# ENGINEERING TEST REPORT

## Signal Booster II
## Model No.: 61-83B-50
## FCC ID: EZZ5PI618350

*Applicant:*

**TX RX Systems, Inc.**
*8625 Industrial Parkway*
*Angola, NY 14006*
*USA*

***Tested in Accordance With***

**Federal Communications Commission (FCC)**
**47 CFR, Parts 2 and 90 (Subpart R)**

**UltraTech's File No.: TXRX-013F90R**

| | |
|---|---|
| This Test report is Issued under the Authority of<br>Tri M. Luu, Professional Engineer,<br>Vice President of Engineering<br>UltraTech Group of Labs<br><br>Date: October 5, 2005 | |
| Report Prepared by: Dan Huynh<br><br>Issued Date: October 5, 2005 | Tested by: Hung Trinh and Wayne Wu<br><br>Test Dates: August 9 - 22, 2005 |

- *The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.*
- *This report must not be used by the client to claim product endorsement by NVLAP or any agency of the US Government.*


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31040/SIT C-1376 46390-2049 200093-0 SL2-IN-E-1119R 00-034

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# EXHIBIT 1. SUBMITTAL CHECK LIST

| Annex No. | Exhibit Type | Description of Contents | Quality Check (OK) |
|---|---|---|---|
| -- | Test Report | • Exhibit 1: Submittal check lists<br>• Exhibit 2: Introduction<br>• Exhibit 3: Performance Assessment<br>• Exhibit 4: EUT Operation and Configuration during Tests<br>• Exhibit 5: Summary of test Results<br>• Exhibit 6: Measurement Data<br>• Exhibit 7: Measurement Uncertainty | OK |
| 1 | Test Setup Photos | Radiated Emission Setup Photos | OK |
| 2 | External Photos of EUT | External Photos | OK |
| 3 | Internal Photos of EUT | Internal Photos | OK |
| 4 | Cover Letters | • Letter from Ultratech for Certification Request<br>• Letter from the Applicant to appoint Ultratech to act as an agent<br>• Letter from the Applicant to request for Confidentiality Filing | OK |
| 5 | Attestation Statements | N/A | N/A |
| 6 | ID Label/Location Info | ID Label and Location of ID Label | OK |
| 7 | Block Diagrams | Block Diagrams | OK |
| 8 | Schematic Diagrams | Schematics | OK |
| 9 | Parts List/Tune Up Info | Parts List/ Tuning Procedures | OK |
| 10 | Operational Description | Operational Description | OK |
| 11 | RF Exposure Info | See Section 6.6 of this test report for MPE evaluation | OK |
| 12 | Users Manual | Installation and Setup Manual for the Two-Way Signal Booster System | OK |

# EXHIBIT 2. INTRODUCTION

## 2.1. SCOPE

| | |
|---|---|
| **Reference:** | FCC Parts 2 and 90 (Subpart R) |
| **Title:** | Code of Federal Regulations (CFR) Title 47 Telecommunication, Parts 2 & 90 |
| **Purpose of Test:** | To obtain FCC equipment authorization for radio operating in the frequency bands 764-776 MHz and 794-806MHz. |
| **Test Procedures:** | Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 - American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz. |
| **Environmental Classification:** | Commercial, industrial or business |

## 2.2. RELATED SUBMITTAL(S)/GRANT(S)

None.

## 2.3. NORMATIVE REFERENCES

| Publication | Year | Title |
|---|---|---|
| FCC CFR Parts 0-19, 80-End | 2004 | Code of Federal Regulations – Telecommunication |
| ANSI C63.4 | 2003 | American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 KHz to 40 GHz |
| TIA/EIA 603, Edition B | 01-Nov-2002 | Land Mobile FM or PM Communications Equipment Measurement and Performance Standards |

# EXHIBIT 3. PERFORMANCE ASSESSMENT

## 3.1. CLIENT INFORMATION

| APPLICANT | |
|---|---|
| **Name:** | TX RX Systems, Inc. |
| **Address:** | 8625 Industrial Parkway<br>Angola, NY 14006<br>USA |
| **Contact Person:** | Mr. Dennis Hohman<br>Phone #: (716) 549-4700 ext 5080<br>Fax #: (716) 549-4772<br>Email Address: dhohman@bird-technologies.com |

| MANUFACTURER | |
|---|---|
| **Name:** | TX RX Systems, Inc. |
| **Address:** | 8625 Industrial Parkway<br>Angola, NY 14006<br>USA |
| **Contact Person:** | Mr. Dennis Hohman<br>Phone #: (716) 549-4700 ext 5080<br>Fax #: (716) 549-4772<br>Email Address: dhohman@bird-technologies.com |

## 3.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

| | |
|---|---|
| **Brand Name:** | TX RX Systems, Inc. |
| **Product Name:** | Signal Booster II |
| **Model Name or Number:** | 61-83B-50 |
| **Type of Equipment:** | Non-broadcast Radio Communication Equipment |
| **External Power Supply:** | N/A |
| **Primary User functions of EUT:** | Signal Booster II is designed to boost the power level of one or more RF signals and retransmit them from a signal distribution system comprised of antennas or radiating coaxial cable. |
| **Transmitting/Receiving Antenna Type:** | Non-Integral |

## 3.3. EUT'S TECHNICAL SPECIFICATIONS

| TRANSMITTER | |
|---|---|
| **Equipment Type:** | Base station (fixed use) |
| **Intended Operating Environment:** | Commercial, industrial or business environment |
| **Power Supply Requirement:** | 100-240 VAC; 50/60 Hz or +24 to +27 VDC |
| **RF Input Power Rating:** | - 15 dBm |
| **RF Output Power Rating:** | + 36 dBm (single carrier) |
| **Operating Frequency Range:** | Uplink: 764-776 MHz; Downlink: 794-806 MHz |
| **RF Output Impedance:** | 50 Ohms |
| **Occupied Bandwidth (99%):** | EXTENDER<br>(The 99% OBW of the rf output signal is the same as that of the rf input signal from a FCC certified transmitter) |
| **Emission Designation:** | • F1D<br>• F3E<br>• G3E |
| **Antenna Connector Type:** | N Female |
| **Antenna Description:** | • Outdoor/Top-Roof Antenna: The Antenna Gain Limit is 10 dBd<br>• In-building antenna: radiating coaxial cable or a network ¼ wave whip antenna (gain not exceed 0 dB) |

| RECEIVER | |
|---|---|
| **Equipment Type:** | Base station (fixed use) |
| **Intended Operating Environment:** | Commercial, industrial or business environment |
| **Power Supply Requirement:** | 100-240 VAC; 50/60 Hz or +24 to +27 VDC |
| **RF Input Power Rating:** | - 15 dBm |
| **Operating Frequency Range:** | Uplink: 764-776 MHz; Downlink: 794-806 MHz |

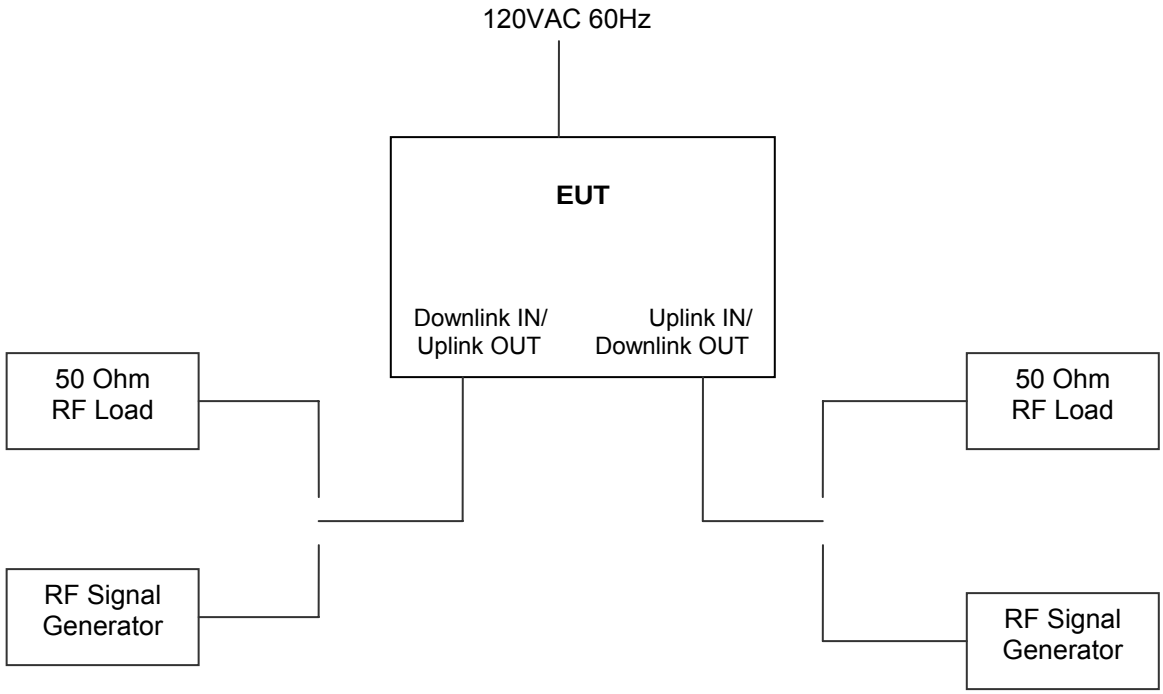
## 3.4. LIST OF EUT'S PORTS

| Port Number | EUT's Port Description | Number of Identical Ports | Connector Type | Cable Type (Shielded/Non-shielded) |
|---|---|---|---|---|
| 1 | Downlink IN – Uplink OUT | 1 | N female | Shielded |
| 2 | Uplink IN – Downlink OUT | 1 | N female | Shielded |
| 3 | Backup DC Power | 1 | 2 Term Barrier | Non-shielded |
| 4 | Alarm Contacts | 1 | 6 Term Barrier | Non-shielded |
| 5 | AC Line Filter | 1 | -- | Non-shielded |
| 6 | Accessory AC Outlet | 2 | AC Duplex Receptacles | Non-shielded |

## 3.5. ANCILLARY EQUIPMENT

None.

## 3.6. GENERAL TEST SETUP



# EXHIBIT 4. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

## 4.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

| | |
|---|---|
| Temperature: | 21°C |
| Humidity: | 51% |
| Pressure: | 102 kPa |
| Power input source: | 100-240 VAC; 50/60 Hz or +24 to +27 VDC |

## 4.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TEST SIGNALS

| | |
|---|---|
| **Operating Modes:** | The transmitter was operated in a continuous transmission mode with the carrier modulated as specified in the Test Data. |
| **Special Test Software:** | N/A |
| **Special Hardware Used:** | N/A |
| **Transmitter Test Antenna:** | The EUT is tested with the transmitter antenna port terminated to a 50 Ohms RF Load. |

| **Transmitter Test Signals** | |
|---|---|
| **Frequency Band(s):** | Uplink: 764-776 MHz;<br>Downlink: 794-806 MHz |
| **Frequency(ies) Tested:**<br>(Near lowest, near middle and near highest frequencies in the frequency range of operation.) | 764, 770 and 776 MHz<br>794, 800 and 806 MHz |
| **RF Power Output (measured maximum output power):**<br><br>**Normal Test Modulation:**<br><br>**Modulating signal source:** | 36.31 dBm<br><br>Unmodulated, G3E, F1D & F3E<br><br>External |

# EXHIBIT 5. SUMMARY OF TEST RESULTS

## 5.1. LOCATION OF TESTS

All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

- AC Power Line Conducted Emissions were performed in UltraTech's shielded room, 24'(L) by 16'(W) by 8'(H).
- Radiated Emissions were performed at the Ultratech's 3 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, province of Ontario.

The above sites have been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville Open Field Test Site has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada File No.: IC2049). Last Date of Site Calibration: January 10, 2005.

## 5.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

| FCC Section(s) | Test Requirements | Applicability (Yes/No) |
|---|---|---|
| 90.541 & 2.1046 | RF Power Output & Intermodulation | Yes |
| 1.1307, 1.1310 & 2.1091 | RF Exposure Limit | Yes |
| 90.539 & 2.1055 | Frequency Stability | (1)Not applicable for amplifier |
| 2.1047(a) | Audio Frequency Response | (2)Not applicable for amplifier |
| 2.1047(b) | Modulation Limiting | (2)Not applicable for amplifier |
| 2.1049 | Occupied Bandwidth | Yes |
| 90.543(c), 2.1051 & 2.1057 | Emission Limitation - Spurious Emissions at Antenna Terminal | Yes |
| 90.543(c), 2.1053 & 2.1057 | Emission Limitation - Field Strength of Spurious Emissions | Yes |
| **Signal Booster II**, **Model No.: 61-83B-50**, by **TX RX Systems, Inc.** has also been tested and found to comply with **FCC Part 15, Subpart B - Radio Receivers and Class A Digital Devices**. The engineering test report has been documented and it is available upon request. | | |

Notes:

(1) Test is not applicable, the EUT is not designed to generate or translate frequencies, it only amplifies the signal it receives.
(2) Test is not applicable, the EUT does not contain modulation circuitry.

## 5.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

An assembly (Fig, 1) added to the backup DC power input terminals to reduce the conducted emissions.

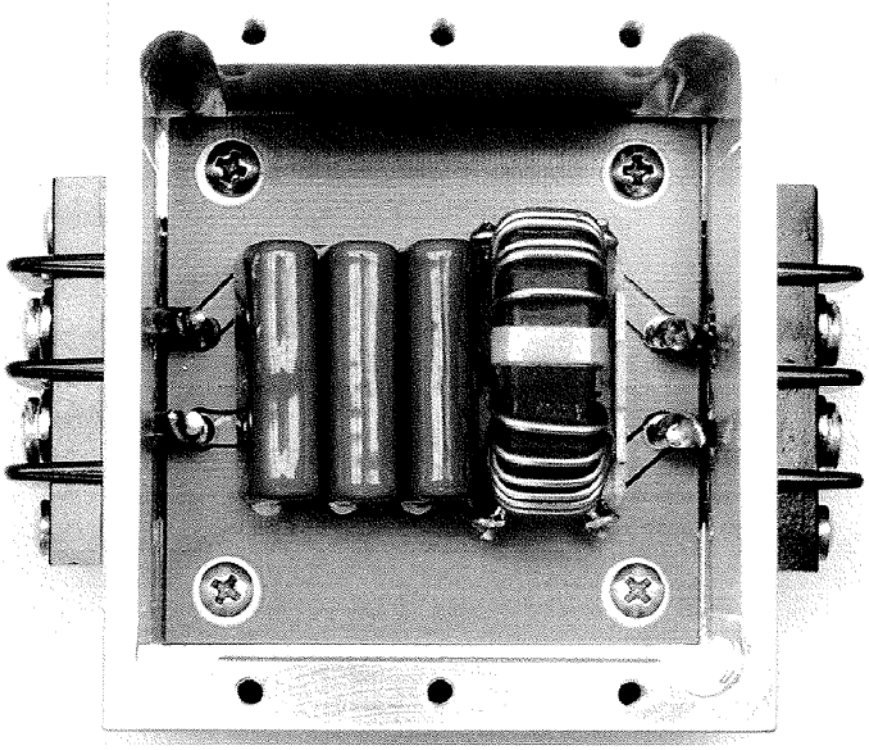


Fig.1

This assembly consists of three capacitors and one inductor. The capacitors are Panasonic part number ECQ-E2225KIB, which are 2.2 µfd, 250V, metallized polypropylene film, non-polarized. TX RX System has assigned part number 8-20967. The inductor is a JW Milller part number 8108, which is 1MH, 10A inductor. TX RX has assigned part number 8-21128.

# EXHIBIT 6. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

## 6.1. TEST PROCEDURES

This section contains test results only. Details of test methods and procedures can be found in Ultratech Test Procedures, File # ULTR P001-2004 and ANSI C63.4.

## 6.2. MEASUREMENT UNCERTAINTIES

The measurement uncertainties stated were calculated in accordance with requirements of UKAS Document NIS 81 with a confidence level of 95%. Please refer to Exhibit 7 for Measurement Uncertainties.

## 6.3. MEASUREMENT EQUIPMENT USED

The measurement equipment used complied with the requirements of the Standards referenced in the Methods & Procedures ANSI C63.4 and CISPR 16-1.

