## INPUT VS OUTPUT COMPARISON

Test Data: Uplink (802 MHz), 11K3F3E Output Signal, @ AGC

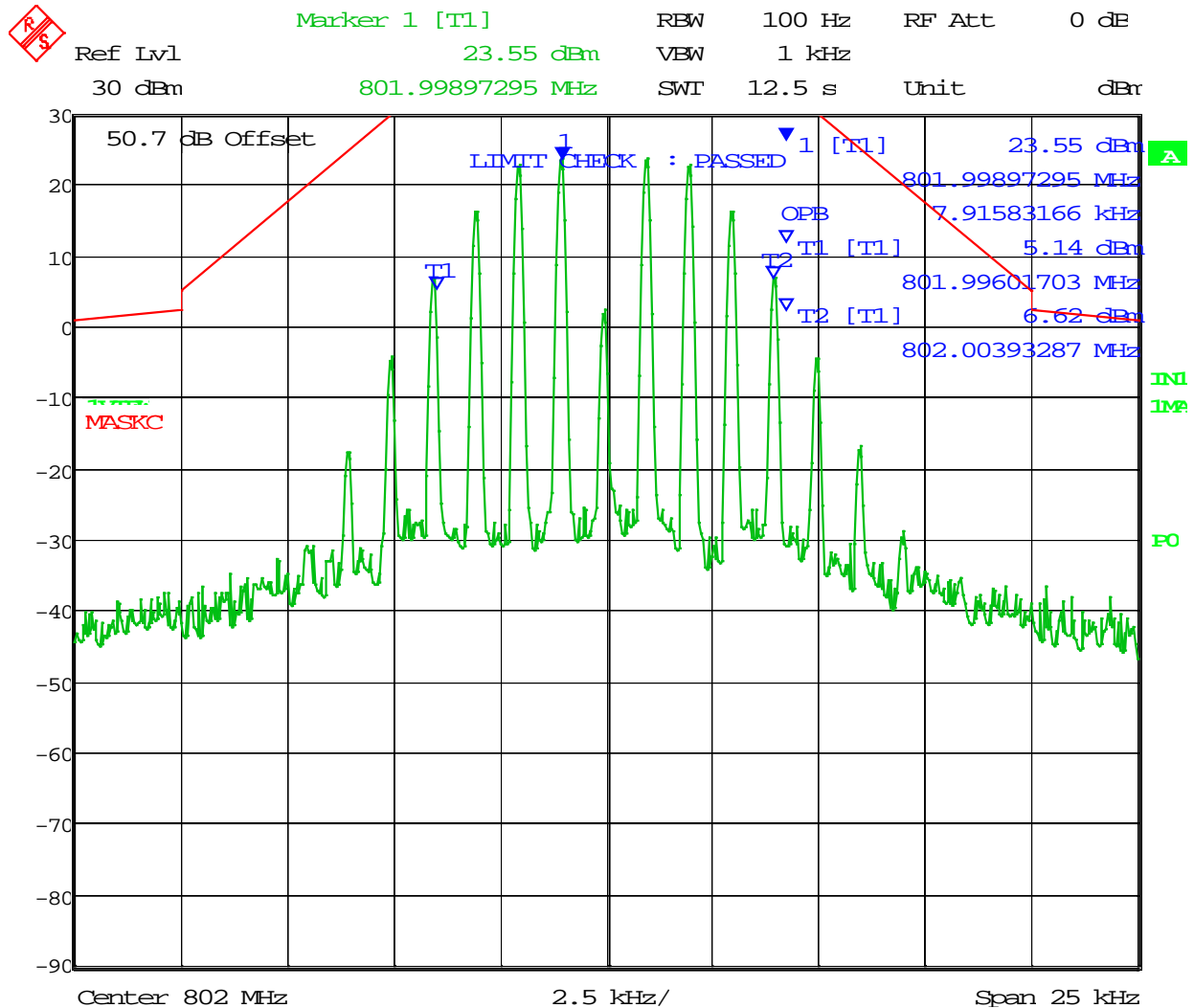


Date: 1.JAN.1997 03:03:23

**RESULT: AGC Output Signal 99% OBW = 7.92 kHz**

## INPUT VS OUTPUT COMPARISON

Test Data: Uplink (802 MHz), 11K3F3E Output Signal, @ AGC +3 dBm

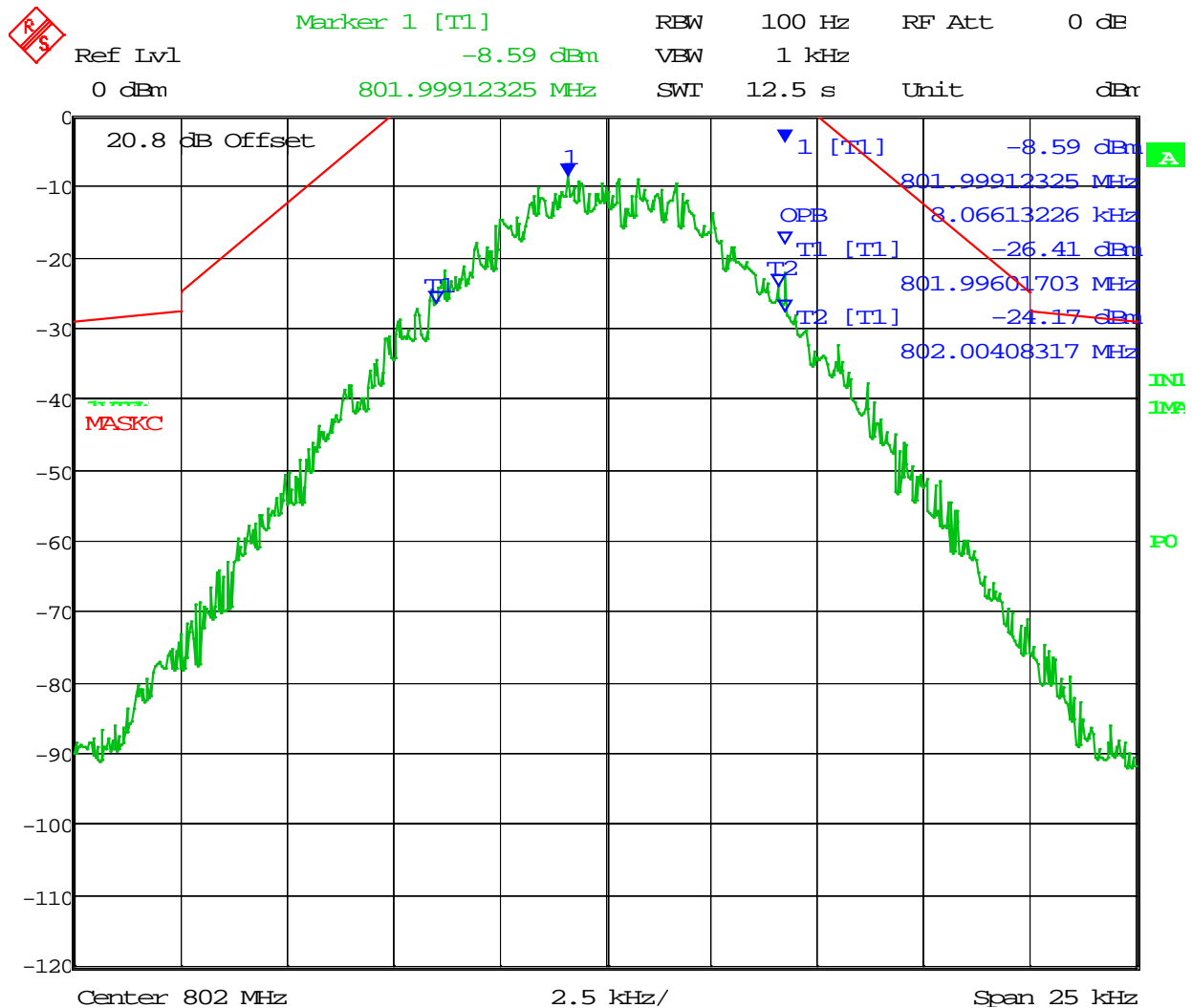


Date: 1.JAN.1997 03:04:15

**RESULT: AGC+3 Output Signal 99% OBW = 7.92 kHz**

## INPUT VS OUTPUT COMPARISON

Test Data: Uplink (802 MHz), 8K10F1D Input Signal

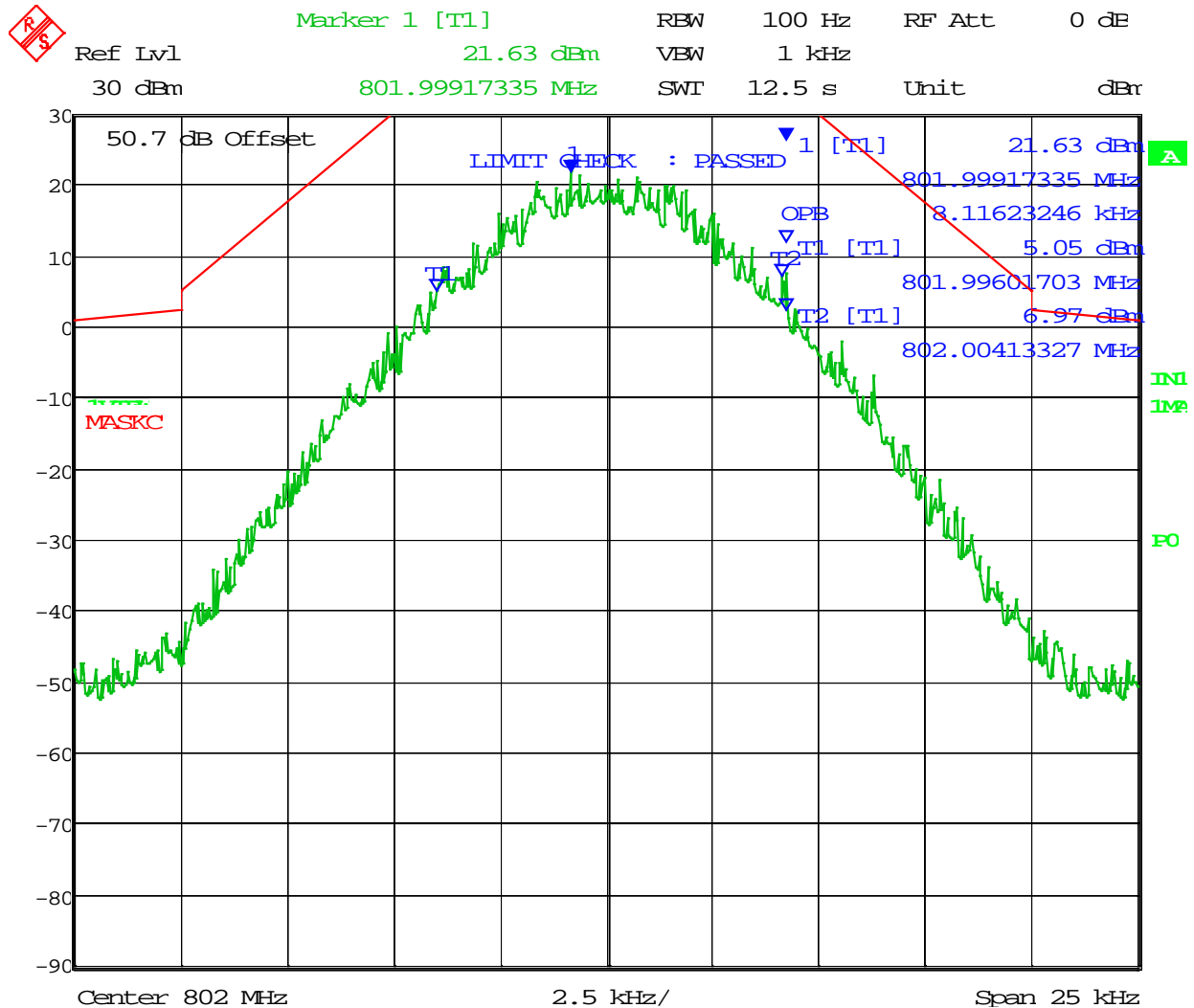


Date: 1.JAN.1997 03:09:22

**RESULT: Input Signal 99% OBW = 8.07 kHz**

## INPUT VS OUTPUT COMPARISON

Test Data: Uplink (802 MHz), 8K10F1D Output Signal, @ AGC

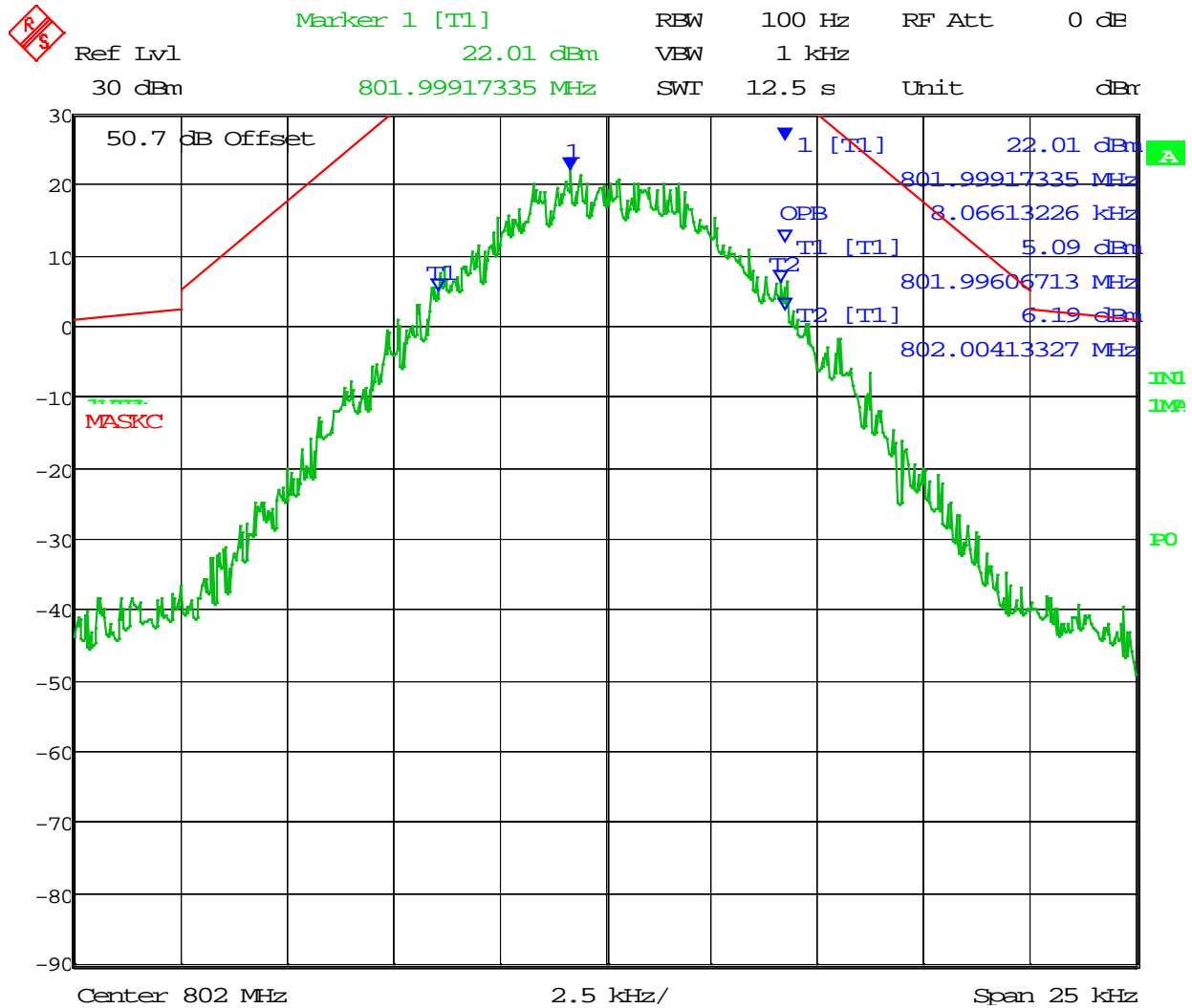


Date: 1.JAN.1997 02:55:17

**RESULT: AGC Output Signal 99% OBW = 8.12 kHz**

## INPUT VS OUTPUT COMPARISON

Test Data: Uplink (802 MHz), 8K10F1D Output Signal, @ AGC +3 dBm

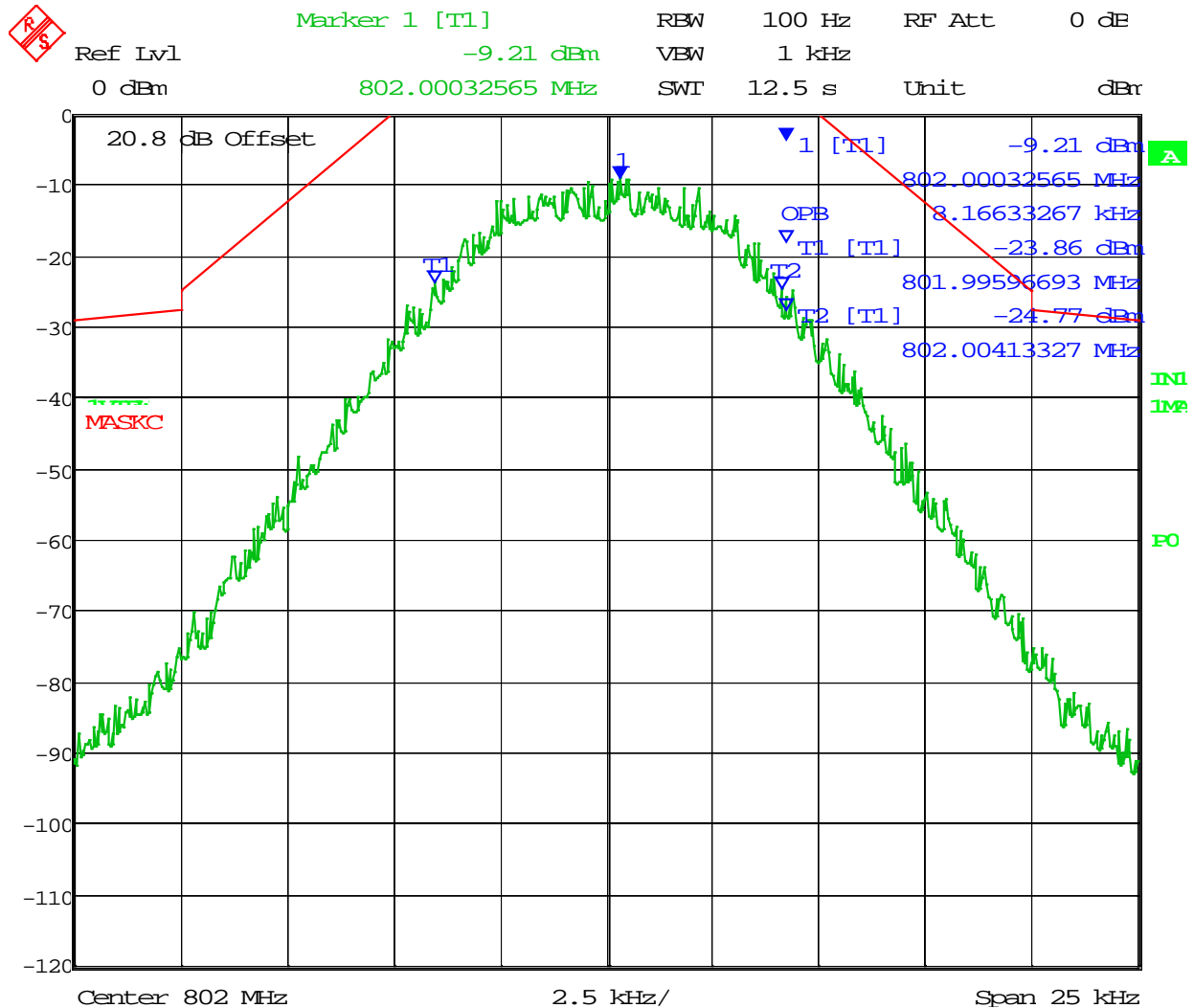


Date: 1.JAN.1997 02:53:59

**RESULT: AGC+3 Output Signal 99% OBW = 8.07 kHz**

## INPUT VS OUTPUT COMPARISON

Test Data: Uplink (802 MHz), 8K10F1W Input Signal

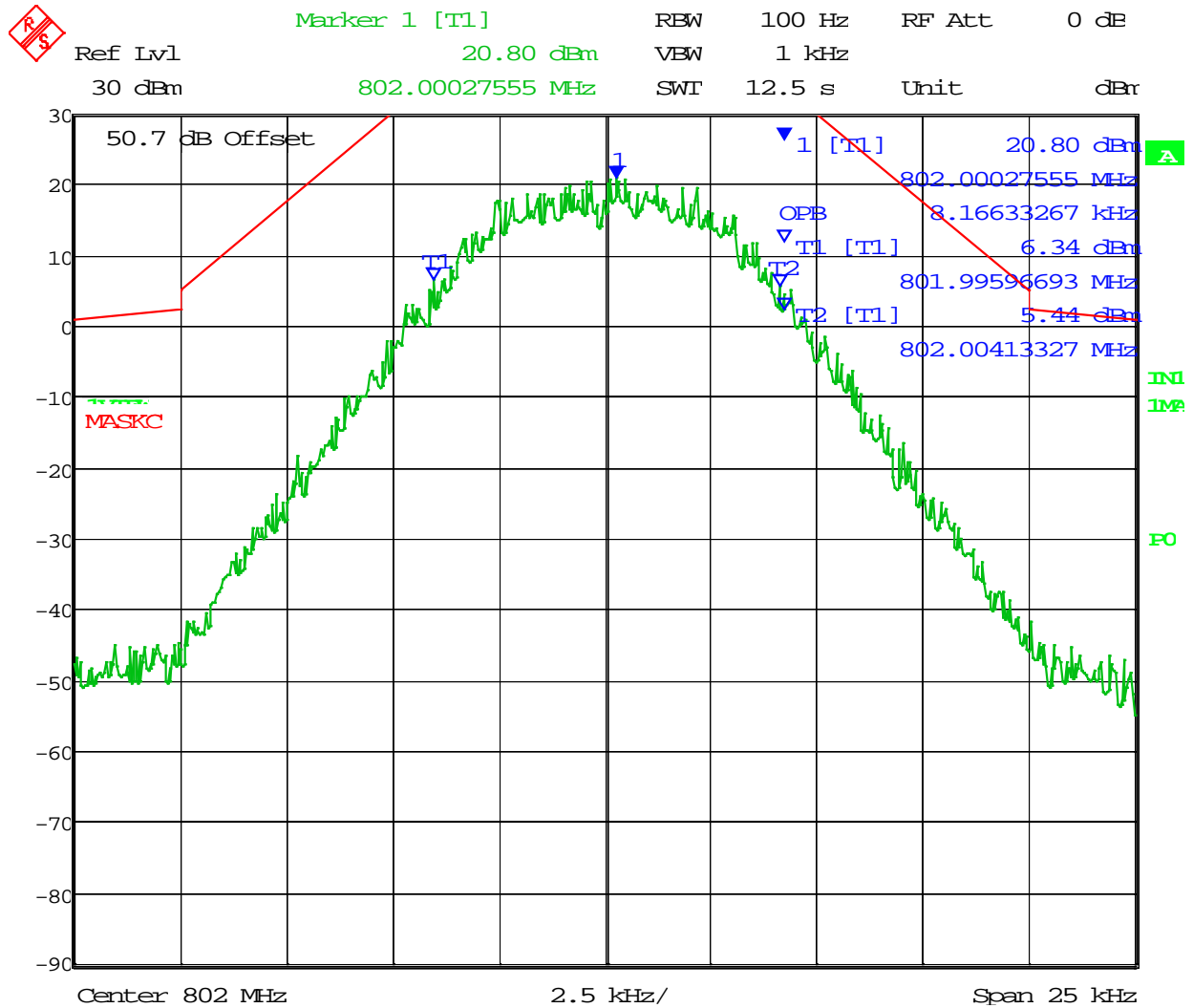


Date: 1.JAN.1997 03:08:26

**RESULT: Input Signal 99% OBW = 8.17 kHz**

## INPUT VS OUTPUT COMPARISON

Test Data: Uplink (802 MHz), 8K10F1W Output Signal, @ AGC



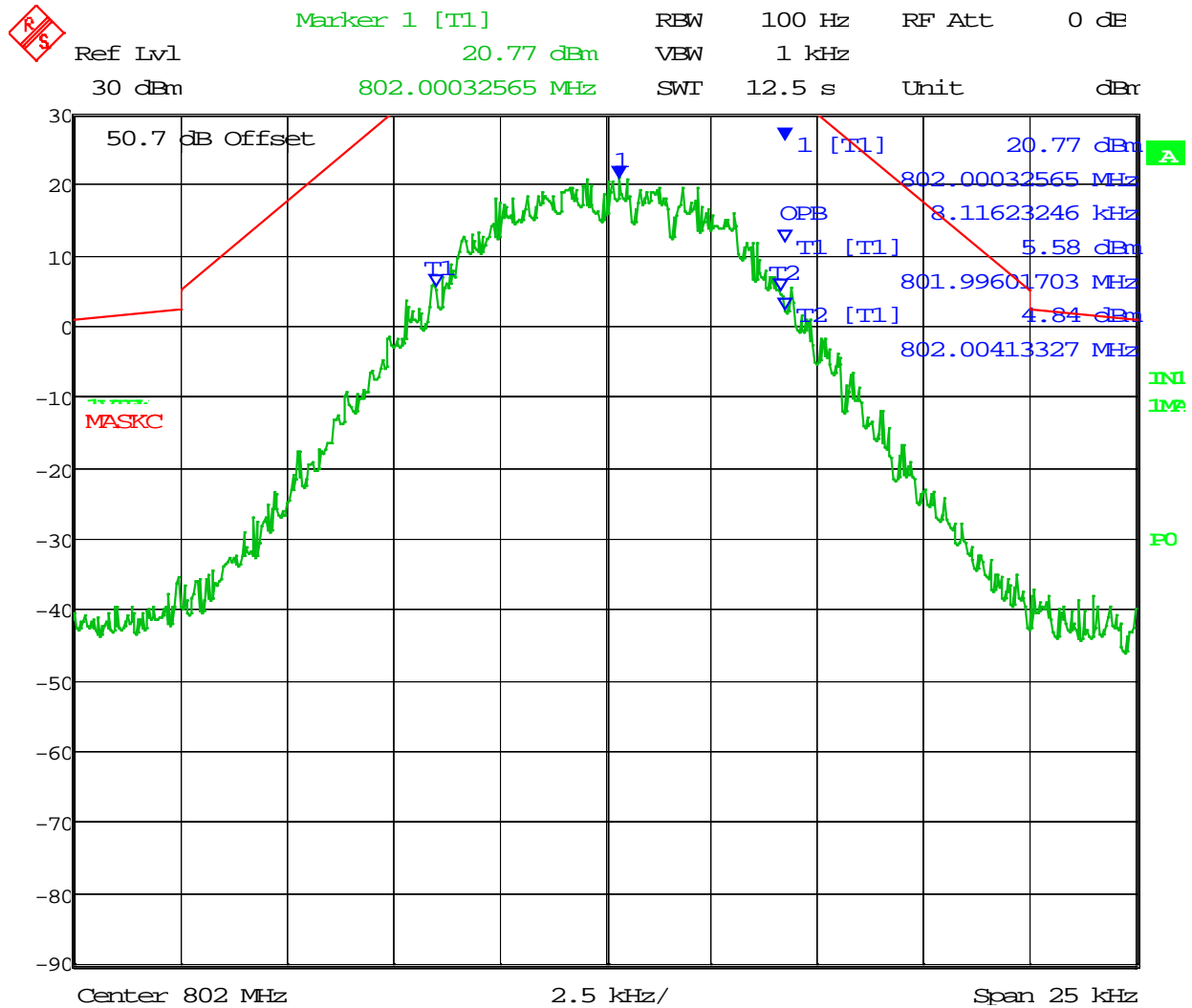
Date: 1.JAN.1997 02:58:51

**RESULT: AGC Output Signal 99% OBW = 8.17 kHz**



## INPUT VS OUTPUT COMPARISON

Test Data: Uplink (802 MHz), 8K10F1W Output Signal, @ AGC +3 dBm



Date: 1.JAN.1997 03:00:45

**RESULT: AGC+3 Output Signal 99% OBW = 8.12 kHz**

## 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.

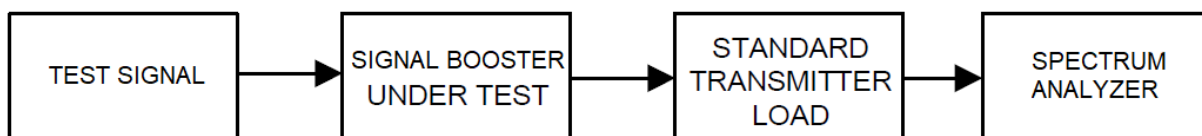