## 6.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUFACTURER

Signal Booster II is a broadband, bi-directional amplifier capable of up to 80 dB of RF gain and a maximum power output of +36 dBm. It is an on-frequency repeater that can also be referred to as a zone enhancer. The unit is deigned for a nominal frequency separation of 30 the uplink and down link branches. The two branches are coupled to the RF input/output ports via a multi-section filter duplexer providing enough isolation to prevent regenerative feedback. Each branch incorporates an Output Leveling Control circuit that reduces device gain by up to 60 dB to maintain full but linear output power output with varying input signal levels and multiple carriers.

## 6.5. RF POWER OUTPUT & INTERMODULATION [§§ 2.1046 & 90.541]

### 6.5.1. Limits

§ 90.541 Transmitting power limits: The transmitting power of base, mobile, portable and control stations operating in the 764-776 MHz and 794-806 MHz frequency band must not exceed the maximum limits in this section, and must also comply with any applicable effective radiated power limits in § 90.545.

(a) The transmitting power of base transmitters must not exceed the limits given in paragraphs (a), (b) and (c) of § 90.635.
(b) The transmitter output power of mobile and control transmitters must not exceed 30 Watts.
(c) The transmitter output power of portable (hand-held) transmitters must not exceed 3 Watts.
(d) Transmitters operating on the narrowband low power channels listed in §§ 90.531(b)(3), 90.531(b)(4), must not exceed 2 watts (ERP).

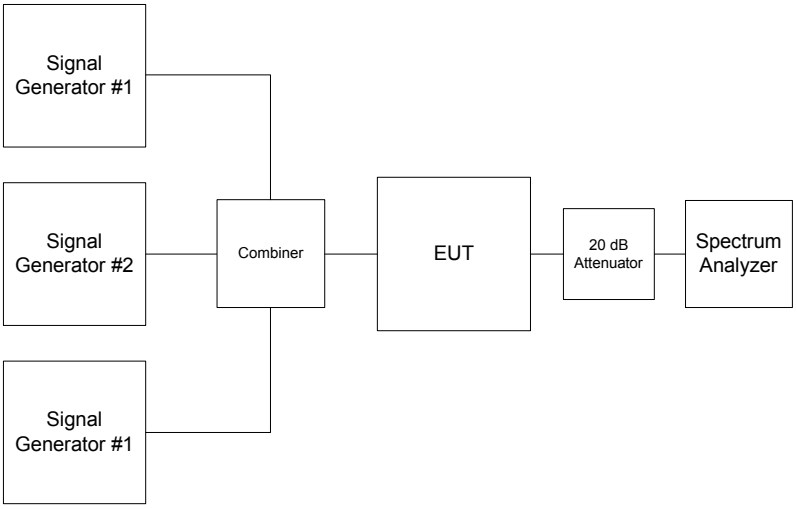
### 6.5.2. Method of Measurements

Refer to ULTRATECH Test Procedures, File # ULTR P001-2004 and ANSI C63.4

### 6.5.3. Test Equipment List

| Test Instruments | Manufacturer | Model No. | Serial No. | Frequency Range |
|---|---|---|---|---|
| Signal Generator | Gigatronics | 6061A | 5130586 | 10 kHz - 1050 MHz |
| Signal Generator | Fluke | 6061A | 4770301 | 10 kHz - 1050 MHz |
| Signal Generator | Gigatronics | 6061A | 5130408 | 10 kHz - 1050 MHz |
| Combiner | Mini-Circuit | 15542 | 0105 | 1 MHz - 1 GHz |
| Spectrum Analyzer | Advantest | R3271 | 15050203 | 100Hz - 26.5GHz |

### 6.5.4. Test Arrangement



## 6.5.5. Test Data

### 6.5.5.1. RF POWER OUTPUT with MODULATION, SINGLE CHANNEL, MAXIMUM RF IN = - 15 dBm

#### *6.5.5.1.1. 120 VAC 60 Hz input*

| Test Frequency (MHz) | Modulation | Total RF Output Power at Antenna Port (dBm) | Maximum Antenna Gain allowed (dB) | Maximum ERP (dBm) | RF Output Power Ratings at Antenna Port (dBm) |
|---|---|---|---|---|---|
| **764-776 MHz Band (Uplink)** | | | | | |
| 764 | F1D/F3E/G3E | 35.38 | 10 | 45.38 | 36 |
| 770 | F1D/F3E/G3E | 36.11 | 10 | 46.11 | 36 |
| 776 | F1D/F3E/G3E | 35.31 | 10 | 45.31 | 36 |
| **794-806 MHz Band (Downlink)** | | | | | |
| 794 | F1D/F3E/G3E | 36.15 | 10 | 46.15 | 36 |
| 800 | F1D/F3E/G3E | 36.12 | 10 | 46.12 | 36 |
| 806 | F1D/F3E/G3E | 36.24 | 10 | 46.24 | 36 |

#### *6.5.5.1.2. +27 VDC input*

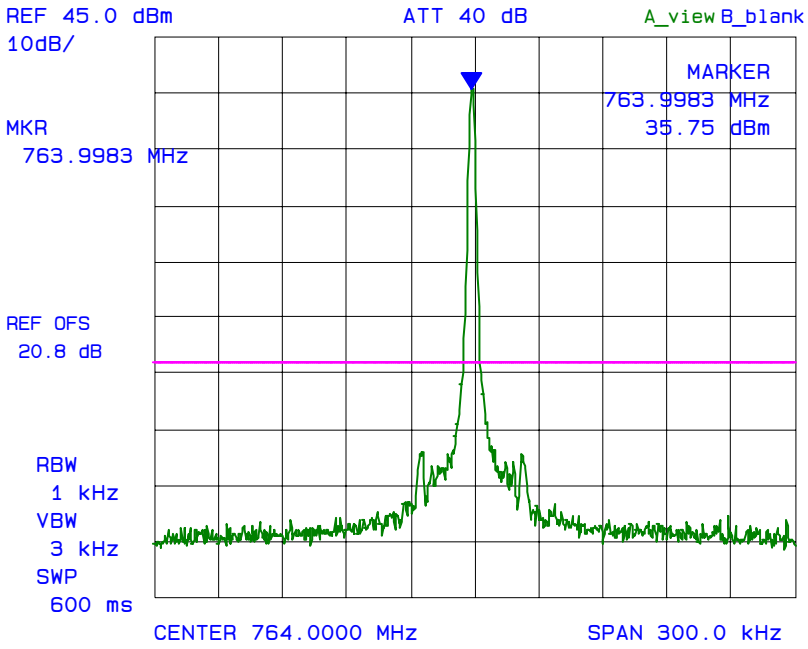
| Test Frequency (MHz) | Modulation | Total RF Output Power at Antenna Port (dBm) | Maximum Antenna Gain allowed (dB) | Maximum ERP (dBm) | RF Output Power Ratings at Antenna Port (dBm) |
|---|---|---|---|---|---|
| **764-776 MHz Band (Uplink)** | | | | | |
| 764 | F1D/F3E/G3E | 35.47 | 10 | 45.47 | 36 |
| 770 | F1D/F3E/G3E | 36.21 | 10 | 46.21 | 36 |
| 776 | F1D/F3E/G3E | 35.41 | 10 | 45.41 | 36 |
| **794-806 MHz Band (Downlink)** | | | | | |
| 794 | F1D/F3E/G3E | 36.21 | 10 | 46.21 | 36 |
| 800 | F1D/F3E/G3E | 36.19 | 10 | 46.19 | 36 |
| 806 | F1D/F3E/G3E | 36.31 | 10 | 46.31 | 36 |

### 6.5.5.2. INTERMODULATION & PEAK POWERS – NO MODULATION

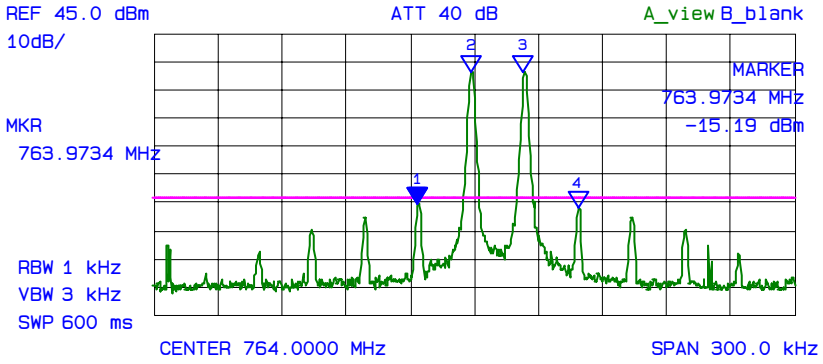
| Frequency (MHz) | Number of In/Out Channels | Modulation | Maximum RF Input (conducted) (dBm) | Maximum RF Output (conducted) (dBm) | Maximum Antenna Gain allowed (dB) | Maximum ERP Measured (dBm) |
|---|---|---|---|---|---|---|
| **764-776 MHz Band (Uplink)** | | | | | | |
| 764.000 | 1 | unmodulated | -15 | 35.75 | 10 | 45.75 |
| 764.000<br>764.025 | 2 | unmodulated | -18.91 | 31.75 | 10 | 41.75 |
| 764.000<br>764.025<br>764.050 | 3 | unmodulated | -20.51 | 31.00 | 10 | 41.00 |
| | | | | | | |
| 770.000 | 1 | unmodulated | -15 | 35.31 | 10 | 45.31 |
| 770.000<br>770.025 | 2 | unmodulated | -19.91 | 32.19 | 10 | 42.19 |
| 770.000<br>770.025<br>770.050 | 3 | unmodulated | -21.11 | 31.28 | 10 | 41.28 |
| | | | | | | |
| 776.000 | 1 | unmodulated | -15 | 34.72 | 10 | 44.72 |
| 776.000<br>775.975 | 2 | unmodulated | -20.01 | 31.75 | 10 | 41.75 |
| 776.000<br>775.975<br>775.950 | 3 | unmodulated | -21.11 | 30.72 | 10 | 40.72 |
| **794-806 MHz Band (Downlink)** | | | | | | |
| 794.000 | 1 | unmodulated | -15 | 35.06 | 10 | 45.06 |
| 794.000<br>794.025 | 2 | unmodulated | -19.41 | 31.72 | 10 | 41.72 |
| 794.000<br>794.025<br>794.050 | 3 | unmodulated | -20.31 | 30.75 | 10 | 40.75 |
| | | | | | | |
| 800.000 | 1 | unmodulated | -15 | 35.97 | 10 | 45.97 |
| 800.000<br>800.025 | 2 | unmodulated | -20.21 | 32.06 | 10 | 42.06 |
| 800.000<br>800.025<br>800.050 | 3 | unmodulated | -21.51 | 30.88 | 10 | 40.88 |
| | | | | | | |
| 806.000 | 1 | unmodulated | -15 | 35.41 | 10 | 45.41 |
| 806.000<br>805.975 | 2 | unmodulated | -20.21 | 31.25 | 10 | 41.25 |
| 806.000<br>805.975<br>805.950 | 3 | unmodulated | -21.31 | 30.31 | 10 | 40.31 |

See the following plots for details.

Plot 6.5.5.2.1
Intermodulation with 1 RF signal input/output in 764-776 MHz band
Fc: 764 MHz
RF Input: -15 dBm



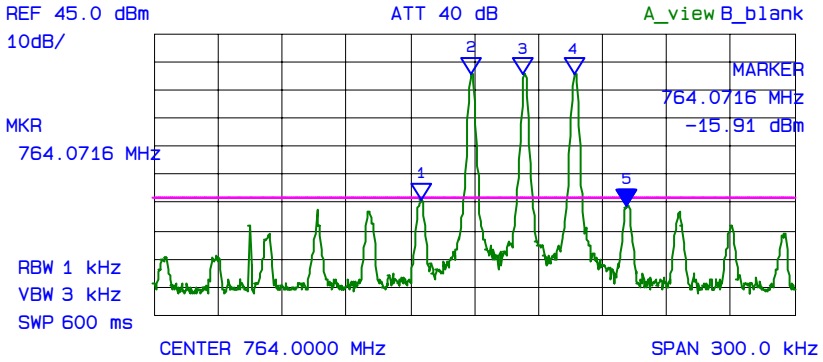
Plot 6.5.5.2.2
Intermodulation with 2 RF signal inputs/outputs in 764-776 MHz band
Fc: 764 MHz & Fc + 25 kHz
RF Input: (2) -19.11 dBm, (3) -18.91 dBm




*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No.1: | 763.9734 MHz | -15.19 dBm | A |
| No.2: | 763.9983 MHz | 31.75 dBm | A |
| No.3: | 764.0231 MHz | 31.81 dBm | A |
| No.4: | 764.0484 MHz | -16.94 dBm | A |
| No.5: | | | |
| No.6: | | | |
| No.7: | | | |
| No.8: | | | |
| Δ: | | | |

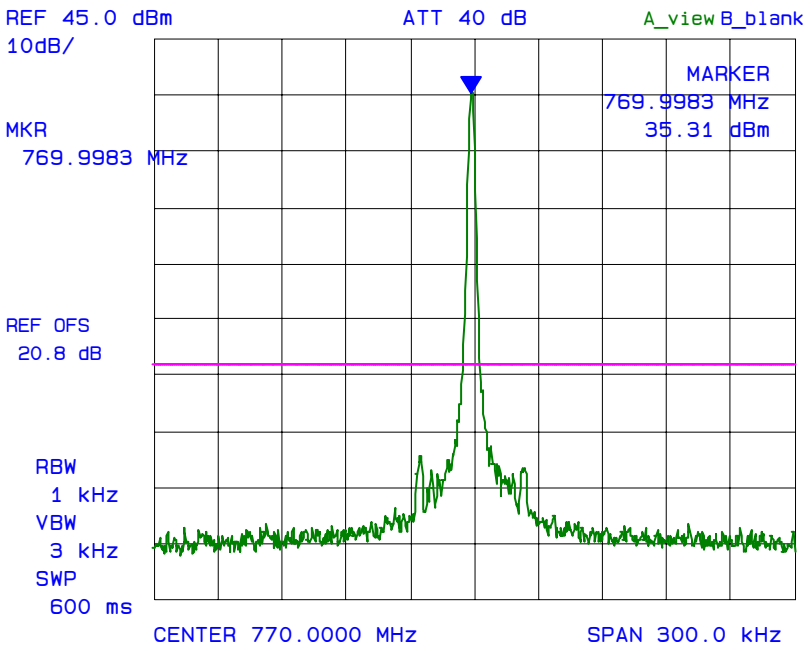
Plot 6.5.5.2.3
Intermodulation with 3 RF signal inputs/outputs in 764-776 MHz band
Fc: 764 MHz, Fc + 25 kHz & Fc + 50 kHz,
RF Input: (2) –20.91dBm, (3) -20.71dBm, (4) –20.51dBm



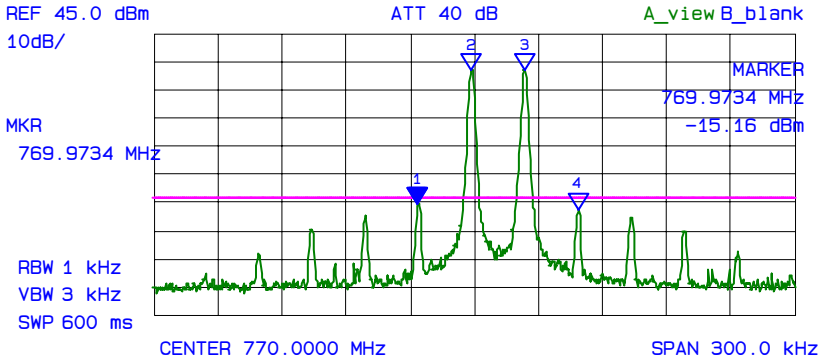

*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No.1: | 763.9751 MHz | -13.63 dBm | A |
| No.2: | 763.9983 MHz | 31.00 dBm | A |
| No.3: | 764.0231 MHz | 30.97 dBm | A |
| No.4: | 764.0467 MHz | 30.97 dBm | A |
| No.5: | 764.0716 MHz | -15.91 dBm | A |
| No.6: | | | |
| No.7: | | | |
| No.8: | | | |
| Δ: | | | |

Plot 6.5.5.2.4
Intermodulation with 1 RF signal input/output in 764-776 MHz band
Fc: 770 MHz
RF Input: -15dBm