NOTE—Sections 90.219 and 2.1033(c) do not require gain test data; inclusion of industrial booster gain test data in test reports submitted for FCC equipment authorization is optional.

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: Downlink Output Measurement Table**

|            | Input Freq. (MHz) | AGC | Input Power (dBm) | Output Power (dBm) | Ant. System Loss (dB) | Ant. System Gain (dBi) | ERP (dBm) | ERP (W) | Limit ERP (W) | Margin (W) | Final Gain (dB) |
|------------|-------------------|-----|-------------------|--------------------|-----------------------|------------------------|-----------|---------|---------------|------------|-----------------|
| at AGC     | 770.0000          | +0  | -61.54            | 30.00              | 0.00                  | 0.00                   | 30.00     | 1.00    | 5.00          | 4.00       | 91.54           |
| +3 dBm AGC | 770.0000          | +3  | -58.54            | 30.00              | 0.00                  | 0.00                   | 30.00     | 1.00    | 5.00          | 4.00       | 88.54           |
| Max Input  | 770.0000          | +62 | 0.00              | 30.00              | 0.00                  | 0.00                   | 30.00     | 1.00    | 5.00          | 4.00       | 30.00           |

**Test Data: Uplink Output Measurement Table**

|            | Input Freq. (MHz) | AGC | Input Power (dBm) | Output Power (dBm) | Ant. System Loss (dB) | Ant. System Gain (dBi) | ERP (dBm) | ERP (W) | Limit ERP (W) | Margin (W) | Final Gain (dB) |
|------------|-------------------|-----|-------------------|--------------------|-----------------------|------------------------|-----------|---------|---------------|------------|-----------------|
| at AGC     | 802.0000          | +0  | -61.54            | 30.04              | 0.00                  | 0.00                   | 30.04     | 1.01    | 5.00          | 3.99       | 91.58           |
| +3 dBm AGC | 802.0000          | +3  | -58.54            | 30.04              | 0.00                  | 0.00                   | 30.04     | 1.01    | 5.00          | 3.99       | 88.58           |
| Max Input  | 802.0000          | +62 | 0.00              | 30.04              | 0.00                  | 0.00                   | 30.04     | 1.01    | 5.00          | 3.99       | 30.04           |

## POWER TO FINAL AMPLIFIER

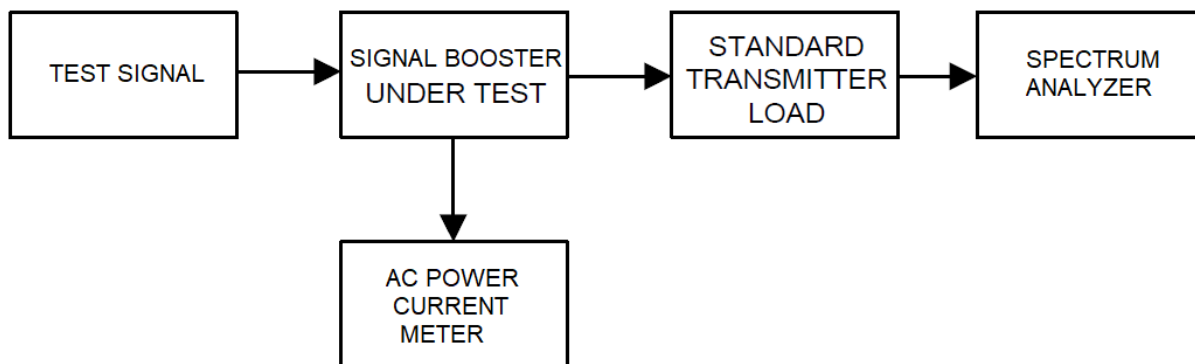
Rule Part No.: FCC Pt. 2.1033(c)(8)

### 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) (2.10 A) = **240 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.

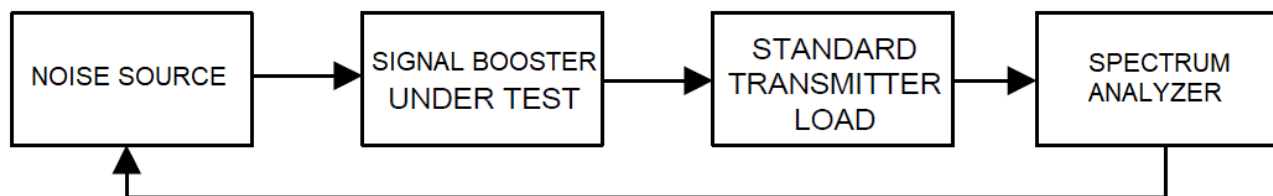
(2) The noise figure of a signal booster must not exceed 9 dB in either direction.

**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

### Test Data: Downlink Noise Calculation

| Fc (MHz) | Source ENR (dB) | T <sub>ON</sub> source (K) | T <sub>OFF</sub> source (K) |
|----------|-----------------|----------------------------|-----------------------------|
| 770      | 15.06811111     | 9605.563037                | 290                         |

#### Step 1 Calibration of Noise Source with ESU 40

| N <sub>SA off</sub> |      | N <sub>SA on</sub> |       | Y <sub>SA</sub> | T <sub>SA</sub> | NF <sub>SA</sub> |
|---------------------|------|--------------------|-------|-----------------|-----------------|------------------|
| dBm                 | fW   | dBm                | fW    | Linear          | Analyzer        | dB               |
| -115.31             | 2.94 | -106.77            | 21.04 | 7.14            | 1225.97         | 7.18             |