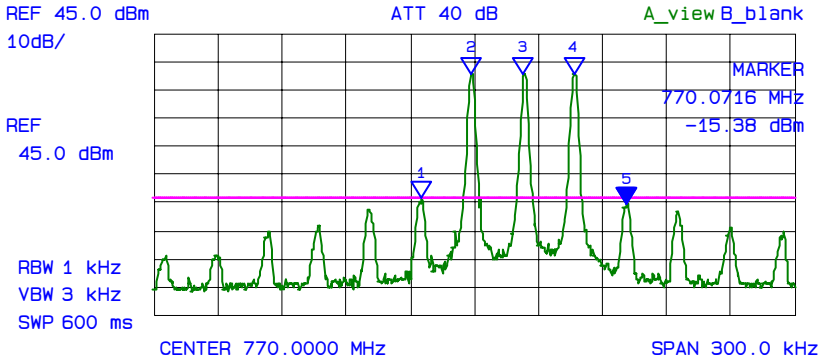
Plot 6.5.5.2.5
Intermodulation with 2 RF signal inputs/outputs in 764-776 MHz band
Fc: 770 MHz & Fc + 25 kHz
RF Input: (2) -20.21 dBm, (3) -19.91 dBm




*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No.1: | 769.9734 MHz | -15.16 dBm | A |
| No.2: | 769.9987 MHz | 32.13 dBm | A |
| No.3: | 770.0236 MHz | 32.19 dBm | A |
| No.4: | 770.0484 MHz | -17.47 dBm | A |
| No.5: | | | |
| No.6: | | | |
| No.7: | | | |
| No.8: | | | |
| Δ: | | | |

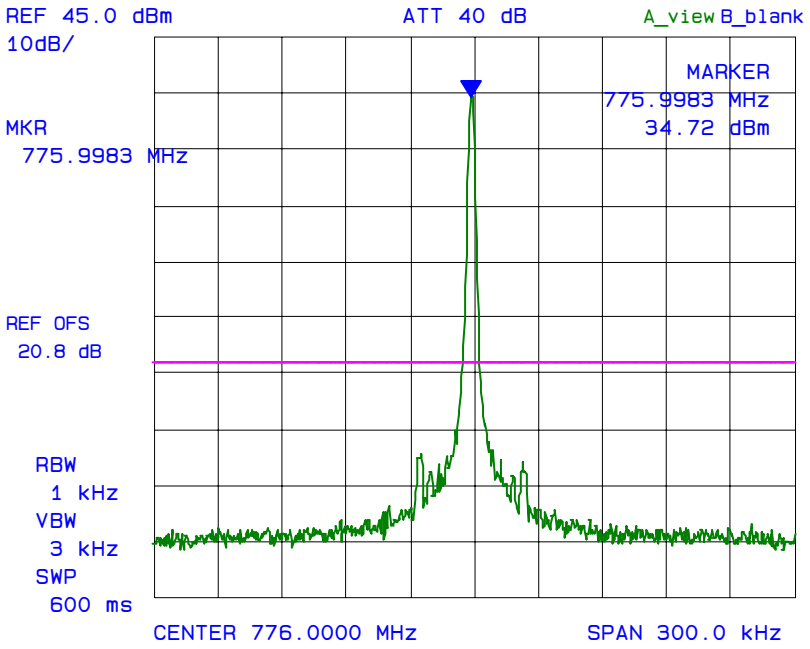
Plot 6.5.5.2.6
Intermodulation with 3 RF signal inputs/outputs in 764-776 MHz band
Fc: 770 MHz, Fc + 25 kHz & Fc + 50 kHz
RF Input: (2) -21.51dBm, (3) -21.11dBm, (4) -21.21dBm



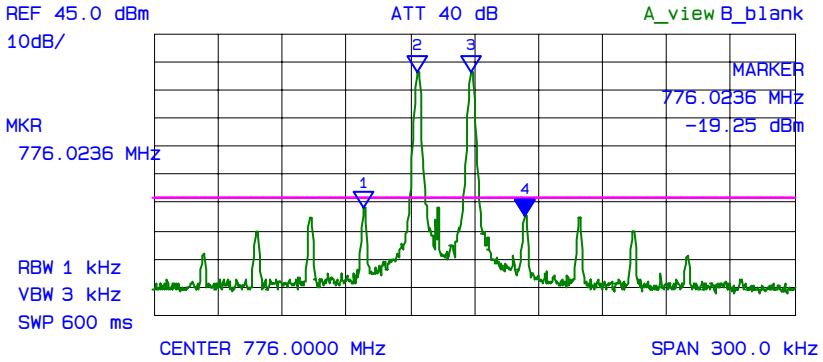

*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No.1: | 769.9751 MHz | -13.25 dBm | A |
| No.2: | 769.9983 MHz | 31.28 dBm | A |
| No.3: | 770.0231 MHz | 31.25 dBm | A |
| No.4: | 770.0467 MHz | 31.19 dBm | A |
| No.5: | 770.0716 MHz | -15.38 dBm | A |
| No.6: | | | |
| No.7: | | | |
| No.8: | | | |
| Δ: | | | |

Plot 6.5.5.2.7
Intermodulation with 1 RF signal input/output in 764-776 MHz band
Fc: 776 MHz
RF Input: -15 dBm



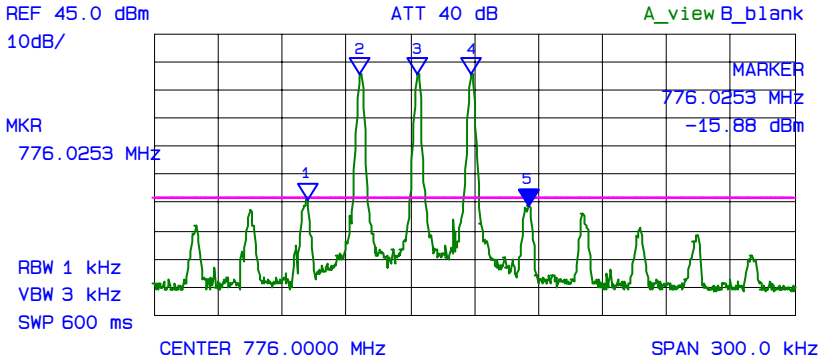
Plot 6.5.5.2.8
Intermodulation with 2 RF signal inputs/outputs in 764-776 MHz band
Fc: 776 MHz & Fc - 25 kHz
RF Input: (2) -20.31 dBm, (3) -20.01 dBm




*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No.1: | 775.9481 MHz | -16.53 dBm | A |
| No.2: | 775.9734 MHz | 31.72 dBm | A |
| No.3: | 775.9983 MHz | 31.75 dBm | A |
| No.4: | 776.0236 MHz | -19.25 dBm | A |
| No.5: | | | |
| No.6: | | | |
| No.7: | | | |
| No.8: | | | |
| Δ: | | | |

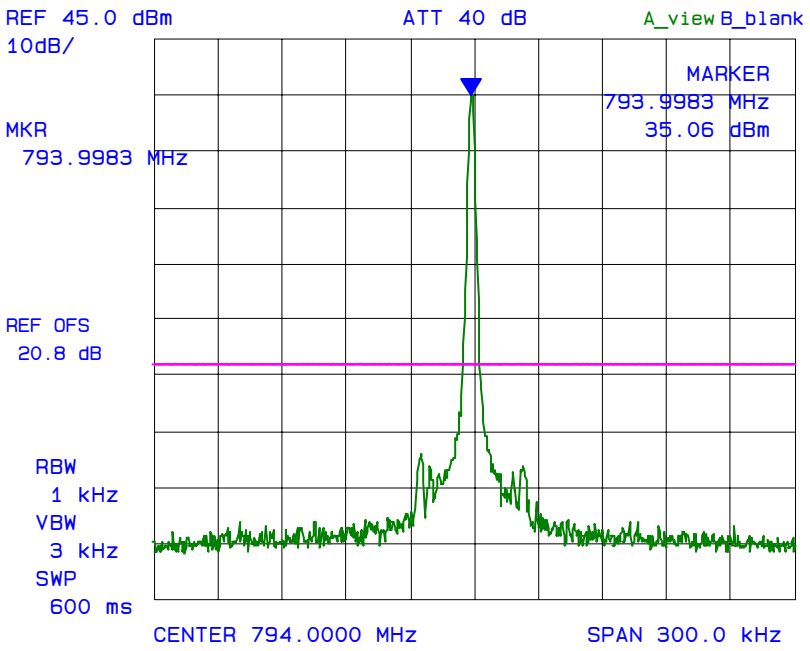
Plot 6.5.5.2.9
Intermodulation with 3 RF signal inputs/outputs in 764-776 MHz band
Fc: 776 MHz, Fc - 25 kHz & Fc - 50 kHz
RF Input: (2) -21.51 dBm, (3) -21.11 dBm, (4) -21.21 dBm



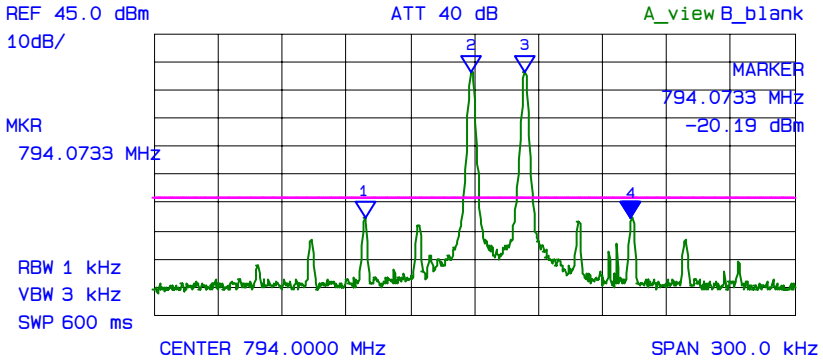

*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No.1: | 775.9216 MHz | -13.97 dBm | A |
| No.2: | 775.9464 MHz | 30.72 dBm | A |
| No.3: | 775.9734 MHz | 30.69 dBm | A |
| No.4: | 775.9983 MHz | 30.66 dBm | A |
| No.5: | 776.0253 MHz | -15.88 dBm | A |
| No.6: | | | |
| No.7: | | | |
| No.8: | | | |
| Δ: | | | |

Plot 6.5.5.2.10
Intermodulation with 1 RF signal input/output in 794-806 MHz band
Fc: 794 MHz
RF Input: -15 dBm



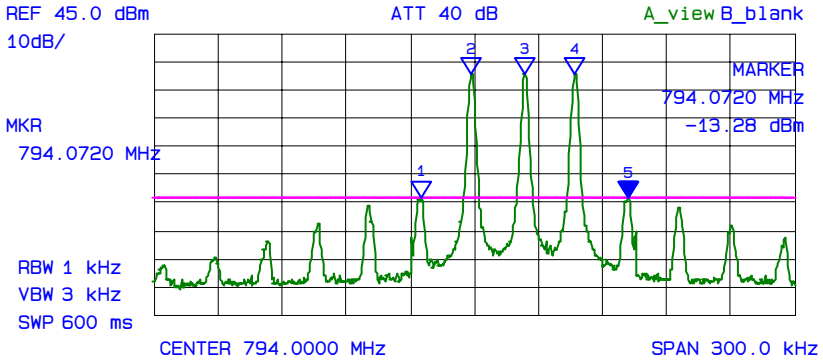
Plot 6.5.5.2.11
Intermodulation with 2 RF signal inputs/outputs in 794-806 MHz band
Fc: 794 MHz & Fc + 25 kHz
RF Input: (2) -19.61 dBm, (3) -19.41 dBm




*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No.1: | 793.9486 MHz | -19.81 dBm | A |
| No.2: | 793.9987 MHz | 31.59 dBm | A |
| No.3: | 794.0236 MHz | 31.72 dBm | A |
| No.4: | 794.0733 MHz | -20.19 dBm | A |
| No.5: | | | |
| No.6: | | | |
| No.7: | | | |
| No.8: | | | |
| Δ: | | | |

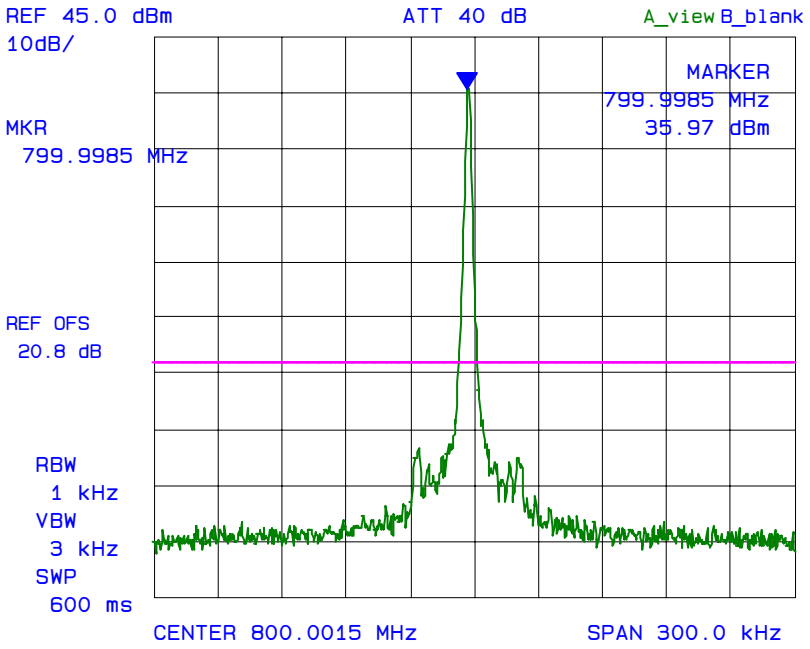
Plot 6.5.5.2.12
Intermodulation with 3 RF signal inputs/outputs in 794-806 MHz band
Fc: 794 MHz, Fc + 25 kHz & Fc + 50 kHz,
RF Input: (2) -20.51dBm, (3) -20.31dBm, (4) -20.81dBm



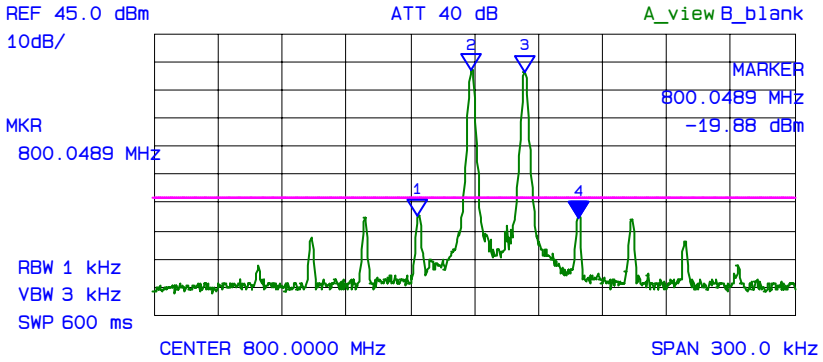

*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No.1: | 793.9751 MHz | -13.00 dBm | A |
| No.2: | 793.9983 MHz | 30.75 dBm | A |
| No.3: | 794.0236 MHz | 30.69 dBm | A |
| No.4: | 794.0471 MHz | 30.69 dBm | A |
| No.5: | 794.0720 MHz | -13.28 dBm | A |
| No.6: | | | |
| No.7: | | | |
| No.8: | | | |
| Δ: | | | |

Plot 6.5.5.2.13
Intermodulation with 1 RF signal input/output in 794-806 MHz band
Fc: 800 MHz
RF Input: -15 dBm



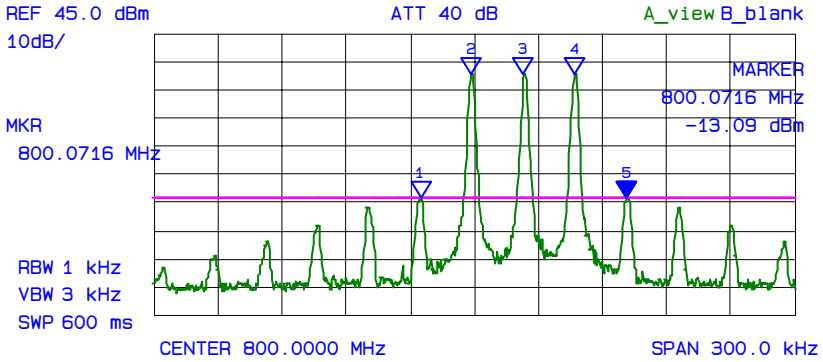
Plot 6.5.5.2.14
Intermodulation with 2 RF signal inputs/outputs in 794-806 MHz band
Fc: 800 MHz & Fc + 25 kHz
RF Input: (2) –20.21dBm, (3) -20.31dBm




*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No.1: | 799.9734 MHz | -19.25 dBm | A |
| No.2: | 799.9983 MHz | 32.06 dBm | A |
| No.3: | 800.0236 MHz | 31.97 dBm | A |
| No.4: | 800.0489 MHz | -19.88 dBm | A |
| No.5: | | | |
| No.6: | | | |
| No.7: | | | |
| No.8: | | | |
| Δ: | | | |