#### Step 2 Noise Measurement with EUT

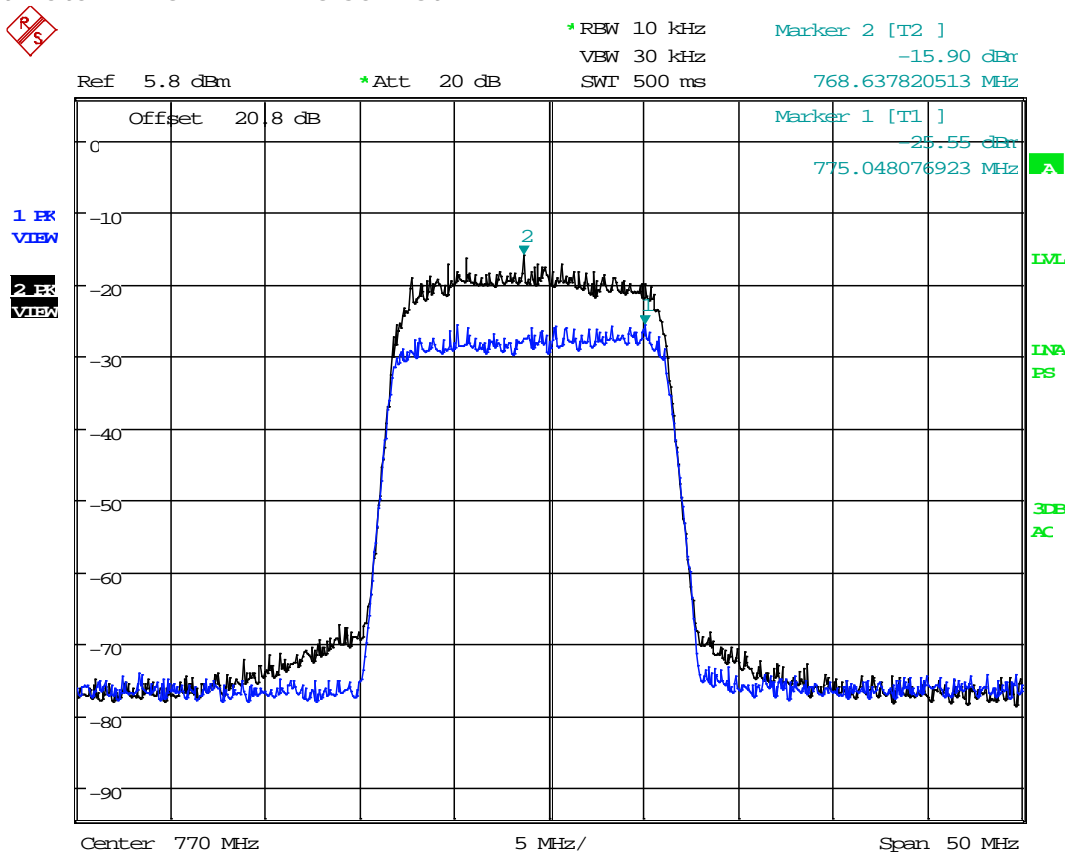
| N <sub>EUT &amp; SA off</sub> |            | N <sub>EUT &amp; SA on</sub> |             | Y <sub>EUT &amp; SA</sub> | T <sub>EUT &amp; SA</sub> | NF   |
|-------------------------------|------------|------------------------------|-------------|---------------------------|---------------------------|------|
| dBm                           | fW         | dBm                          | fW          | Linear                    | Cascade                   | dB   |
| -25.55                        | 2786121169 | -15.9                        | 25703957828 | 9.23                      | 842.49                    | 5.92 |

#### Step 3 Noise Figure Calculation for EUT

| Gain       | Gain  | T <sub>EUT</sub> |
|------------|-------|------------------|
| Num        | dB    | EUT              |
| 1266643297 | 91.03 | 842.49           |

| NF   | Limit | Margin |
|------|-------|--------|
| dB   | ≤ dB  | dB     |
| 5.92 | 9.00  | 3.08   |

### Test Data: Downlink Noise Plot



Date: 18.MAY.2018 09:08:21

Blue Trace = "Noise Source off", Black Trace = "Noise Source on"

Applicant: Radio Solutions, Inc.  
FCC ID: 2AHVP SB700M2A  
Report: 652AUT18TestReport\_Rev1

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## NOISE FIGURE

### Test Data: Uplink Noise Calculation

| Fc (MHz) | Source ENR (dB) | T <sub>ON</sub> source (K) | T <sub>OFF</sub> source (K) |
|----------|-----------------|----------------------------|-----------------------------|
| 802      | 15.0642         | 9597.177529                | 290                         |

#### Step 1 Calibration of Noise Source with ESU 40

| N <sub>SA off</sub> |      | N <sub>SA on</sub> |       | Y <sub>SA</sub> | T <sub>SA</sub> | NF <sub>SA</sub> |
|---------------------|------|--------------------|-------|-----------------|-----------------|------------------|
| dBm                 | fW   | dBm                | fW    | Linear          | Analyzer        | dB               |
| -115.74             | 2.67 | -107.3             | 18.62 | 6.98            | 1265.78         | 7.30             |

#### Step 2 Noise Measurement with EUT

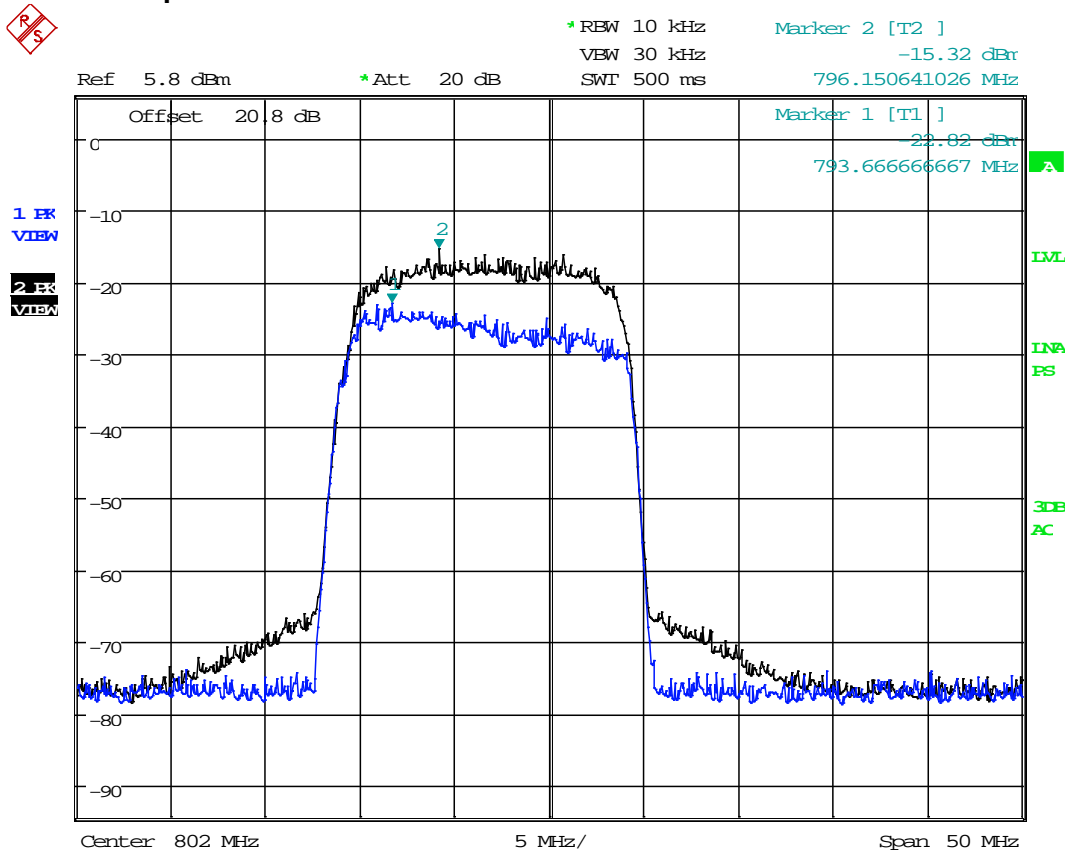
| N <sub>EUT &amp; SA off</sub> |            | N <sub>EUT &amp; SA on</sub> |             | Y <sub>EUT &amp; SA</sub> | T <sub>EUT &amp; SA</sub> | NF   |
|-------------------------------|------------|------------------------------|-------------|---------------------------|---------------------------|------|
| dBm                           | fW         | dBm                          | fW          | Linear                    | Cascade                   | dB   |
| -22.82                        | 5223961890 | -15.32                       | 29376496520 | 5.62                      | 1723.05                   | 8.41 |

#### Step 3 Noise Figure Calculation for EUT

| Gain       | Gain  | T <sub>EUT</sub> |
|------------|-------|------------------|
| Num        | dB    | EUT              |
| 1513884631 | 91.80 | 1723.05          |

| NF   | Limit | Margin |
|------|-------|--------|
| dB   | ≤ dB  | dB     |
| 8.41 | 9.00  | 0.59   |

### Test Data: Uplink Noise Plot



Date: 18.MAY.2018 09:01:50

Blue Trace = "Noise Source off", Black Trace = "Noise Source on"

Applicant: Radio Solutions, Inc.  
FCC ID: 2AHVP SB700M2A  
Report: 652AUT18TestReport\_Rev1

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## 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.

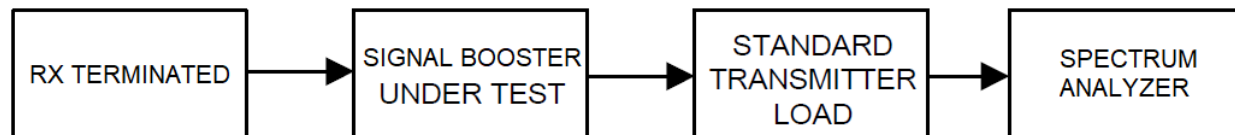
(ii) In general, the ERP of noise within the passband should not exceed  $-43$  dBm in 10 kHz measurement bandwidth.

(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.

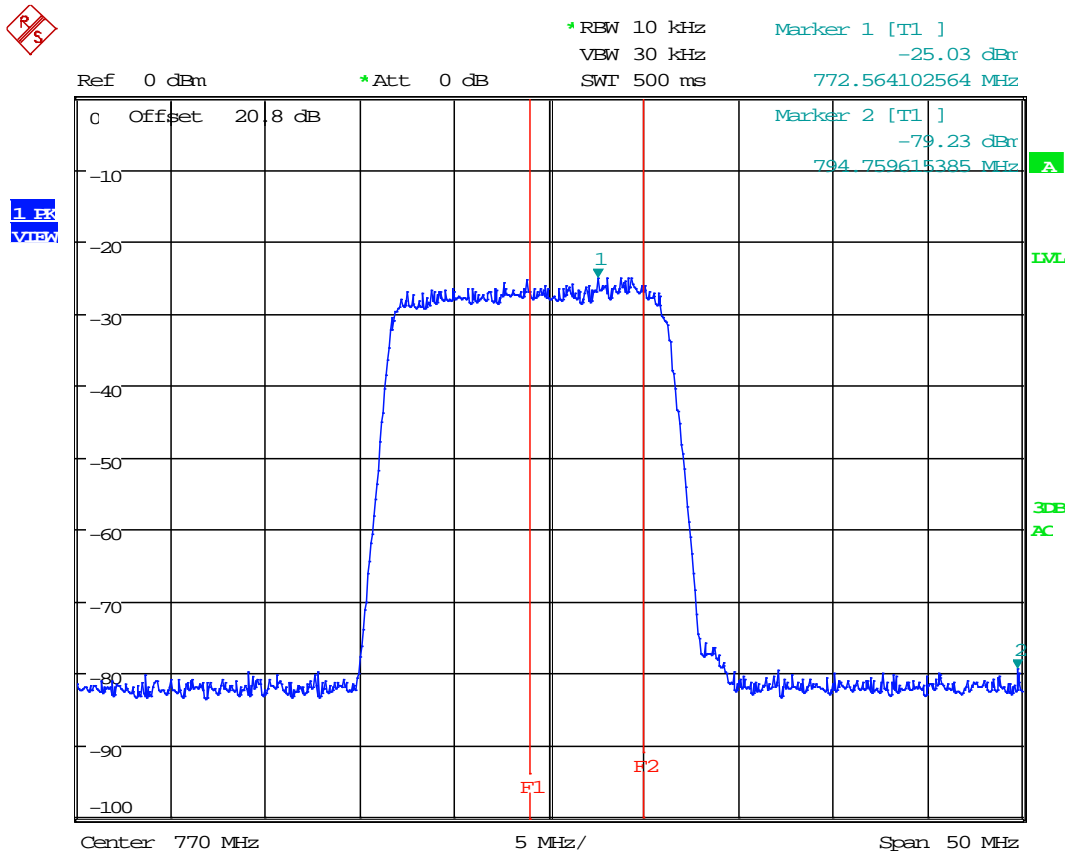
### Test Setup Block Diagram:





## PASSBAND NOISE

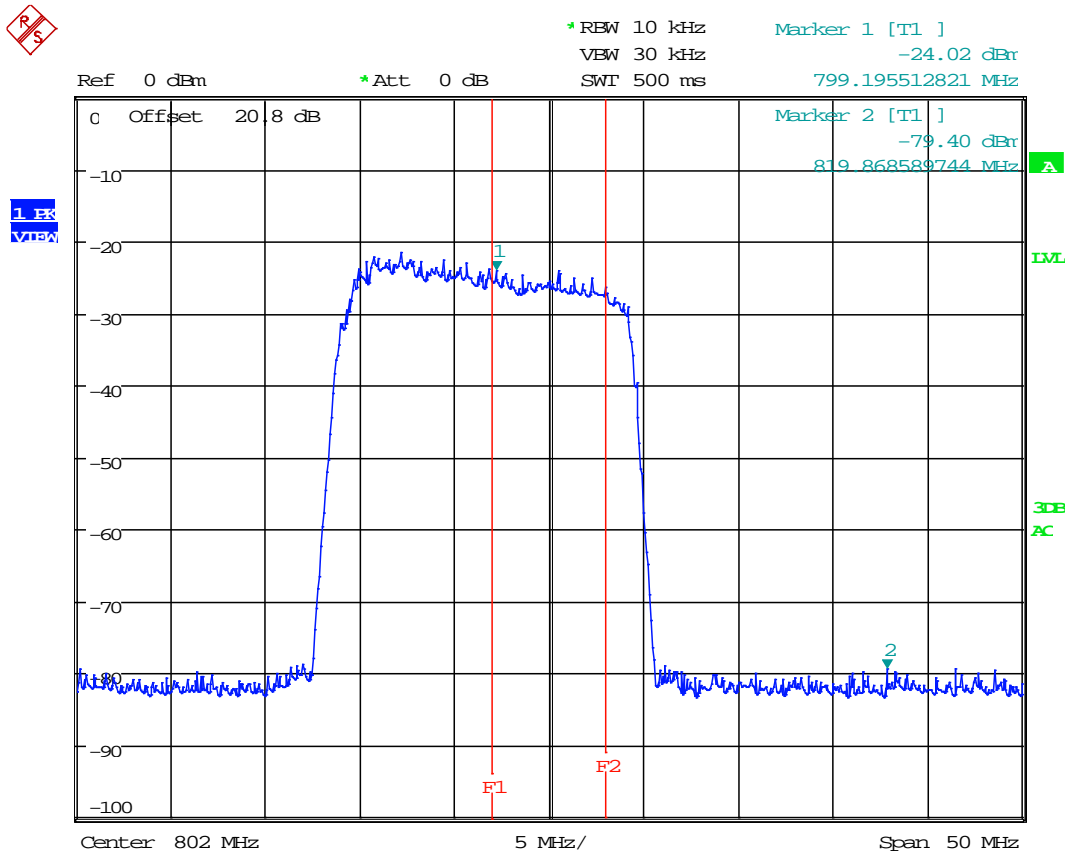
Test Data: Downlink Passband Noise Plot



Date: 18.MAY.2018 08:32:17

## PASSBAND NOISE

### Test Data: Uplink Passband Noise Plot



Date: 18.MAY.2018 08:49:19

## INTERMODULATION SPURIOUS EMISSIONS

**Rule Part No.:** KDB 935210 s.4.7.2, FCC Part 2.1051(a), FCC Pt. 90.219(d)(6)(i),  
FCC Pt. 90.210(c)(1), (2)

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:

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

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

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

For 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.

(i) In general, the ERP of intermodulation products should not exceed  $-30$  dBm in 10 kHz measurement bandwidth.

## INTERMODULATION SPURIOUS EMISSIONS

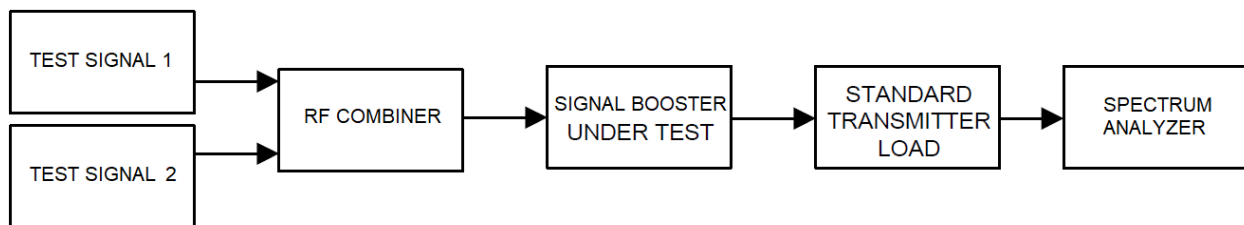
**Test Procedure:** KDB 935210 s.4.7.2, TIA 603-E

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

Test Data: Downlink (770 MHz) @ AGC 90.210 Table

Max amplitude spur = 20 kHz off channel

Less strict of:  $29 \cdot \log(f_d^2/11)$  or 50 dB attenuation;  $29 \cdot \log(20^2/11) = 45.26 \text{ dBc}$

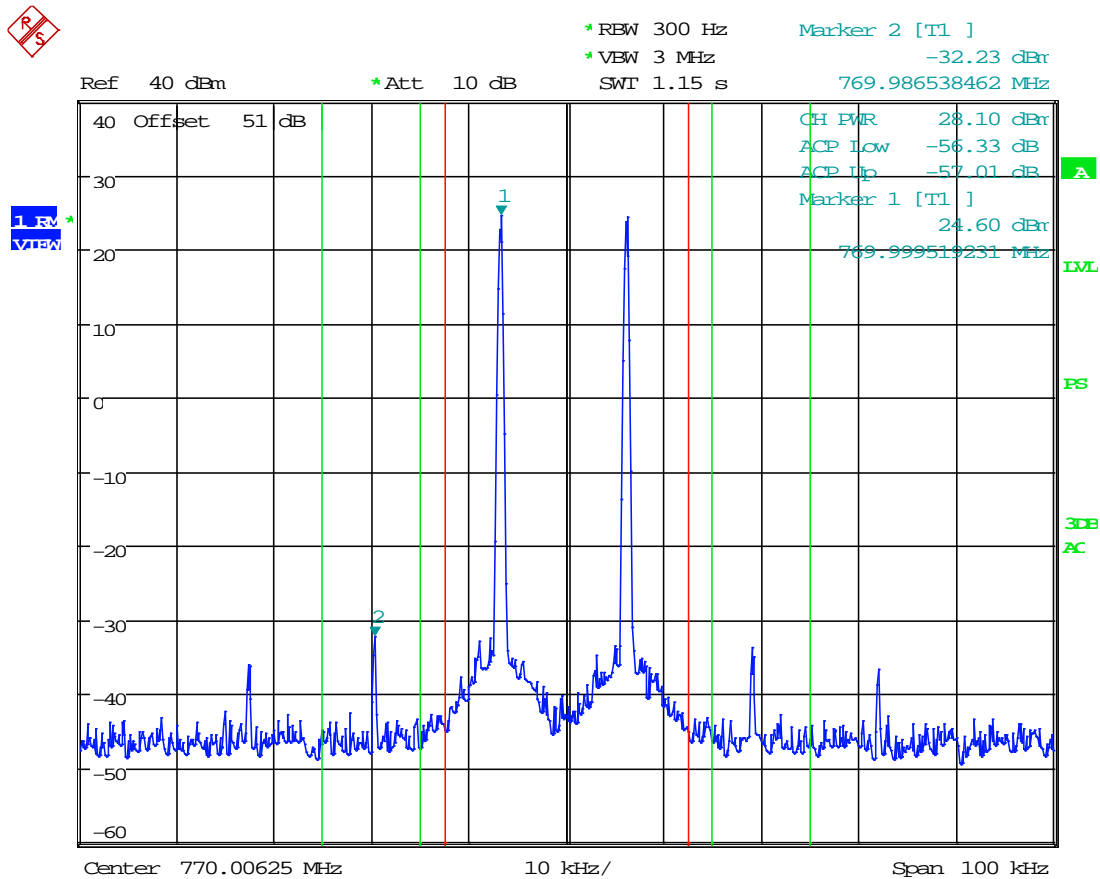
| 90.210(c)(2) | Channel Power (dBm) | Intermod Peak Power (dBm) | Limit of Mask C at Spur (dBm) | Margin (W) |
|--------------|---------------------|---------------------------|-------------------------------|------------|
| Lower        | 28.10               | -32.23                    | -17.16                        | 15.07      |

Test Data: Downlink (770 MHz) @ AGC 90.219 Table

| 90.219(d)(6)(i) | Channel Power (dBm) | Intermod Channel Power (dB) | Ant. System Loss (dB) | Ant. System Gain (dBi) | ERP (dBm) | Limit ERP (dBm) | Margin (W) |
|-----------------|---------------------|-----------------------------|-----------------------|------------------------|-----------|-----------------|------------|
| Lower           | 28.10               | -56.33                      | 0.00                  | 0.00                   | -28.23    | -30.00          | -1.77      |
| Upper           | 28.10               | -57.01                      | 0.00                  | 0.00                   | -28.91    | -30.00          | -1.09      |

## INTERMODULATION SPURIOUS EMISSIONS

Test Data: Downlink (770 MHz) @ AGC Plot



Date: 14.MAY.2018 16:49:34

## INTERMODULATION SPURIOUS EMISSIONS

Test Data: Downlink (770 MHz) @ AGC+3 dBm 90.210 Table

Max amplitude spur = 20 kHz off channel

Less strict of:  $29 \cdot \log(f_d^2/11)$  or 50 dB attenuation;  $29 \cdot \log(20^2/11) = 45.26 \text{ dBc}$

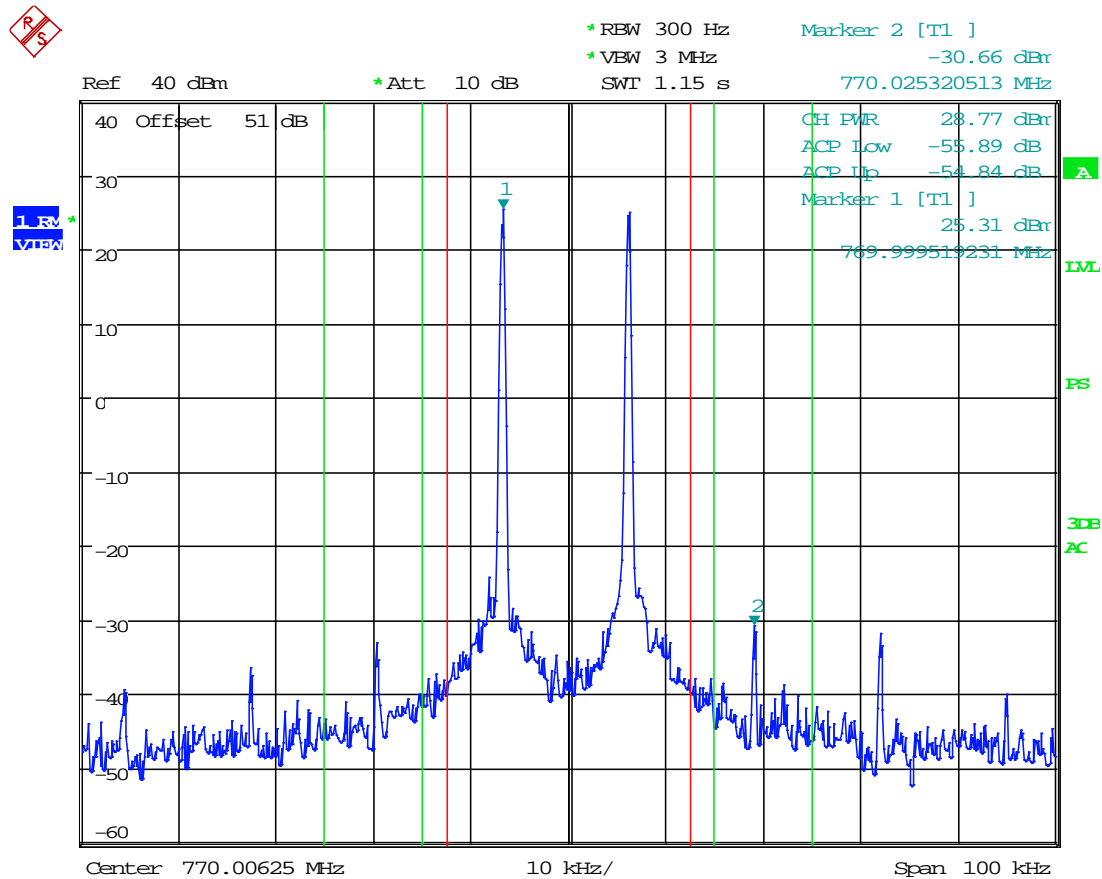
| 90.210(c)(2) | Channel Power (dBm) | Intermod Peak Power (dBm) | Limit of Mask C at Spur (dBm) | Margin (W) |
|--------------|---------------------|---------------------------|-------------------------------|------------|
| Lower        | 28.77               | -30.66                    | -16.49                        | 14.17      |