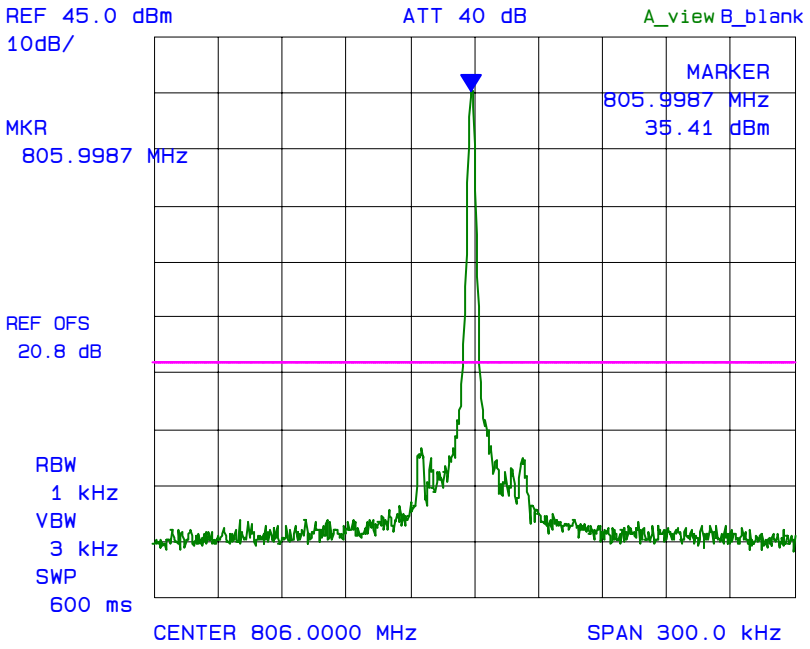
Plot 6.5.5.2.15
Intermodulation with 3 RF signal inputs/outputs in 794-806 MHz band
Fc: 800 MHz, Fc + 25 kHz & Fc + 50 kHz
RF Input: (2) –21.51dBm, (3) -21.51dBm, (4) –21.81dBm



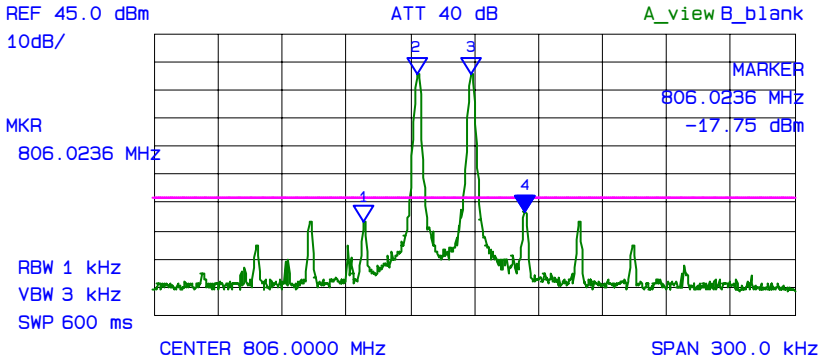

*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No.1: | 799.9747 MHz | -13.06 dBm | A |
| No.2: | 799.9983 MHz | 30.88 dBm | A |
| No.3: | 800.0231 MHz | 30.72 dBm | A |
| No.4: | 800.0471 MHz | 30.88 dBm | A |
| No.5: | 800.0716 MHz | -13.09 dBm | A |
| No.6: | | | |
| No.7: | | | |
| No.8: | | | |
| Δ: | | | |

Plot 6.5.5.2.16
Intermodulation with 1 RF signal input/output in 794-806 MHz band
Fc: 806 MHz
RF Input: -15 dBm



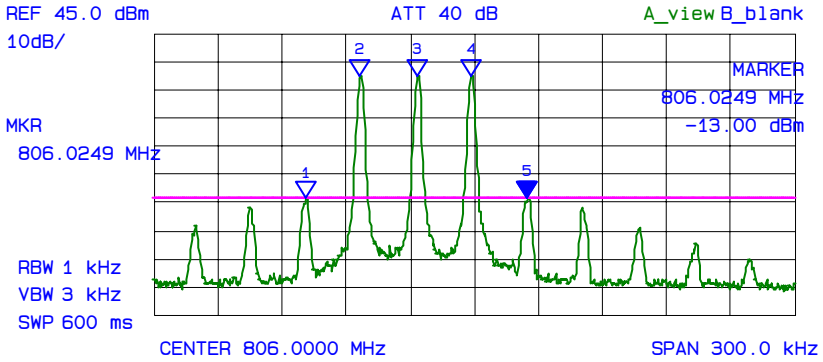
Plot 6.5.5.2.17
Intermodulation with 2 RF signal inputs/outputs in 794-806 MHz band
Fc: 806 MHz & Fc - 25 kHz
RF Input: (2) -20.41dBm, (3) -20.21dBm




*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No.1: | 805.9481 MHz | -21.59 dBm | A |
| No.2: | 805.9730 MHz | 31.25 dBm | A |
| No.3: | 805.9983 MHz | 31.22 dBm | A |
| No.4: | 806.0236 MHz | -17.75 dBm | A |
| No.5: | | | |
| No.6: | | | |
| No.7: | | | |
| No.8: | | | |
| Δ: | | | |

Plot 6.5.5.2.18
Intermodulation with 3 RF signal inputs/outputs in 794-806 MHz band
Fc: 806 MHz, Fc - 25 kHz & Fc - 50 kHz
RF Input: (2) -21.51dBm, (3) -21.31dBm, (4) -21.71dBm




*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No.1: | 805.9211 MHz | -13.13 dBm | A |
| No.2: | 805.9464 MHz | 30.28 dBm | A |
| No.3: | 805.9734 MHz | 30.31 dBm | A |
| No.4: | 805.9983 MHz | 30.28 dBm | A |
| No.5: | 806.0249 MHz | -13.00 dBm | A |
| No.6: | | | |
| No.7: | | | |
| No.8: | | | |
| Δ: | | | |

## 6.6. RF EXPOSURE REQUIREMENTS [§§ 1.1310 & 2.1091]

### 6.6.1. Limits

**FCC 1.1310:**- The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

| Frequency range (MHz) | Electric field strength (V/m) | Magnetic field strength (A/m) | Power density (mW/cm²) | Averaging time (minutes) |
|---|---|---|---|---|
| **(A) Limits for Occupational/Controlled Exposures** | | | | |
| 0.3–3.0 | 614 | 1.63 | *(100) | 6 |
| 3.0–30 | 1842/f | 4.89/f | *(900/f²) | 6 |
| 30–300 | 61.4 | 0.163 | 1.0 | 6 |
| 300–1500 | | | f/300 | 6 |
| 1500–100,000 | | | 5 | 6 |
| **(B) Limits for General Population/Uncontrolled Exposure** | | | | |
| 0.3–1.34 | 614 | 1.63 | *(100) | 30 |
| 1.34–30 | 824/f | 2.19/f | *(180/f²) | 30 |
| 30–300 | 27.5 | 0.073 | 0.2 | 30 |
| 300–1500 | | | f/1500 | 30 |
| 1500–100,000 | | | 1.0 | 30 |

f = frequency in MHz
* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

### 6.6.2. Method of Measurements

Refer to FCC @ 1.1310 and 2.1091

- In order to demonstrate compliance with MPE requirements (see Section 2.1091), the following information is typically needed:

(1) Calculation that estimates the minimum separation distance (20 cm or more) between an antenna and persons required to satisfy power density limits defined for free space.
(2) Antenna installation and device operating instructions for installers (professional/unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirement.
(3) Any caution statements and/or warning labels that are necessary in order to comply with the exposure limits.
(4) Any other RF exposure related issues that may affect MPE compliance.

**Calculation Method of RF Safety Distance**:

$S = PG/4\Pi r^2 = EIRP/4\Pi r^2$

Where:
P: power input to the antenna in mW
EIRP: Equivalent (effective) isotropic radiated power.
S: power density $mW/cm^2$
G: numeric gain of antenna relative to isotropic radiator
r: distance to centre of radiation in cm

$r = \sqrt{PG/4\Pi S}$

- For portable transmitters (see Section 2.1093), or devices designed to operate next to a person's body, compliance is determined with respect to the SAR limit (define in the body tissues) for near-field exposure conditions. If the maximum average output power, operating condition configurations and exposure conditions are comparable to those of existing cellular and PCS phones, SAR evaluation may be required in order to determine if such a device complies with SAR limit. When SAR evaluation data is not available, and the additional supporting information cannot assure compliance, the Commission may request that an SAR evaluation be performed, as provided for in Section 1.1307(d).

### 6.6.3. Test Data

**Antenna Gain Limit specified by Manufacturer: 0 dB (In-building Antenna)**

| (1) Lowest Frequency (MHz) | Measured RF Conducted Power (dBm) | Calculated EIRP (dBm) | (2) Calculated Minimum RF Safety Distance r (cm)* | Manufacturer' Specified Separation Distance (cm) |
|---|---|---|---|---|
| 794 | 36.31 | 38.46 | 33 | 33 |

(1) The calculation is based on the lowest frequency (794 MHz) in the downlink frequency band and the highest conducted power (36.31dBm) for the worst case.

(2) The minimum separation distance between the antenna and bodies of users are calculated using the following formula:

RF EXPOSURE DISTANCE LIMITS: $r = (PG/4\Pi S)^{1/2} = (EIRP/4\Pi S)^{1/2}$

$S = 794/1500$ mW/cm$^2$ (for General Population/ Uncontrolled Exposure)
EIRP = 38.46 dBm = $10^{(38.46/10)}$ mW

$r = (EIRP/4\Pi S)^{1/2} = (10^{(38.46/10)} / 4\Pi(794/1500))^{1/2} = 33$ cm

**Antenna Gain Limit specified by Manufacturer: 10 dB (Roof Top Antenna)**

| (1) Lowest Frequency (MHz) | Measured RF Conducted Power (dBm) | Calculated EIRP (dBm) | Calculated Minimum RF Safety Distance r (cm)* | Manufacturer' Specified Separation Distance (cm) |
|---|---|---|---|---|
| 764 | 36.21 | 48.36 | 104 | 104 |

(1) The calculation is based on the lowest frequency (764 MHz) in the uplink frequency band and the highest conducted power (36.21dBm) for the worst case.

(2) The minimum separation distance between the antenna and bodies of users are calculated using the following formula:

RF EXPOSURE DISTANCE LIMITS: $r = (PG/4\Pi S)^{1/2} = (EIRP/4\Pi S)^{1/2}$

$S = 764/1500$ mW/cm$^2$ (for General Population/ Uncontrolled Exposure)
EIRP = 48.36 dBm = $10^{(48.36/10)}$ mW

$r = (EIRP/4\Pi S)^{1/2} = (10^{(48.36/10)} / 4\Pi(764/1500))^{1/2} = 104$ cm

| Evaluation of RF Exposure Compliance Requirements | |
|---|---|
| **RF Exposure Requirements** | **Compliance with FCC Rules** |
| Minimum calculated separation distance between antenna and persons required:<br><br>*Indoor Antenna: 33 cm<br>*Outdoor Antenna: 104 cm | Manufacturer' instruction for separation distance between antenna and persons required:<br><br>Indoor Antenna: 33 cm<br>Outdoor Antenna: 104 cm |
| Antenna installation and device operating instructions for installers (professional/unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirement | See user's manual for details. |
| Caution statements and/or warning labels that are necessary in order to comply with the exposure limits | See user's manual for RF exposure information. |
| Any other RF exposure related issues that may affect MPE compliance | None. |

## 6.7. OCCUPIED BANDWIDTH [§ 2.1049]

### 6.7.1. Limits

The spectral shape of the output should look similar to input for all modulations.

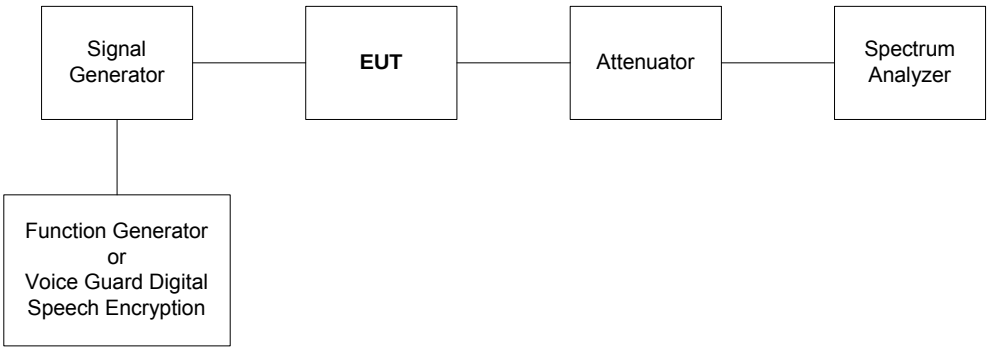
### 6.7.2. Method of Measurements

Refer to ULTRATECH Test Procedures, File # ULTR P001-2004 and ANSI C63.4.

### 6.7.3. Test Equipment List

| Test Instruments | Manufacturer | Model No. | Serial No. | Frequency Range |
|---|---|---|---|---|
| Spectrum Analyzer | Advantest | R3271 | 15050203 | 100Hz-26.5GHz |
| Function Generator | Stanford Research Systems | DS345 | 34591 | 1Hz -30.2 MHz |
| Voice Guard Digital Speech Encryption | General Electric | 9600-SW | 9614517 | -- |
| Attenuator | Weinschel Corp | 48-30-34 | BM5354 | DC - 18 GHz |
| Signal Generator | Gigatronic | 6061A | 5130586 | 10 kHz - 1050 MHz |

### 6.7.4. Test Arrangement

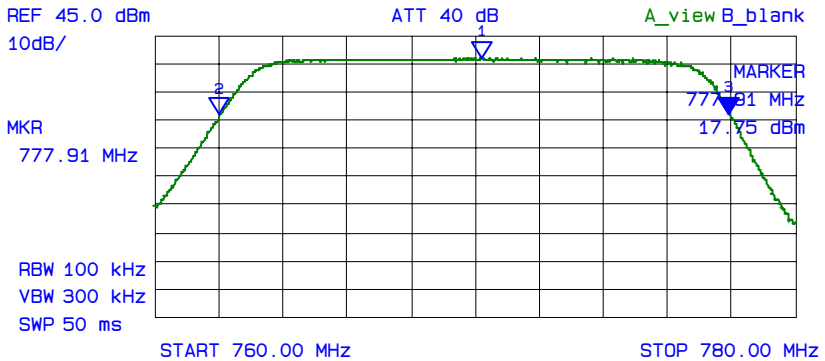


## 6.7.5. Test Data

### 6.7.5.1. 20 dB Bandwidth and Gain of the Amplifier

See the following plots for 20 dB passband gains of 764-776 MHz and 794-806 MHz bands.