Test Data: Downlink (770 MHz) @ AGC+3 dBm 90.219 Table

| 90.219(d)(6)(i) | Channel Power (dBm) | Intermod Channel Power (dB) | Ant. System Loss (dB) | Ant. System Gain (dBi) | ERP (dBm) | Limit ERP (dBm) | Margin (W) |
|-----------------|---------------------|-----------------------------|-----------------------|------------------------|-----------|-----------------|------------|
| Lower           | 28.77               | -55.89                      | 0.00                  | 0.00                   | -27.12    | -30.00          | -2.88      |
| Upper           | 28.77               | -54.84                      | 0.00                  | 0.00                   | -26.07    | -30.00          | -3.93      |

## INTERMODULATION SPURIOUS EMISSIONS

Test Data: Downlink (770 MHz) @ AGC+3 dBm Plot



Date: 14.MAY.2018 16:50:40



## INTERMODULATION SPURIOUS EMISSIONS

Test Data: Uplink (802 MHz) @ AGC 90.210 Table

Max amplitude spur = 20 kHz off channel

Less strict of:  $29 \cdot \log(f_d^2/11)$  or 50 dB attenuation;  $29 \cdot \log(20^2/11) = 45.26 \text{ dBc}$

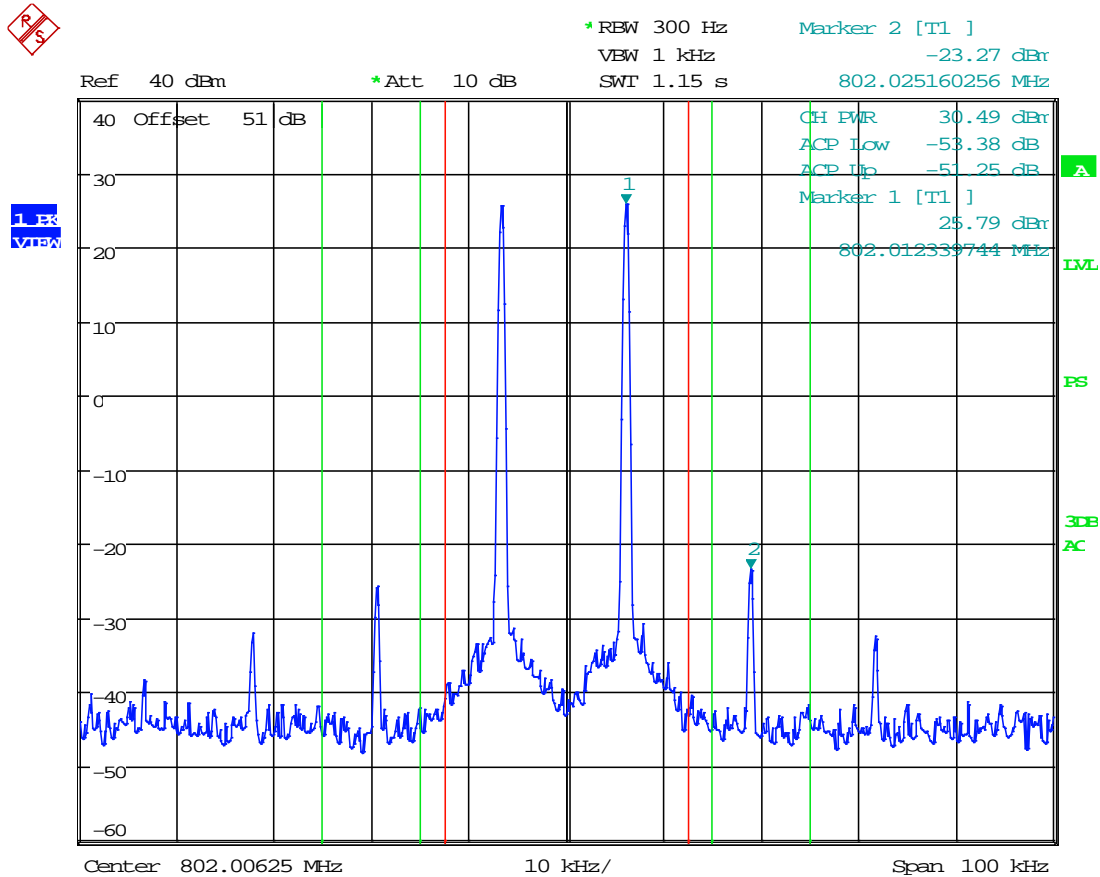
| 90.210(c)(2) | Channel Power (dBm) | Intermod Peak Power (dBm) | Limit of Mask C at Spur (dBm) | Margin (W) |
|--------------|---------------------|---------------------------|-------------------------------|------------|
| Lower        | 30.49               | -23.27                    | -14.77                        | 8.50       |

Test Data: Uplink (802 MHz) @ AGC 90.219 Table

| 90.219(d)(6)(i) | Channel Power (dBm) | Intermod Channel Power (dB) | Ant. System Loss (dB) | Ant. System Gain (dBi) | ERP (dBm) | Limit ERP (dBm) | Margin (W) |
|-----------------|---------------------|-----------------------------|-----------------------|------------------------|-----------|-----------------|------------|
| Lower           | 30.49               | -53.38                      | 0.00                  | 0.00                   | -22.89    | -30.00          | -7.11      |
| Upper           | 30.49               | -51.25                      | 0.00                  | 0.00                   | -20.76    | -30.00          | -9.24      |

## INTERMODULATION SPURIOUS EMISSIONS

Test Data: Uplink (802 MHz) @ AGC Plot



Date: 15.MAY.2018 15:37:26

## INTERMODULATION SPURIOUS EMISSIONS

Test Data: Uplink (802 MHz) @ AGC+3 dBm 90.210 Table

Max amplitude spur = 20 kHz off channel

Less strict of:  $29 \cdot \log(f_d^2/11)$  or 50 dB attenuation;  $29 \cdot \log(20^2/11) = 45.26 \text{ dBc}$

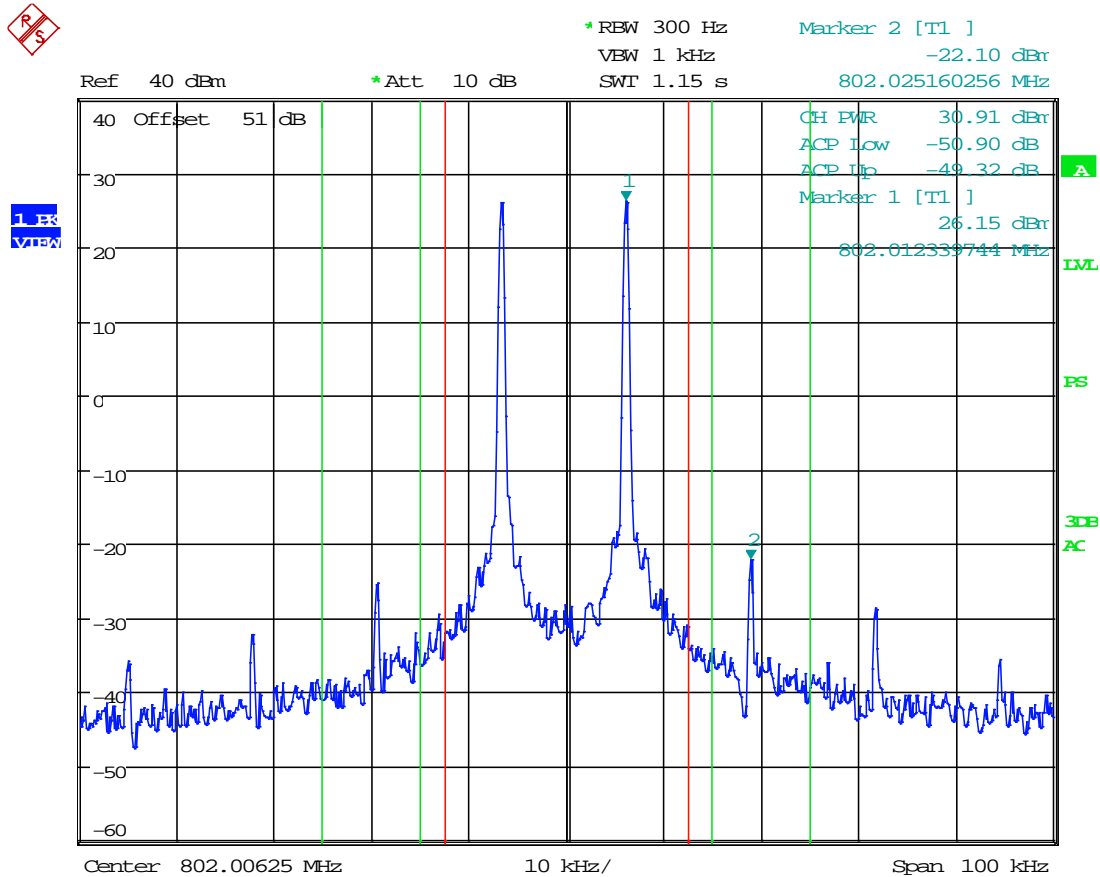
| 90.210(c)(2) | Channel Power (dBm) | Intermod Peak Power (dBm) | Limit of Mask C at Spur (dBm) | Margin (W) |
|--------------|---------------------|---------------------------|-------------------------------|------------|
| Lower        | 30.91               | -22.10                    | -14.35                        | 7.75       |

Test Data: Uplink (802 MHz) @ AGC+3 dBm 90.219 Table

| 90.219(d)(6)(i) | Channel Power (dBm) | Intermod Channel Power (dB) | Ant. System Loss (dB) | Ant. System Gain (dBi) | ERP (dBm) | Limit ERP (dBm) | Margin (W) |
|-----------------|---------------------|-----------------------------|-----------------------|------------------------|-----------|-----------------|------------|
| Lower           | 30.91               | -50.90                      | 0.00                  | 0.00                   | -19.99    | -30.00          | -10.01     |
| Upper           | 30.91               | -49.32                      | 0.00                  | 0.00                   | -18.41    | -30.00          | -11.59     |

## INTERMODULATION SPURIOUS EMISSIONS

Test Data: Uplink (802 MHz) @ AGC+3 dBm Plot



Date: 15.MAY.2018 15:39:38

## SPURIOUS EMISSIONS AT ANTENNA TERMINALS (CONDUCTED)

**Rule Part No.:** KDB 935210 s.4.7.3, FCC Part 2.1051(a), FCC Pt. 90.219(e)(3), FCC Pt. 90.210(c)(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:** The more strict limit of the following must be met:

(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.

(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:

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

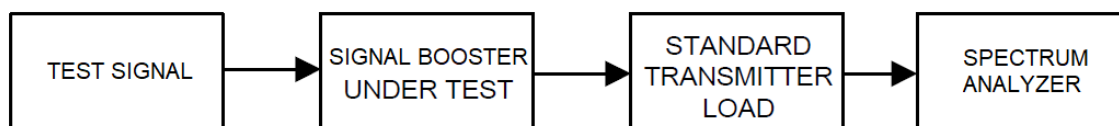
**Limit:**  $50 + 10 \cdot \log(1) = 50 \text{ dBc} = -20 \text{ dBm}$ , (more strict than 90.219(e)(3) limit of -13 dBm)

**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

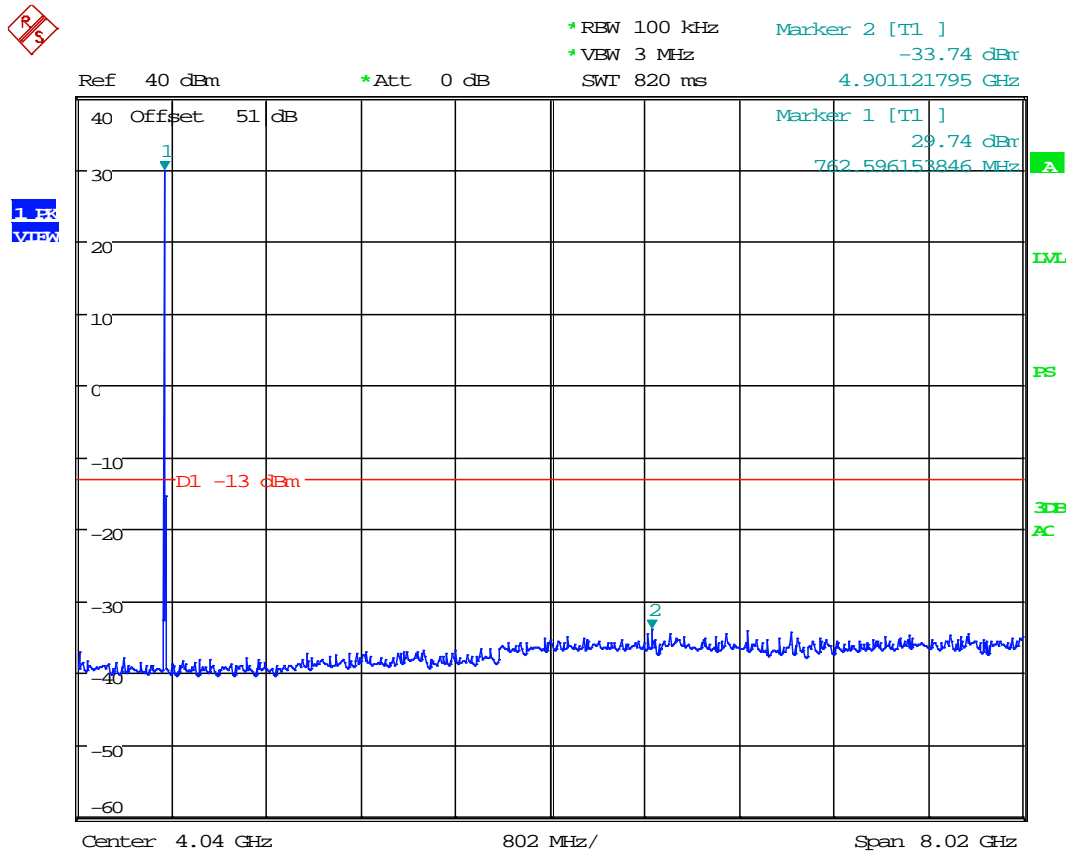


## SPURIOUS EMISSIONS AT ANTENNA TERMINALS

Test Data: Downlink Spurious Emissions Table

| Peak Spurious Level (dBm) | Limit of Mask C $\geq 250\%$ BW (dBm) | Margin (dBm) |
|---------------------------|---------------------------------------|--------------|
| -33.74                    | -20.00                                | 13.74        |

Test Data: Downlink Spurious Emissions Plot



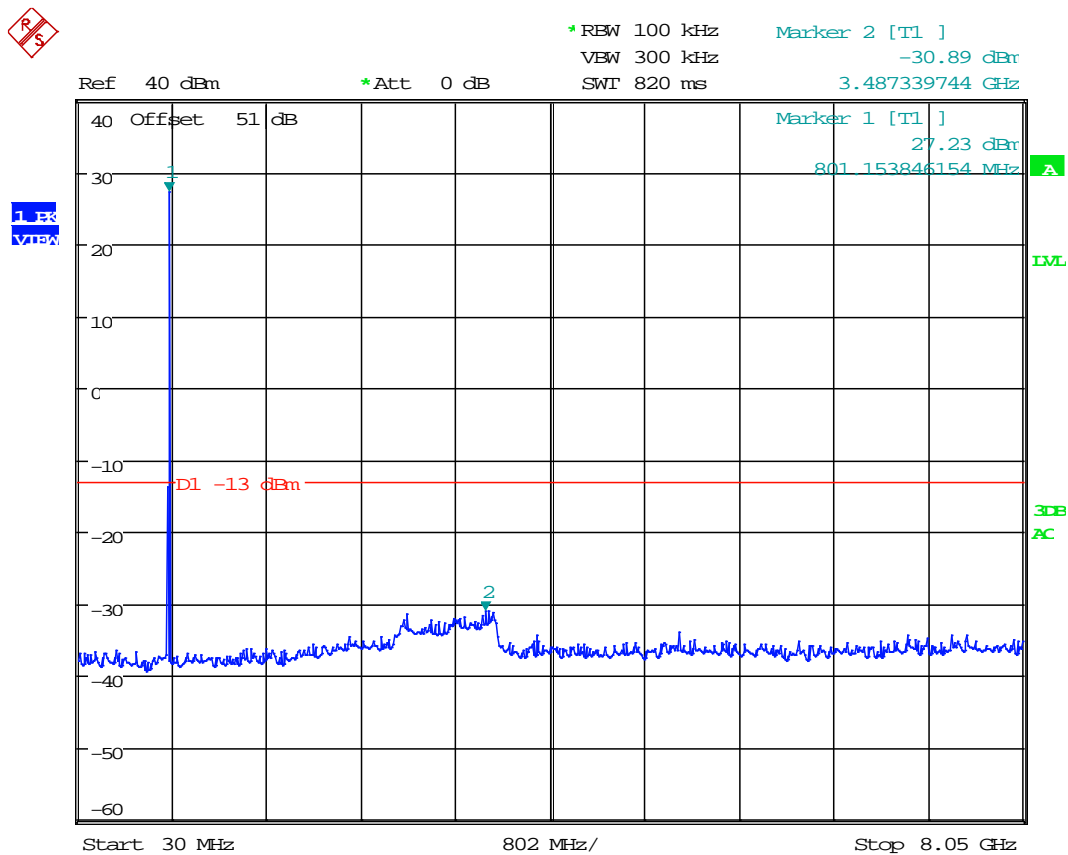
Date: 14.MAY.2018 16:58:15

## SPURIOUS EMISSIONS AT ANTENNA TERMINALS

Test Data: Uplink Spurious Emissions Table

| Peak Spurious Level (dBm) | Limit of Mask C $\geq 250\%$ BW (dBm) | Margin (dBm) |
|---------------------------|---------------------------------------|--------------|
| -30.89                    | -20.00                                | 10.89        |

Test Data: Uplink Spurious Emissions Plot



Date: 15.MAY.2018 14:02:21

## FREQUENCY STABILITY

**Rule Part No.:** KDB 935210 s.4.8, FCC Part 2.1055(a)(1), FCC Pt. 90.219(e)(4)(i)

Section 90.219(e)(4)(i) requires that a signal being retransmitted by an amplifier, repeater, or industrial booster meets the frequency stability requirements of Section 90.213. However, this requirement presumes that the EUT processes an input signal in ways that can influence the output signal frequency/frequencies; however, most signal boosters do not incorporate an oscillator. If the amplifier, booster, or repeater does not alter the input signal in any way, then a frequency stability test may not be required.

**Requirements:** FCC Part 2.1055(a)(1)

(a) The frequency stability shall be measured with variation of ambient temperature as follows:

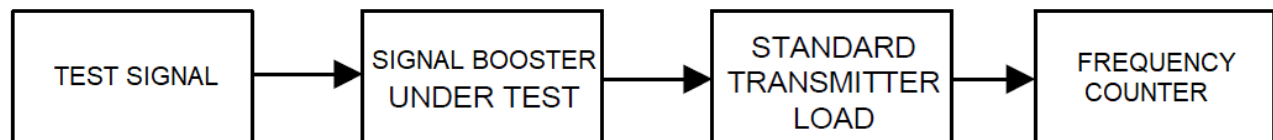
(1) From  $-30^{\circ}$  to  $+50^{\circ}$  centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.

**Test Procedure:** KDB 935210 s.4.8, FCC Part 2.1055(b), TIA 603-E

When performing frequency stability measurements on these types of devices, the instability associated with the EUT must be isolated from any frequency instability associated with the measurement instrumentation. One method for realizing such isolation is to connect the reference clock input of the signal generator to the reference output of the frequency counter, to confirm that any frequency instability is associated with the EUT, and is not due to differences between the reference oscillators internal to the measurement instrumentation.

(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than  $10^{\circ}$  centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.

**Test Setup Block Diagram:**



**RESULT: Not Applicable to EUT.**



## FIELD STRENGTH OF SPURIOUS EMISSIONS

**Rule Part No.:** KDB 935210 s.4.9, FCC Part 2.1053(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:** The more strict limit of the following must be met:

(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.

(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:

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

**Limit:**  $50 + 10 \log (P_w) = 50 \text{ dBc} = \text{-20 dBm}$ , (more strict than 90.219(e)(3) limit of -13 dBm)

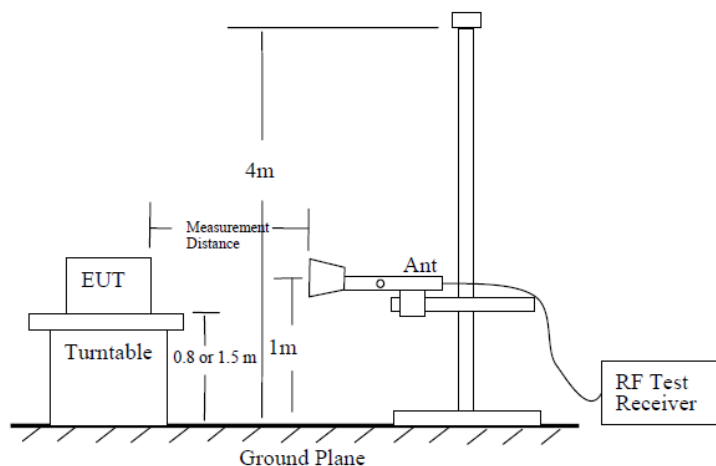
**Test Procedure:** KDB 935210 s.4.7.3, TIA 603-E

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.

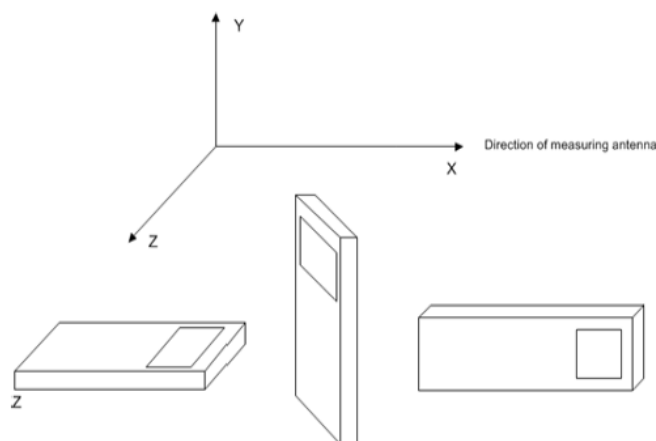
- a) Connect a signal generator to the input of the EUT.
- b) Configure the signal generator to produce a CW signal.
- c) Set the frequency of the CW signal to the center channel of the EUT passband.
- d) Set the output power level so that the resultant signal is just below the AGC threshold (see 4.2).
- 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.