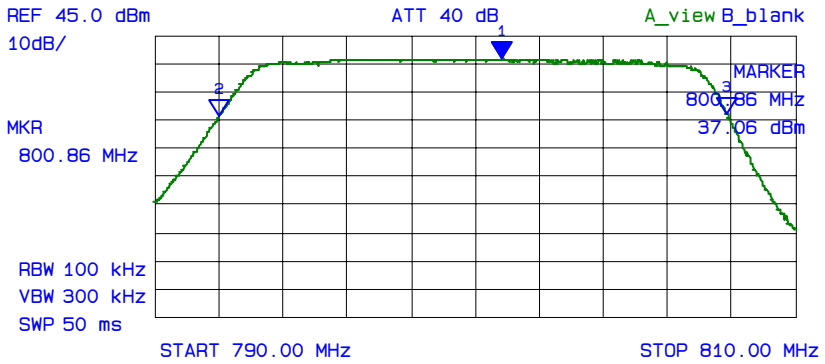
Plot 6.7.5.1.1
20 dB BW of the 764-776 MHz Passband Gain
RF Input: -15 dBm, Max Gain: 52.28 dB




*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No.1: | 770.20 MHz | 37.28 dBm | A |
| No.2: | 762.03 MHz | 17.00 dBm | A |
| No.3: | 777.91 MHz | 17.75 dBm | A |
| No.4: | | | |
| No.5: | | | |
| No.6: | | | |
| No.7: | | | |
| No.8: | | | |
| 1: | | | |

Plot 6.7.5.1.2
20 dB BW of the 794-806 MHz Passband Gain
RF Input: -15 dBm, Max Gain: 52.06 dB




*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No.1: | 800.86 MHz | 37.06 dBm | A |
| No.2: | 792.00 MHz | 16.91 dBm | A |
| No.3: | 807.86 MHz | 17.53 dBm | A |
| No.4: | | | |
| No.5: | | | |
| No.6: | | | |
| No.7: | | | |
| No.8: | | | |
| 1: | | | |

### 6.7.5.2. 99% Occupied Bandwidth Measurements

**Remark**: 99% OBW of the RF input and RF output signals were measured for comparison.

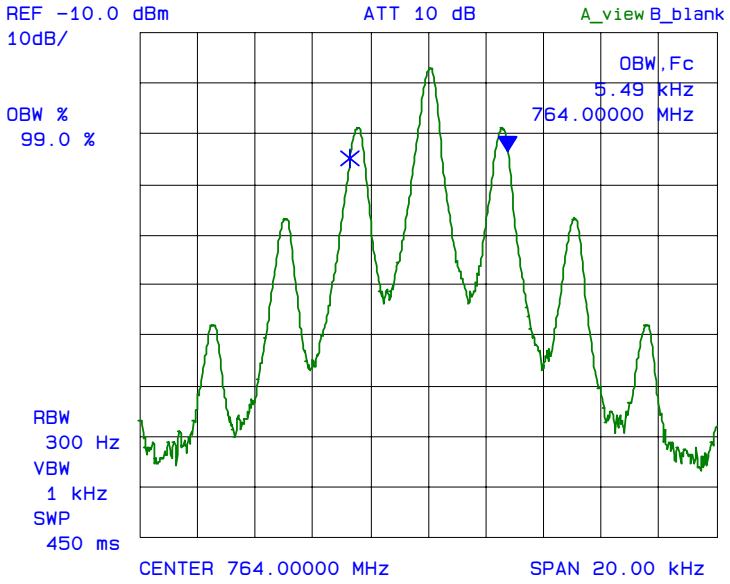
| Frequency (MHz) | Measured 99% OBW (kHz) | |
|---|---|---|
| | RF IN | RF OUT |
| **Channel Spacing: 6.25 kHz, Modulation: FM with 2.5 kHz sine wave signal** | | |
| 764 | 5.49 | 5.46 |
| 770 | 5.46 | 5.46 |
| 776 | 5.49 | 5.49 |
| 794 | 5.43 | 5.43 |
| 800 | 5.43 | 5.43 |
| 806 | 5.46 | 5.46 |
| **Channel Spacing: 6.25, Modulation: FM with an external 9600 b/s random data source** | | |
| 764 | 4.07 | 4.05 |
| 770 | 4.05 | 4.07 |
| 776 | 4.05 | 4.03 |
| 794 | 4.03 | 4.03 |
| 800 | 4.03 | 4.05 |
| 806 | 4.03 | 4.05 |
| **Channel Spacing: 12.5 kHz, Modulation: Modulation: FM with 2.5 kHz sine wave signal** | | |
| 764 | 10.14 | 10.14 |
| 770 | 10.00 | 10.00 |
| 776 | 10.04 | 10.00 |
| 794 | 10.07 | 10.07 |
| 800 | 10.11 | 10.11 |
| 806 | 10.00 | 10.00 |
| **Channel Spacing: 12.5 kHz, Modulation: FM with an external 9600 b/s random data source** | | |
| 764 | 10.25 | 10.18 |
| 770 | 10.29 | 10.32 |
| 776 | 10.14 | 10.14 |
| 794 | 10.18 | 10.21 |
| 800 | 10.54 | 10.68 |
| 806 | 10.32 | 10.43 |

| Frequency (MHz) | Measured 99% OBW (kHz) | |
|---|---|---|
| | RF IN | RF OUT |
| **Channel Spacing: 25 kHz, Modulation: Modulation: FM with 2.5 kHz sine wave signal** | | |
| 764 | 15.30 | 15.30 |
| 770 | 15.04 | 15.09 |
| 776 | 15.09 | 15.09 |
| 794 | 15.09 | 15.09 |
| 800 | 15.21 | 15.21 |
| 806 | 15.17 | 15.17 |
| **Channel Spacing: 25 kHz, Modulation: FM with an external 9600 b/s random data source** | | |
| 764 | 16.59 | 16.63 |
| 770 | 16.33 | 16.63 |
| 776 | 16.54 | 16.50 |
| 794 | 16.67 | 16.41 |
| 800 | 16.80 | 16.50 |
| 806 | 16.67 | 16.50 |

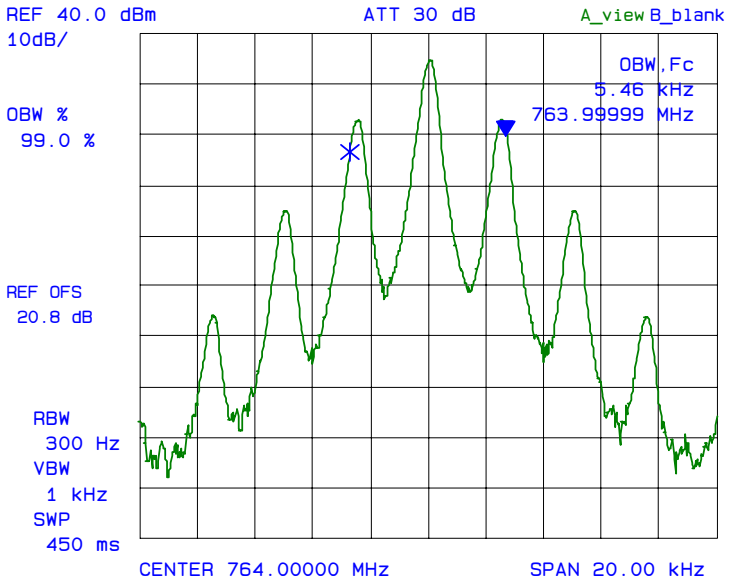
See the following plots for 99% occupied bandwidth measurements.

### *6.7.5.2.1. 6.25 kHz Channel Spacing*

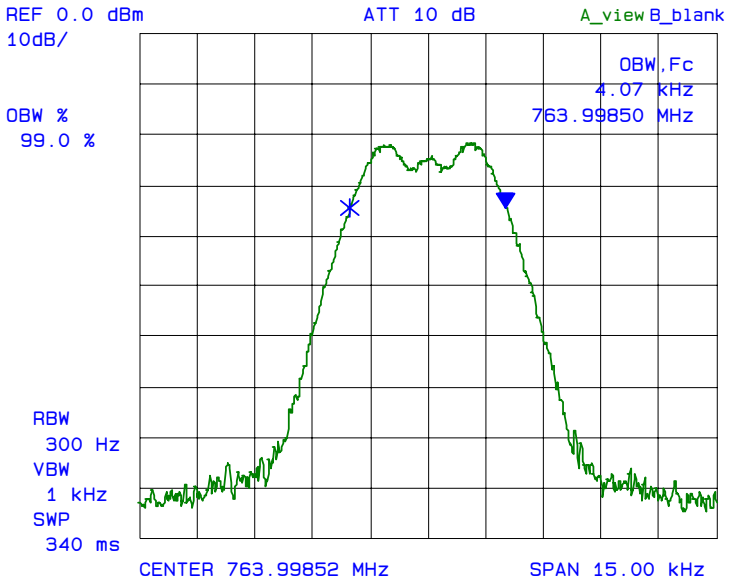
Plot 6.7.5.2.1.1: 99% Occupied Bandwidth (Input)
Fc: 764 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



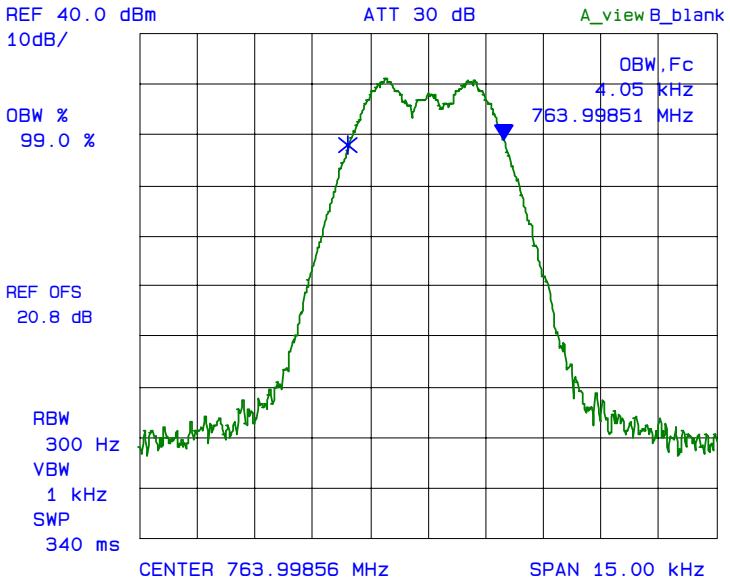

Plot 6.7.5.2.1.2: 99% Occupied Bandwidth (Output)
Fc: 764 MHz, Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



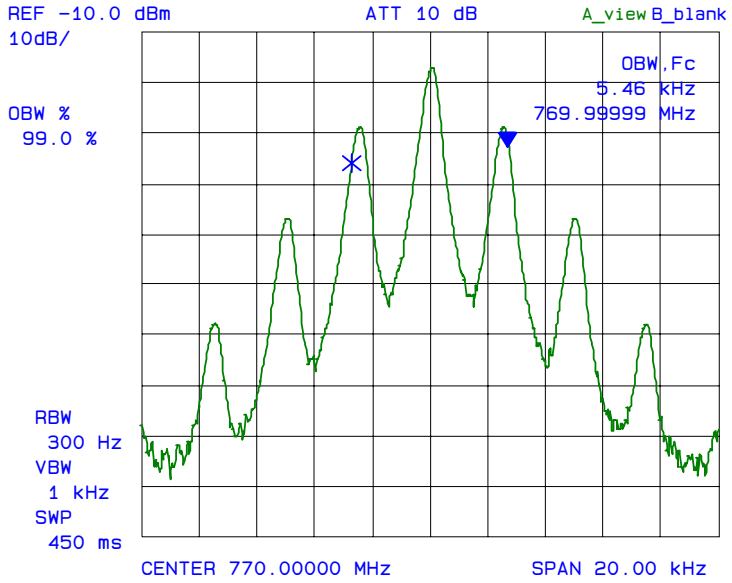
Plot 6.7.5.2.1.3: 99% Occupied Bandwidth (Input)
Fc: 764 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



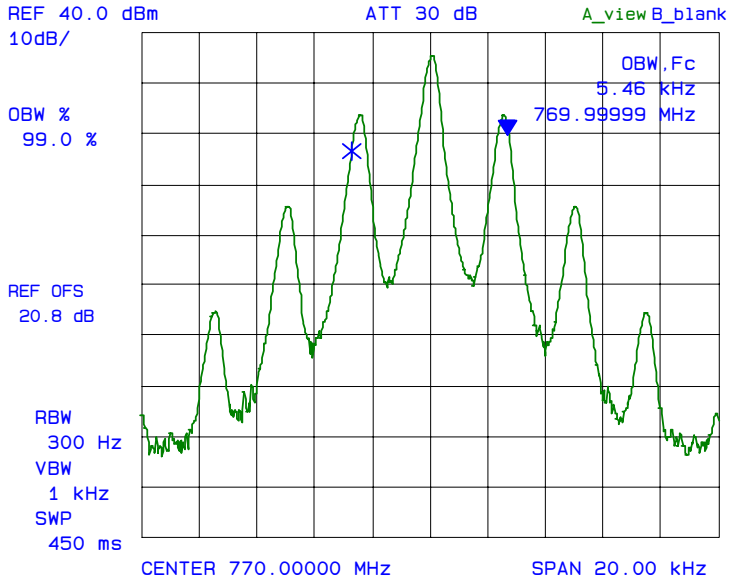

Plot 6.7.5.2.1.4: 99% Occupied Bandwidth (Output)
Fc: 764 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



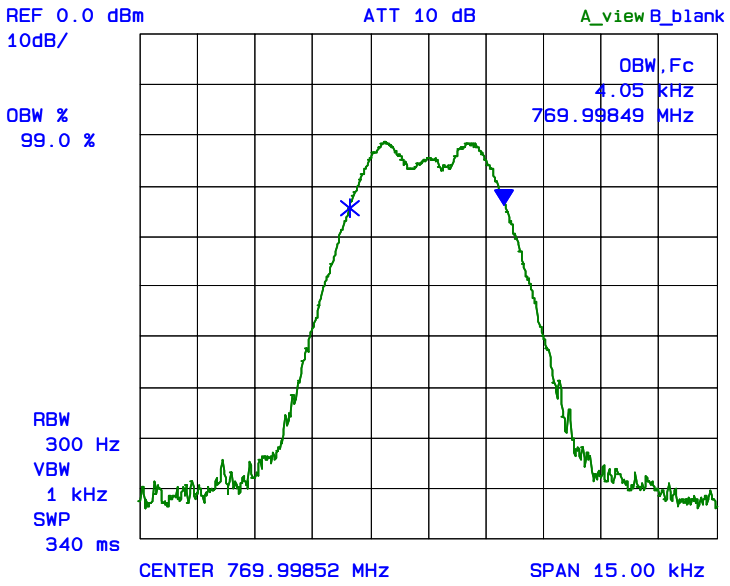
Plot 6.7.5.2.1.5: 99% Occupied Bandwidth (Input)
Fc: 770 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



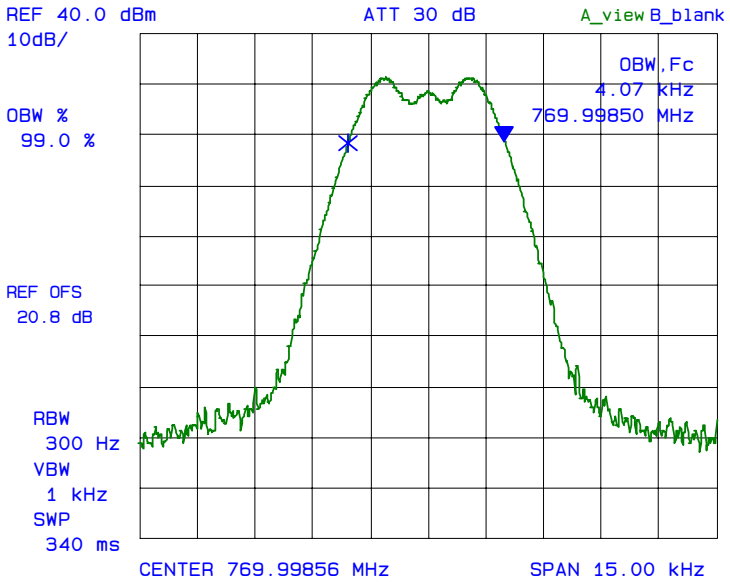

Plot 6.7.5.2.1.6: 99% Occupied Bandwidth (Output)
Fc: 770 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



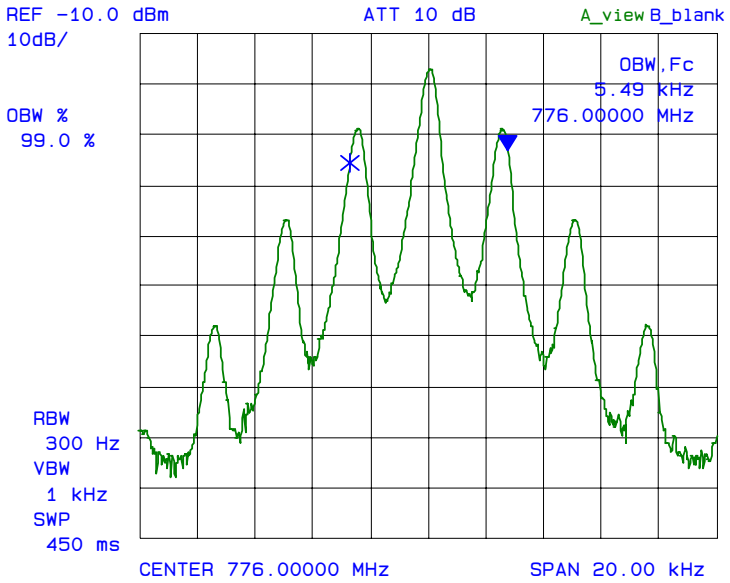
Plot 6.7.5.2.1.7: 99% Occupied Bandwidth (Input)
Fc: 770 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



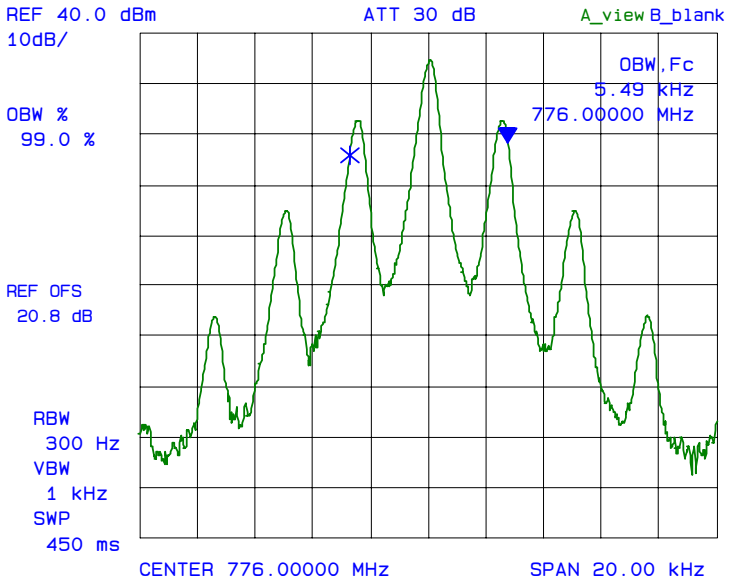

Plot 6.7.5.2.1.8: 99% Occupied Bandwidth (Output)
Fc: 770 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



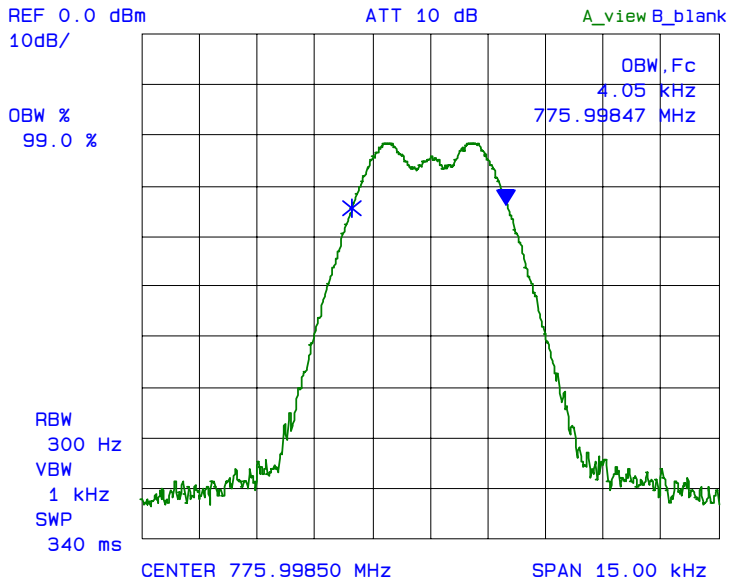
Plot 6.7.5.2.1.9: 99% Occupied Bandwidth (Input)
Fc: 776 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



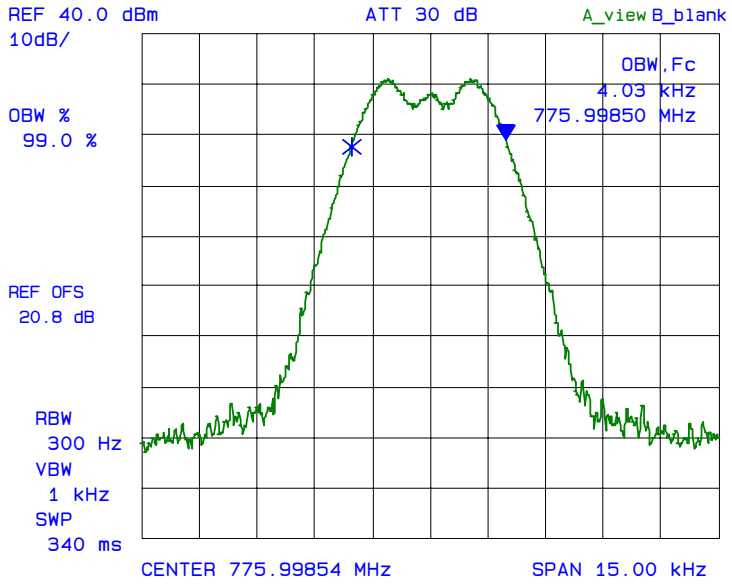

Plot 6.7.5.2.1.10: 99% Occupied Bandwidth (Output)
Fc: 776 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



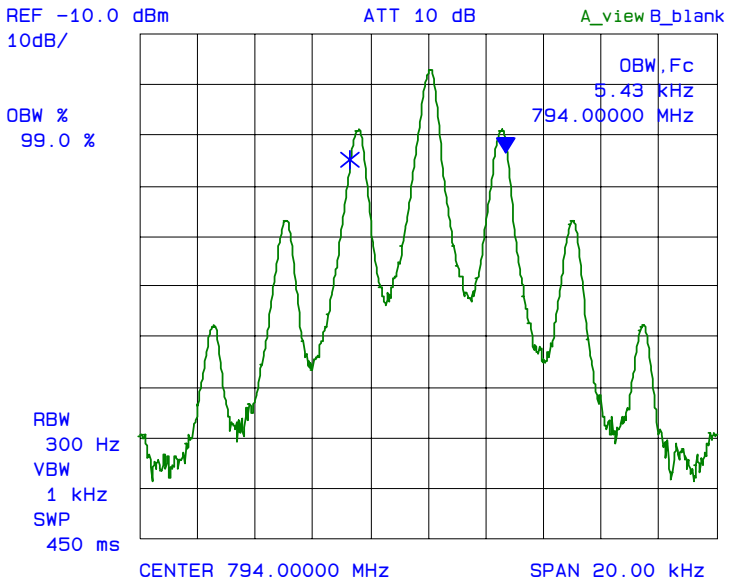
Plot 6.7.5.2.1.11: 99% Occupied Bandwidth (Input)
Fc: 776 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



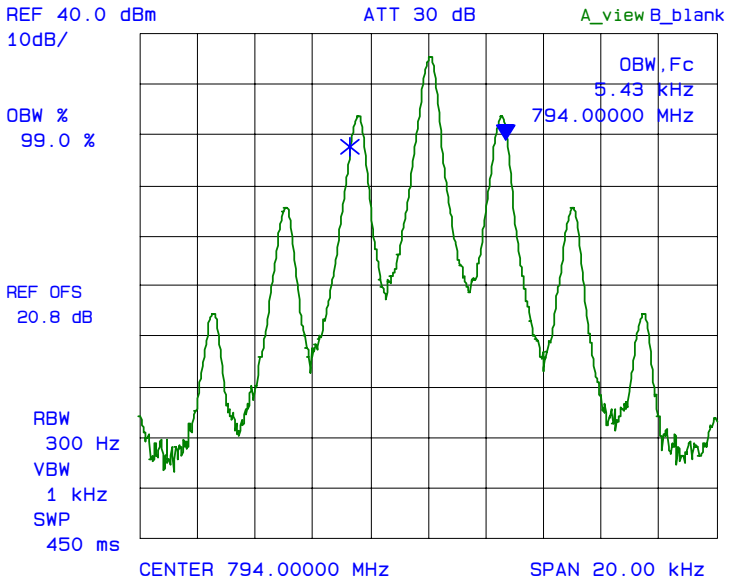

Plot 6.7.5.2.1.12: 99% Occupied Bandwidth (Output)
Fc: 776 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



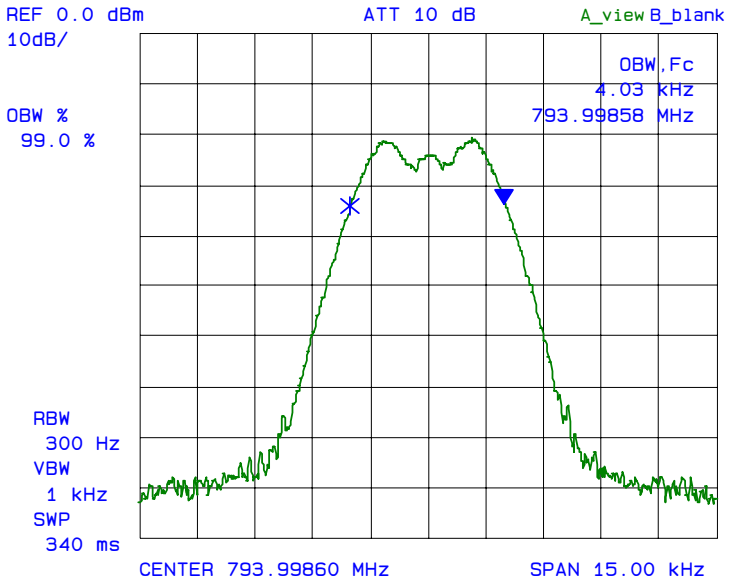
Plot 6.7.5.2.1.13: 99% Occupied Bandwidth (Input)
Fc: 794 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



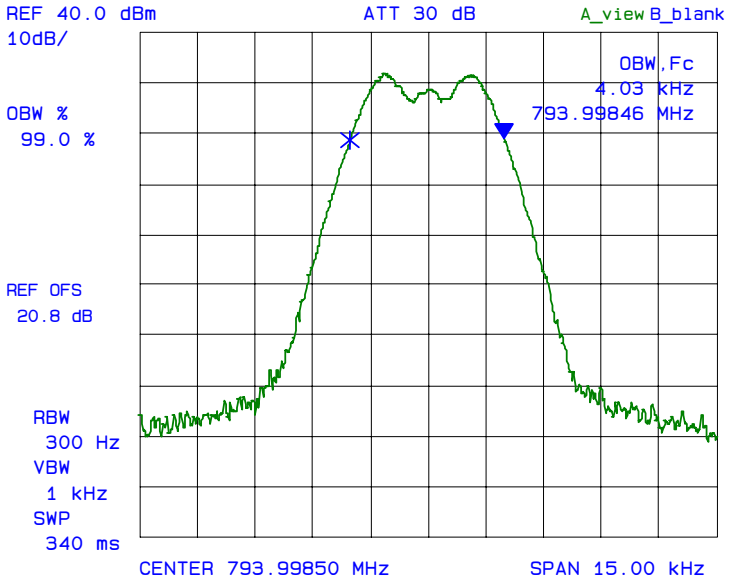

Plot 6.7.5.2.1.14: 99% Occupied Bandwidth (Output)
Fc: 794 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



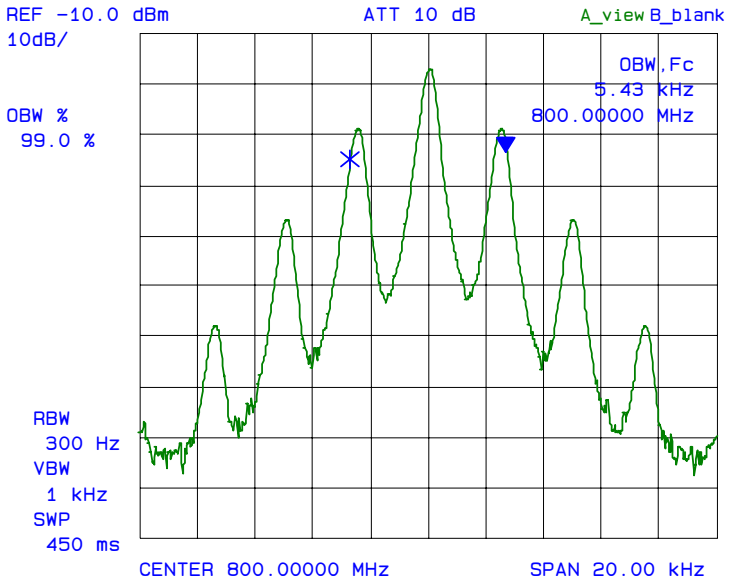
Plot 6.7.5.2.1.15: 99% Occupied Bandwidth (Input)
Fc: 794 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



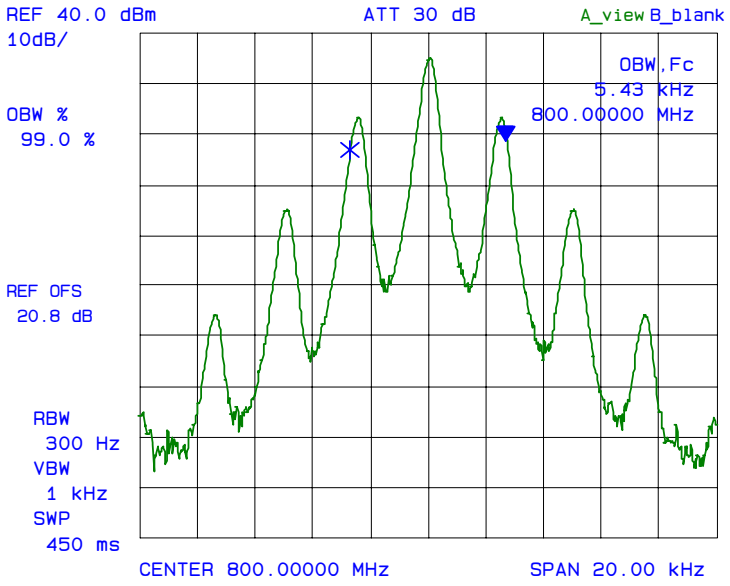

Plot 6.7.5.2.1.16: 99% Occupied Bandwidth (Output)
Fc: 794 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



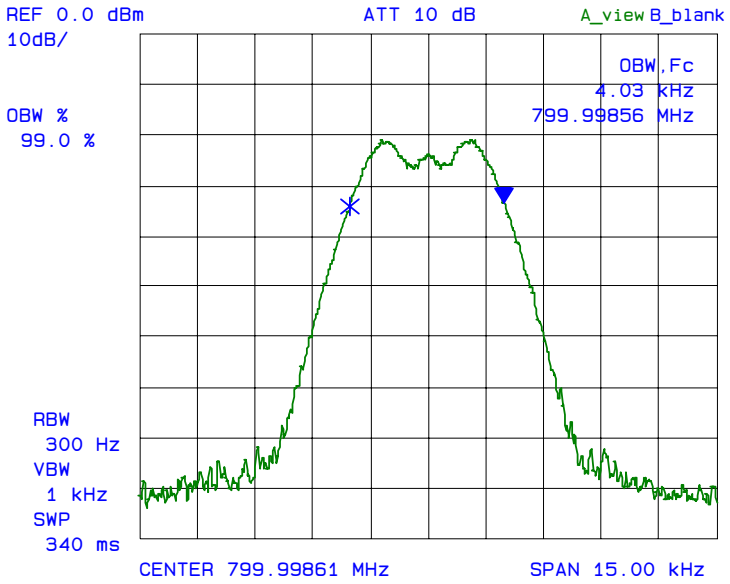
Plot 6.7.5.2.1.17: 99% Occupied Bandwidth (Input)
Fc: 800 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



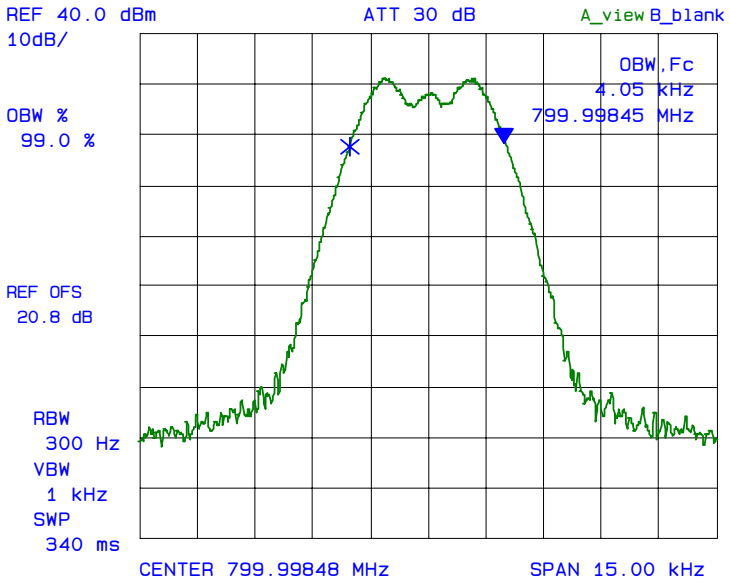

Plot 6.7.5.2.1.18: 99% Occupied Bandwidth (Output)
Fc: 800 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