## FIELD STRENGTH OF SPURIOUS EMISSIONS

### Test Site Setup:



### EUT Orientation(s):



**Note:** The tabulated data shows the results of the radiated field strength emissions test. The spectrum was scanned from the lowest frequency generated internally to at least the tenth harmonic of the fundamental. This test was conducted in accordance with the standard listed above using the substitution method. Measurements were made at the test site of TIMCO ENGINEERING, INC. located at 849 NW State Road 45, Newberry, FL 32669. The measurements below represent the worst case of all the frequencies tested.

**Note:** The six (6) highest emissions or more of each worst-case operational modes of the EUT are represented below. Emissions 20 dB below the limit are not required to be reported.

## FIELD STRENGTH OF SPURIOUS EMISSIONS

### Test Data: Downlink Spurious Emissions Table

| Tuned Freq (MHz) | Emission Frequency (MHz) | Meter Reading (dBuV) | Antenna Polarity | Coax Loss (dB) | Correction Factor (dB/m) | Field Strength (dBuV/m) | Distance (m) | ERP (dBm) | Limit (dBm) | Margin (dB) |
|------------------|--------------------------|----------------------|------------------|----------------|--------------------------|-------------------------|--------------|-----------|-------------|-------------|
| 770.00           | 0.01                     | 2.97                 | H                | 18.90          | 18.47                    | 40.34                   | 3.00         | -57.04    | -20.00      | 37.04       |
| 770.00           | 0.04                     | 19.73                | H                | 14.10          | 13.55                    | 47.38                   | 3.00         | -50.00    | -20.00      | 30.00       |
| 770.00           | 0.07                     | 0.03                 | H                | 11.80          | 11.79                    | 23.62                   | 3.00         | -73.76    | -20.00      | 53.76       |
| 770.00           | 70.05                    | 14.34                | V                | 0.99           | 6.01                     | 21.34                   | 3.00         | -76.04    | -20.00      | 56.04       |
| 770.00           | 85.58                    | 12.99                | H                | 1.11           | 9.86                     | 23.96                   | 3.00         | -73.41    | -20.00      | 53.41       |
| 770.00           | 130.53                   | 12.88                | V                | 1.29           | 13.16                    | 27.33                   | 3.00         | -70.04    | -20.00      | 50.04       |
| 770.00           | 156.96                   | 12.27                | H                | 1.43           | 16.60                    | 30.30                   | 3.00         | -67.07    | -20.00      | 47.07       |
| 770.00           | 410.26                   | 12.65                | V                | 2.31           | 14.72                    | 29.68                   | 3.00         | -67.70    | -20.00      | 47.70       |
| 770.00           | 489.74                   | 12.97                | H                | 2.62           | 16.80                    | 32.39                   | 3.00         | -64.99    | -20.00      | 44.99       |
| 770.00           | 971.80                   | 13.68                | V                | 3.66           | 22.73                    | 40.07                   | 3.00         | -57.31    | -20.00      | 37.31       |
| 770.00           | 2417.38                  | 25.95                | H                | 5.89           | 31.87                    | 63.71                   | 3.00         | -33.67    | -20.00      | 13.67       |
| 770.00           | 2713.21                  | 25.78                | V                | 6.21           | 32.47                    | 64.46                   | 3.00         | -32.92    | -20.00      | 12.92       |
| 770.00           | 4641.03                  | 27.60                | V                | 8.15           | 33.93                    | 69.68                   | 3.00         | -27.70    | -20.00      | 7.70        |
| 770.00           | 5801.60                  | 29.13                | H                | 9.12           | 34.81                    | 73.06                   | 3.00         | -24.32    | -20.00      | 4.32        |
| 770.00           | 7110.01                  | 28.44                | V                | 10.09          | 36.34                    | 74.87                   | 3.00         | -22.51    | -20.00      | 2.51        |
| 770.00           | 7622.12                  | 31.44                | H                | 10.43          | 35.19                    | 77.06                   | 3.00         | -20.32    | -20.00      | 0.32        |

### Test Data: Uplink Spurious Emissions Table

| Tuned Freq (MHz) | Emission Frequency (MHz) | Meter Reading (dBuV) | Antenna Polarity | Coax Loss (dB) | Correction Factor (dB/m) | Distance (m) | Field Strength (dBuV/m) | ERP (dBm) | Limit (dBm) | Margin (dB) |
|------------------|--------------------------|----------------------|------------------|----------------|--------------------------|--------------|-------------------------|-----------|-------------|-------------|
| 802.00           | 0.01                     | 4.87                 | H                | 18.90          | 18.04                    | 3.00         | 41.81                   | -55.57    | -20.00      | 35.57       |
| 802.00           | 0.04                     | 19.61                | H                | 14.10          | 13.55                    | 3.00         | 47.26                   | -50.12    | -20.00      | 30.12       |
| 802.00           | 0.07                     | 0.54                 | H                | 11.80          | 11.79                    | 3.00         | 24.13                   | -73.25    | -20.00      | 53.25       |
| 802.00           | 45.26                    | 12.70                | H                | 0.76           | 12.52                    | 3.00         | 25.98                   | -71.39    | -20.00      | 51.39       |
| 802.00           | 70.87                    | 15.74                | V                | 1.00           | 6.09                     | 3.00         | 22.83                   | -74.55    | -20.00      | 54.55       |
| 802.00           | 131.35                   | 13.60                | H                | 1.30           | 13.37                    | 3.00         | 28.27                   | -69.11    | -20.00      | 49.11       |
| 802.00           | 131.35                   | 13.31                | V                | 1.30           | 13.37                    | 3.00         | 27.98                   | -69.40    | -20.00      | 49.40       |
| 802.00           | 616.67                   | 12.92                | V                | 2.90           | 18.73                    | 3.00         | 34.55                   | -62.83    | -20.00      | 42.83       |
| 802.00           | 635.90                   | 13.60                | H                | 2.94           | 19.25                    | 3.00         | 35.79                   | -61.58    | -20.00      | 41.58       |
| 802.00           | 856.41                   | 12.90                | H                | 3.49           | 22.20                    | 3.00         | 38.59                   | -58.79    | -20.00      | 38.79       |
| 802.00           | 894.87                   | 13.02                | V                | 3.55           | 21.71                    | 3.00         | 38.28                   | -59.10    | -20.00      | 39.10       |
| 802.00           | 2360.49                  | 26.05                | V                | 5.82           | 31.92                    | 3.00         | 63.79                   | -33.59    | -20.00      | 13.59       |
| 802.00           | 2371.87                  | 25.79                | H                | 5.83           | 31.91                    | 3.00         | 63.53                   | -33.84    | -20.00      | 13.84       |
| 802.00           | 4663.78                  | 28.49                | V                | 8.16           | 33.90                    | 3.00         | 70.55                   | -26.82    | -20.00      | 6.82        |
| 802.00           | 5403.37                  | 28.39                | H                | 8.79           | 34.36                    | 3.00         | 71.54                   | -25.83    | -20.00      | 5.83        |
| 802.00           | 7041.83                  | 28.44                | V                | 10.04          | 36.20                    | 3.00         | 74.68                   | -22.69    | -20.00      | 2.69        |
| 802.00           | 7531.09                  | 29.72                | H                | 10.38          | 35.89                    | 3.00         | 75.99                   | -21.39    | -20.00      | 1.39        |

## 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   | $\pm 49.5$ Hz                | (1)   |
| RF Conducted Power  | $\pm 0.93$ dB                | (1)   |
| Conducted spurious emission of transmitter valid up to 40GHz  | $\pm 1.86$ dB                |       |
| Occupied Bandwidth  | $\pm 2.65$ %                 |       |
| Audio Frequency Response  | $\pm 1.86$ dB                |       |
| Modulation limiting   | $\pm 1.88$ %                 |       |
| Radiated RF Power   | $\pm 1.4$ dB                 |       |
| Maximum frequency deviation:<br>Within 300 Hz and 6kHz of audio freq.<br>Within 6kHz and 25kHz of audio Freq. | $\pm 1.88$ %<br>$\pm 2.04$ % |       |
| Rad Emissions Sub Meth up to 26.5GHz  | $\pm 2.14$ dB                |       |
| Adjacent channel power  | $\pm 1.47$ dB                | (1)   |
| Transient Frequency Response  | $\pm 1.88$ %                 |       |
| Temperature   | $\pm 1.0^{\circ}$ C          | (1)   |
| Humidity  | $\pm 5.0$ %                  |       |

**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   |
|--|---------------------|------------------------------|--|---------------|------------|
| Coaxial Cable - BMBM-0065-01 Black DC-2G     | Belden              |                              | BMBM-0065-01                                 | 07/18/16      | 07/18/18   |
| Coaxial Cable - BMBM-0061-01 RG400           | Pasternack          | PE3582LF-24                  | BMBM-0061-01                                 | 01/31/17      | 01/31/19   |
| Coaxial Cable - BMBM-0061-02 RG400           | Pasternack          | PE3582LF-24                  | BMBM-0061-02                                 | 01/31/17      | 01/31/19   |
| 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<br>KMKM-0670-01<br>KFKF-0197-00 | N/A           | N/A        |
| CHAMBER                                      | Panashield          | 3M                           | N/A  | 04/25/16      | 05/31/18   |
| Ant: Double-Ridged Horn/ETS Horn 1           | ETS-Lindgren        | 3117                         | 00035923                                     | 01/30/17      | 01/30/19   |
| Software: Field Strength Program             | Timco               | N/A                          | Version 4.10.7.0                             | N/A           | N/A        |
| Antenna: Passive Loop                        | EMCO                | 6512                         | 9706-1211                                    | 07/26/17      | 07/26/19   |
| EMI Test Receiver R & S ESIB 40              | Rohde & Schwarz     | ESIB 40                      | 100274                                       | 08/18/16      | 08/18/18   |
| EMI Test Receiver R & S ESU 40               | Rohde & Schwarz     | ESU 40                       | 100320                                       | 04/01/16      | 04/01/19   |
| Attenuator N 20dB 20W DC-12G                 | Narda               | 768-20-SP                    | 155  | 07/10/17      | 07/10/19   |
| Attenuator N 20dB 20W DC-12G                 | Narda               | 768-20-SP                    | 344  | 07/10/17      | 07/10/19   |
| Attenuator BNC 10dB DC-2G                    | MiniCircuits        | HAT-10+                      | #54  | 07/14/17      | 07/14/19   |
| Bore-sight Antenna Positioning Tower         | Sunol Sciences      | TLT2                         | N/A  | N/A           | N/A        |
| Terminator N 20W DC-18G                      | Narda               | 8205                         | #14  | 04/06/17      | 04/06/19   |
| Attenuator N 30dB 100W DC-6G                 | Pasternack          | PE7214-30                    | #109   | 05/24/17      | 05/23/19   |
| Splitter 1 – 1000 MHz                        | MiniCircuits        | ZFSC-4-1-BNC+                | U115700825                                   | N/A           | N/A        |
| Coaxial Cable – NMNM-0300-00 Yellow          | Insulated Wire Inc. | n/a                          | NMNM-0300-00                                 | 05/14/2018    | 05/14/2020 |
| Coaxial Cable – NMNM-0180-00 Aqua            | Micro-Coax          | UFB311A-0-0720-50U50U        | 225362-001 (#100)                            | 07/14/2016    | 07/14/2018 |
| Coaxial Cable – NMNM-0180-01 Aqua            | Micro-Coax          | UFB311A-0-0720-50U50U        | 225362-002 (#101)                            | 07/14/2016    | 07/14/2018 |

### \*EMI RECEIVER SOFTWARE VERSION

The receiver firmware used was version 4.43 Service Pack 3

## END OF TEST REPORT

Applicant: Radio Solutions, Inc.  
 FCC ID: 2AHVP SB700M2A  
 Report: 652AUT18TestReport\_Rev1

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