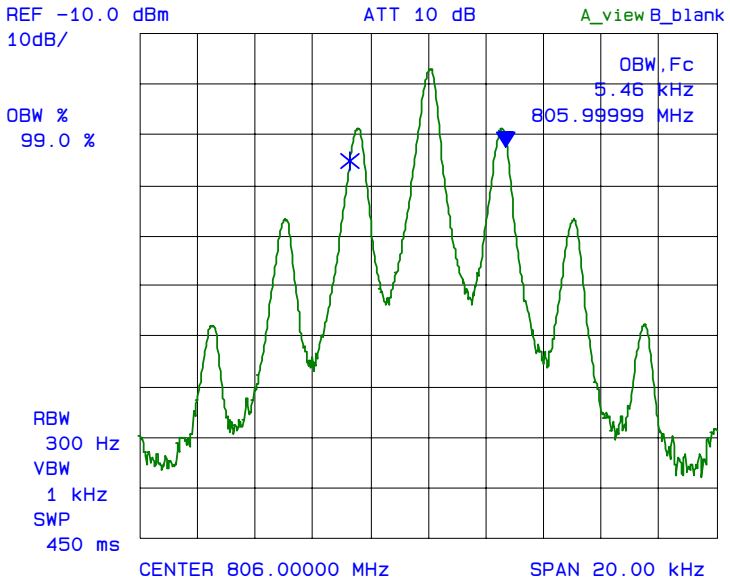
Plot 6.7.5.2.1.19: 99% Occupied Bandwidth (Input)
Fc: 800 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



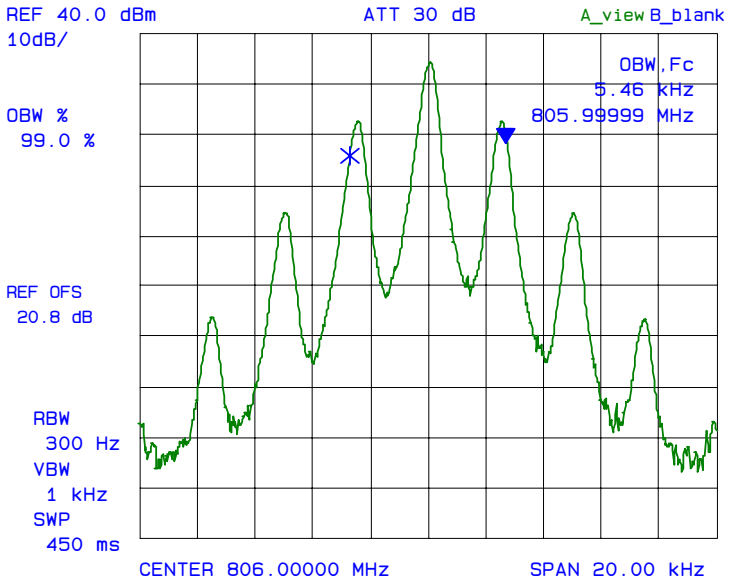

Plot 6.7.5.2.1.20: 99% Occupied Bandwidth (Output)
Fc: 800 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



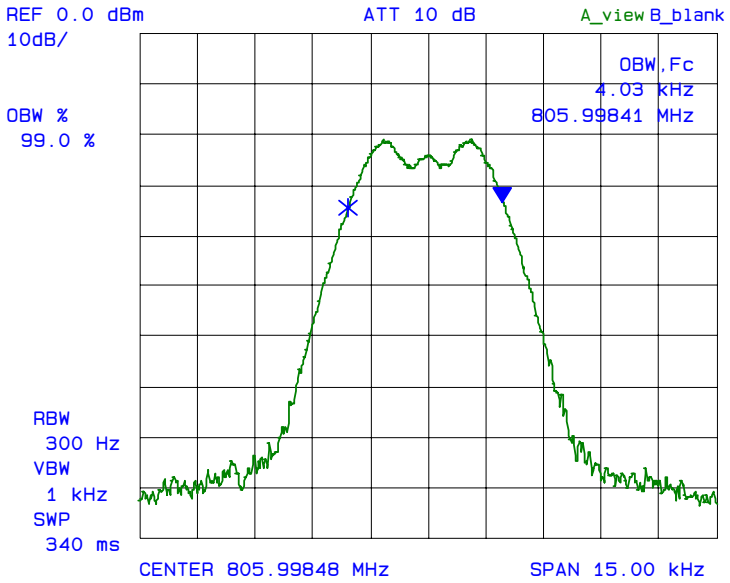
Plot 6.7.5.2.1.21: 99% Occupied Bandwidth (Input)
Fc: 806 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



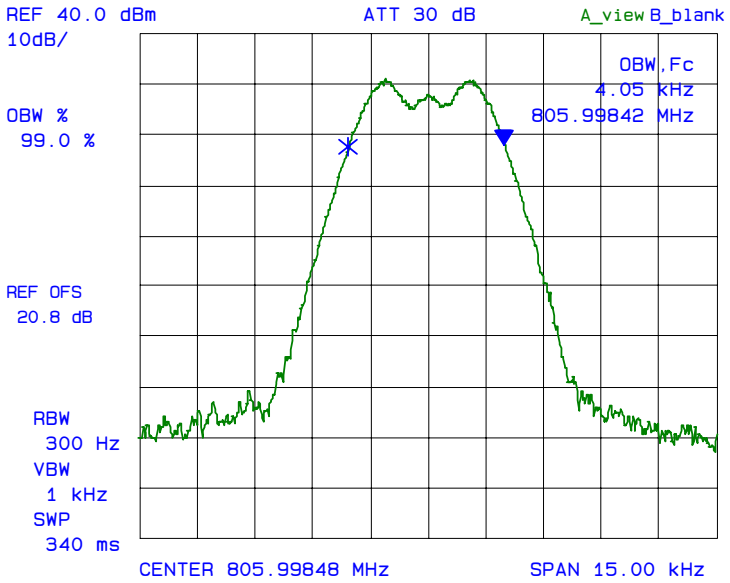

Plot 6.7.5.2.1.22: 99% Occupied Bandwidth (Output)
Fc: 806 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



Plot 6.7.5.2.1.23: 99% Occupied Bandwidth (Input)
Fc: 806 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source

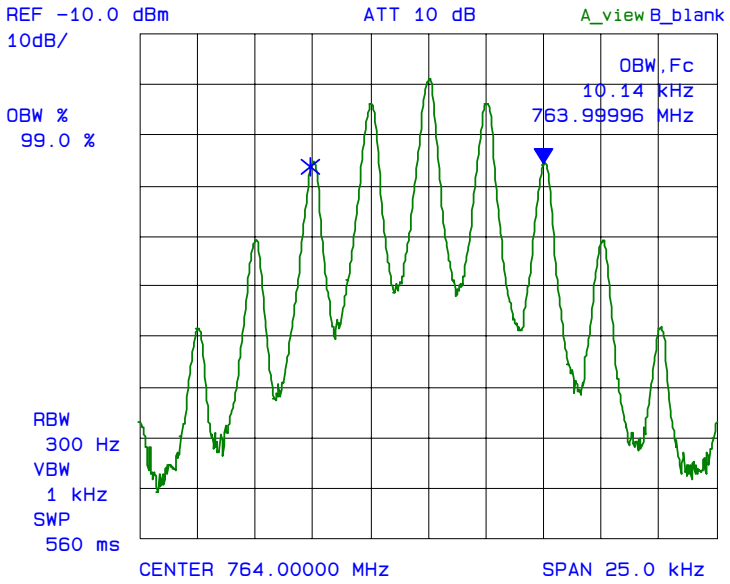



Plot 6.7.5.2.1.24: 99% Occupied Bandwidth (Output)
Fc: 806 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source

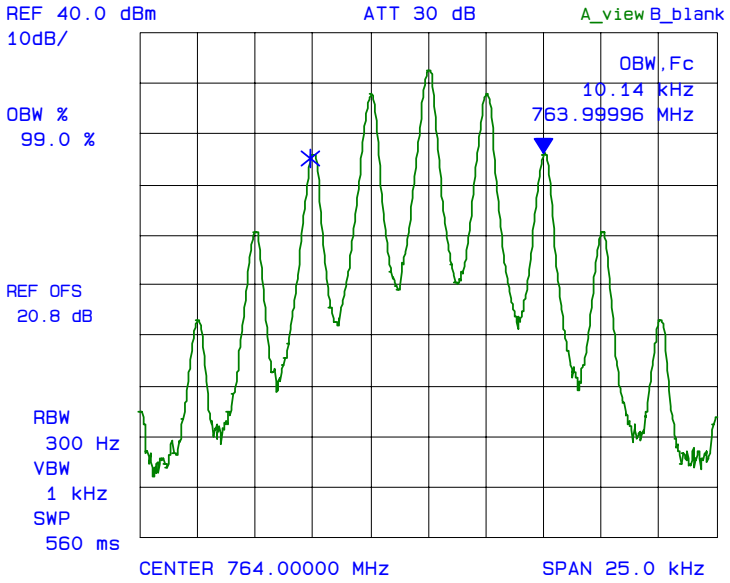


### *6.7.5.2.2. 12.5 kHz Channel Spacing*

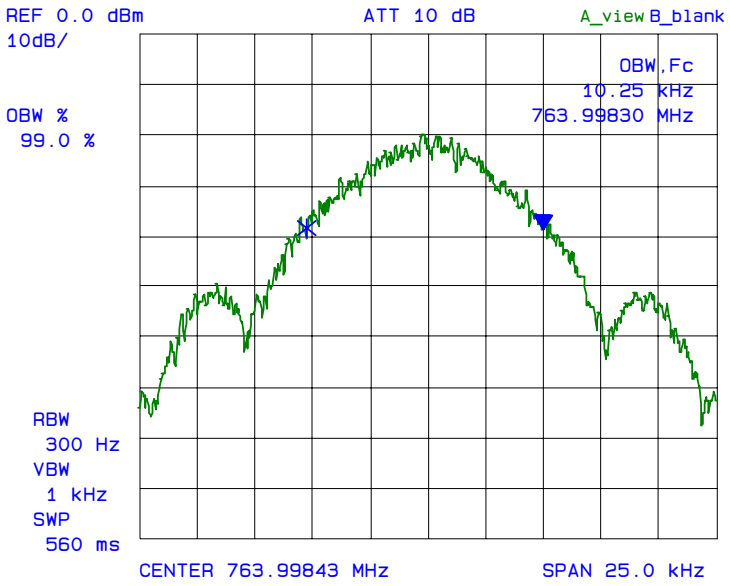
Plot 6.7.5.2.2.1: 99% Occupied Bandwidth (Input)
Fc: 764 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



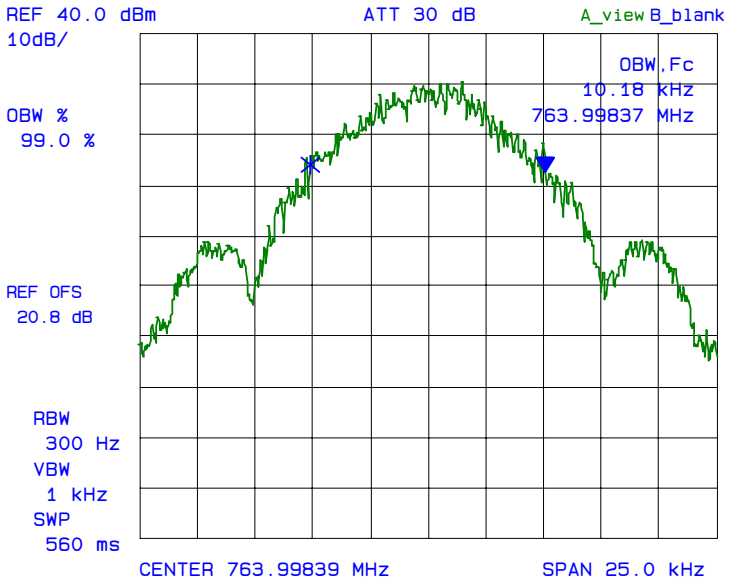

Plot 6.7.5.2.2.2: 99% Occupied Bandwidth (Output)
Fc: 764 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



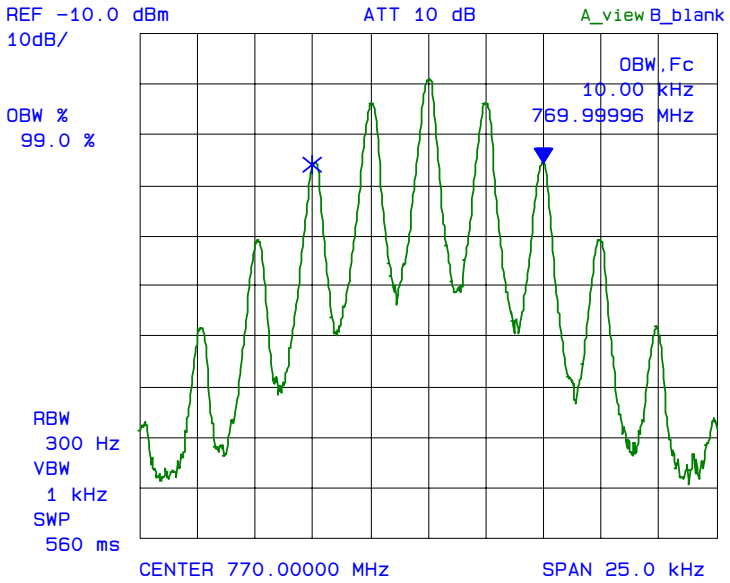
Plot 6.7.5.2.2.3: 99% Occupied Bandwidth (Input)
Fc: 764 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



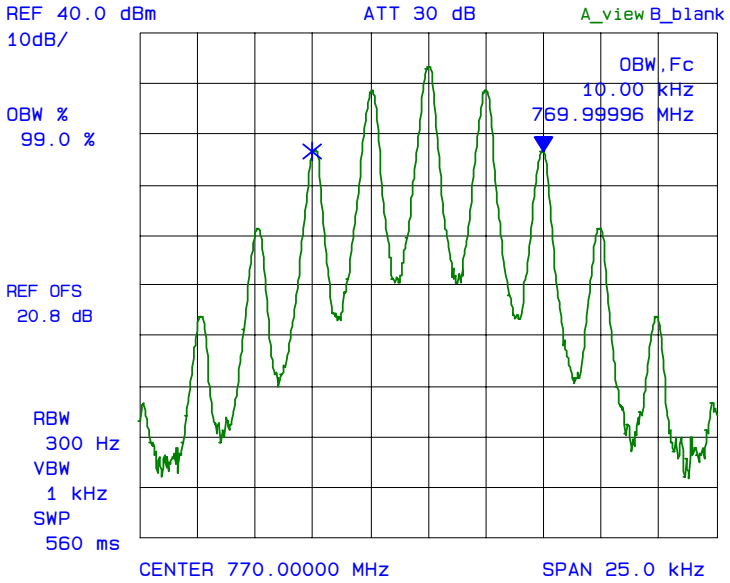

Plot 6.7.5.2.2.4: 99% Occupied Bandwidth (Output)
Fc: 764 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



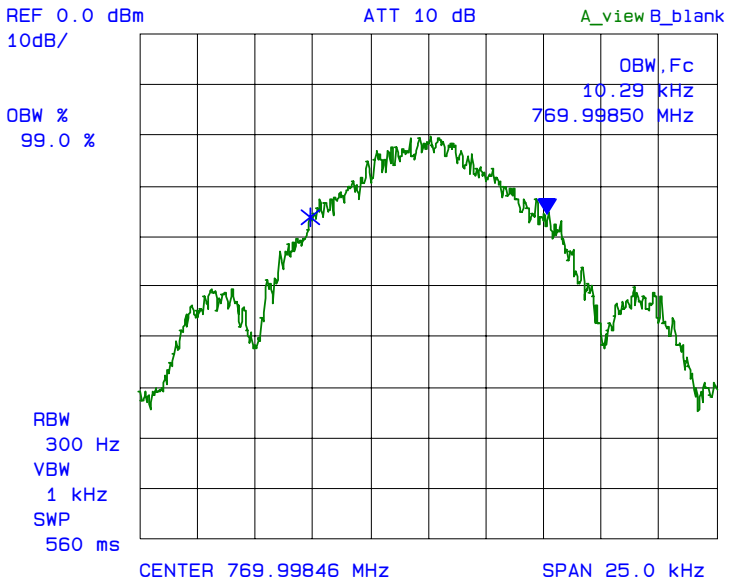
Plot 6.7.5.2.2.5: 99% Occupied Bandwidth (Input)
Fc: 770 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal.



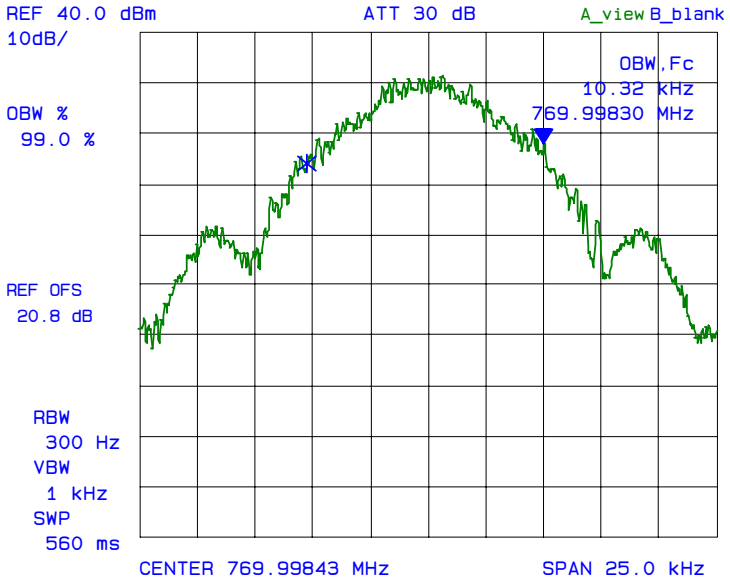

Plot 6.7.5.2.2.6: 99% Occupied Bandwidth (Output)
Fc: 770 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



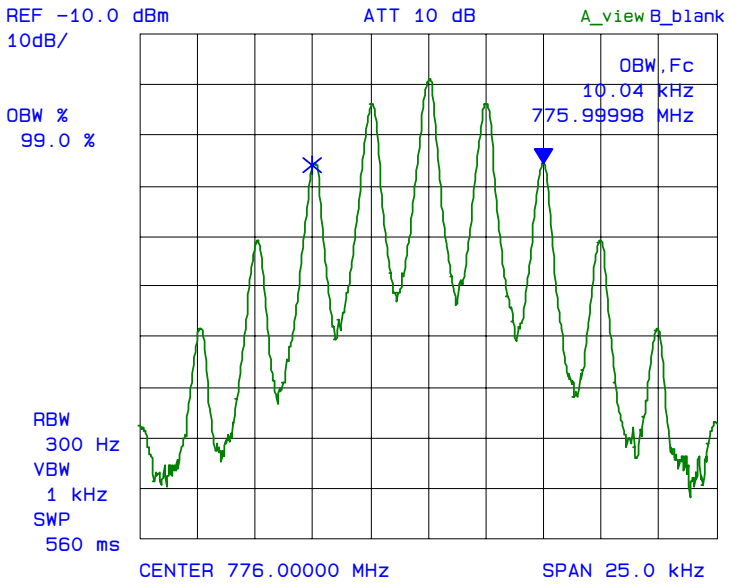
Plot 6.7.5.2.2.7: 99% Occupied Bandwidth (Input)
Fc: 770 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



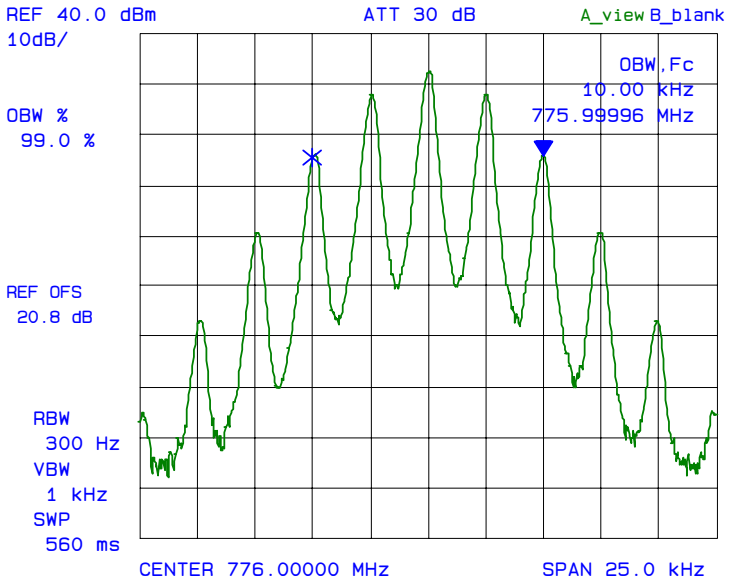

Plot 6.7.5.2.2.8: 99% Occupied Bandwidth (Output)
Fc: 770 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



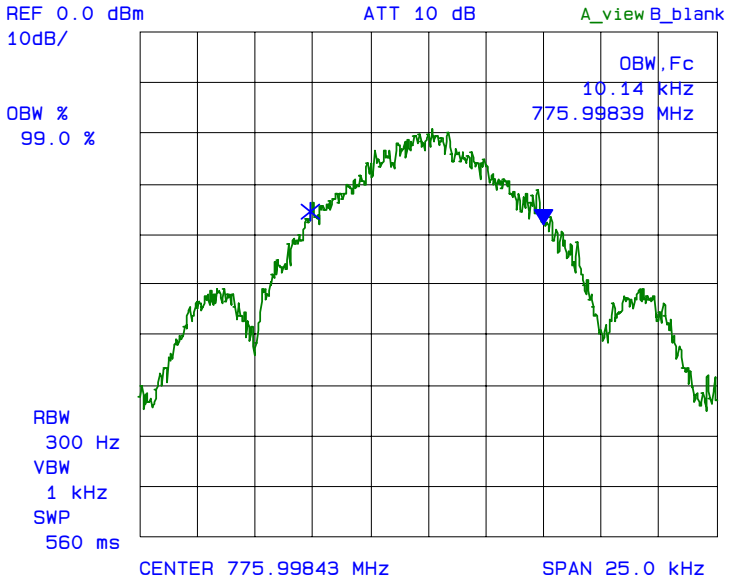
Plot 6.7.5.2.2.9: 99% Occupied Bandwidth (Input)
Fc: 776 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



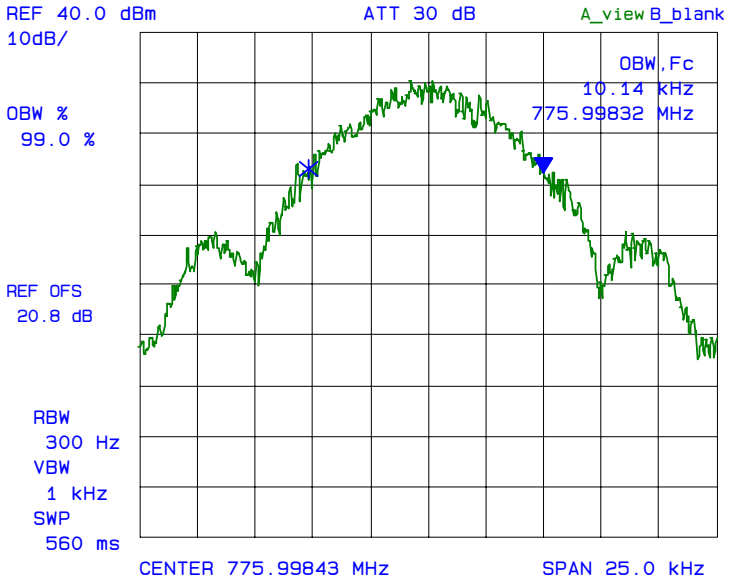

Plot 6.7.5.2.2.10: 99% Occupied Bandwidth (Output)
Fc: 776 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



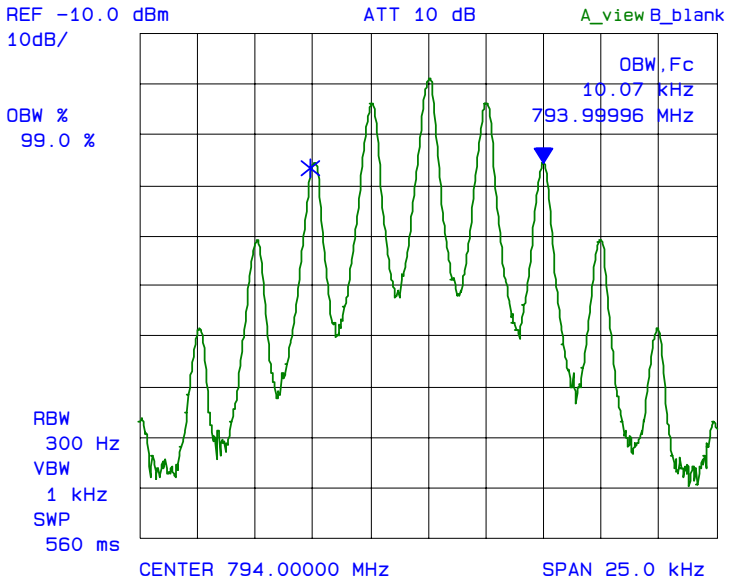
Plot 6.7.5.2.2.11: 99% Occupied Bandwidth (Input)
Fc: 776 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



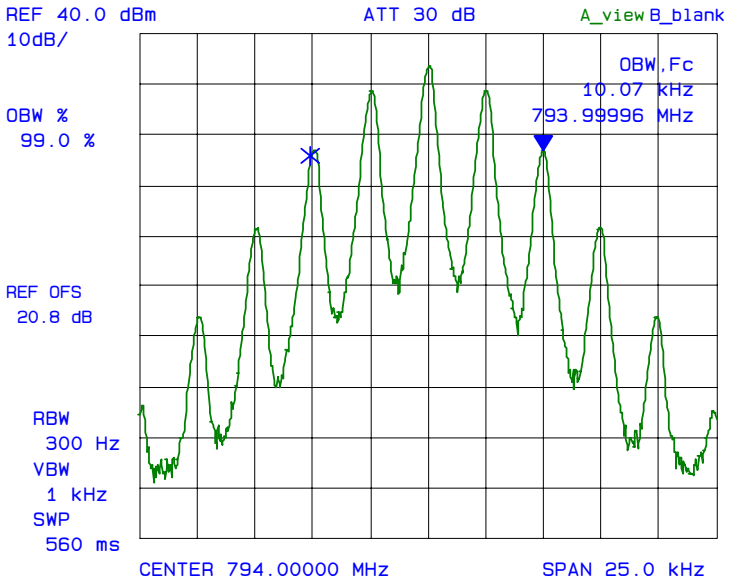

Plot 6.7.5.2.2.12: 99% Occupied Bandwidth (Output)
Fc: 776 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



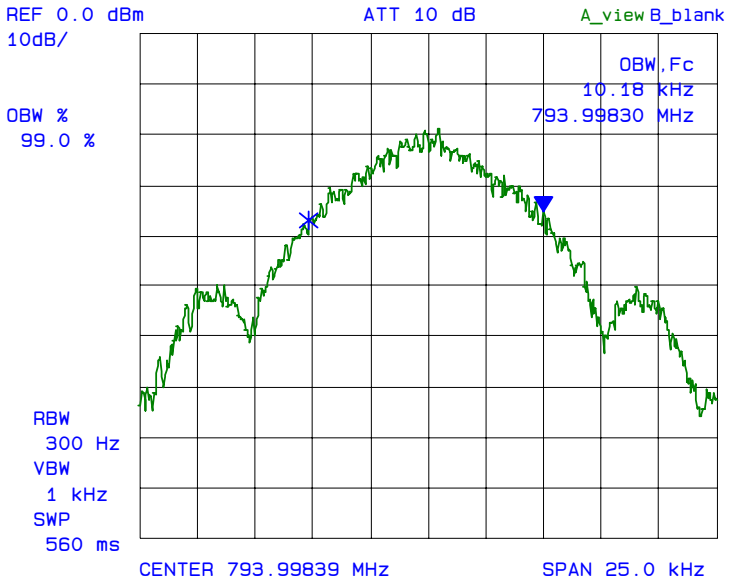
Plot 6.7.5.2.2.13: 99% Occupied Bandwidth (Input)
Fc: 794 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



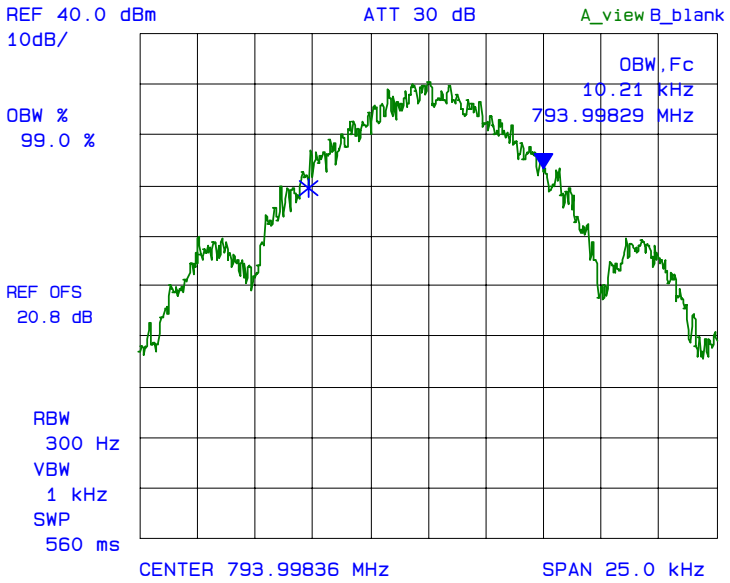

Plot 6.7.5.2.2.14: 99% Occupied Bandwidth (Output)
Fc: 794 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



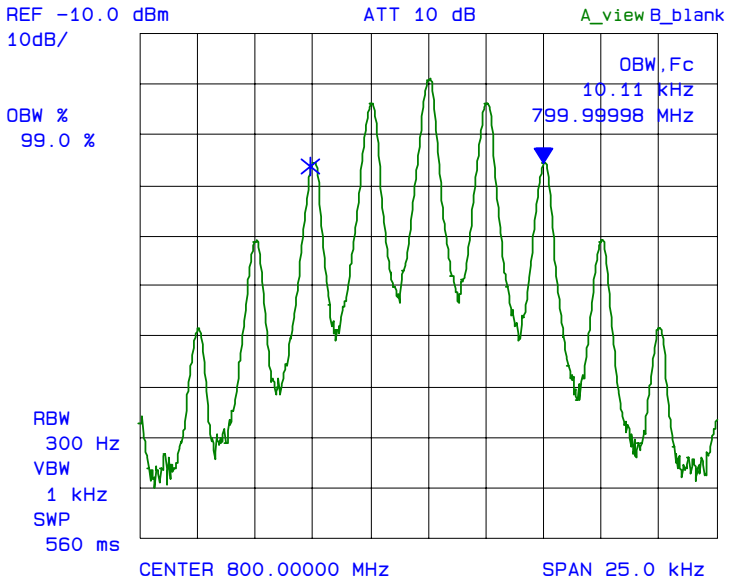
Plot 6.7.5.2.2.15: 99% Occupied Bandwidth (Input)
Fc: 794 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



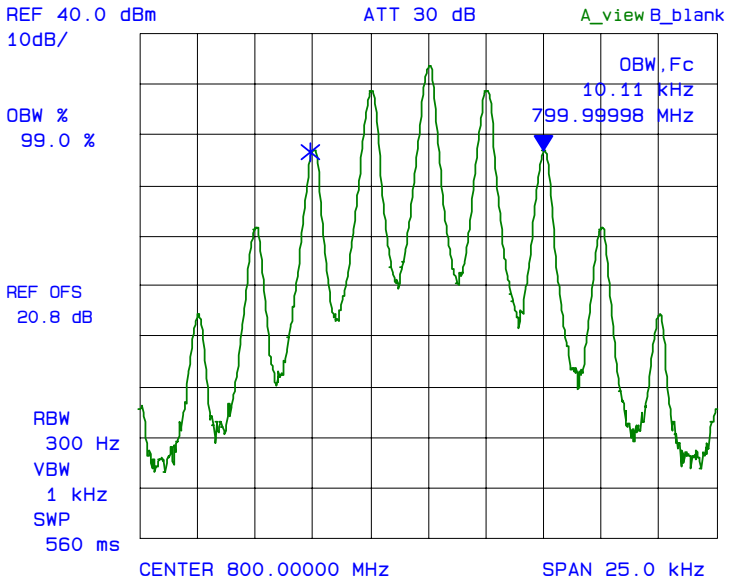

Plot 6.7.5.2.2.16: 99% Occupied Bandwidth (Output)
Fc: 794 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



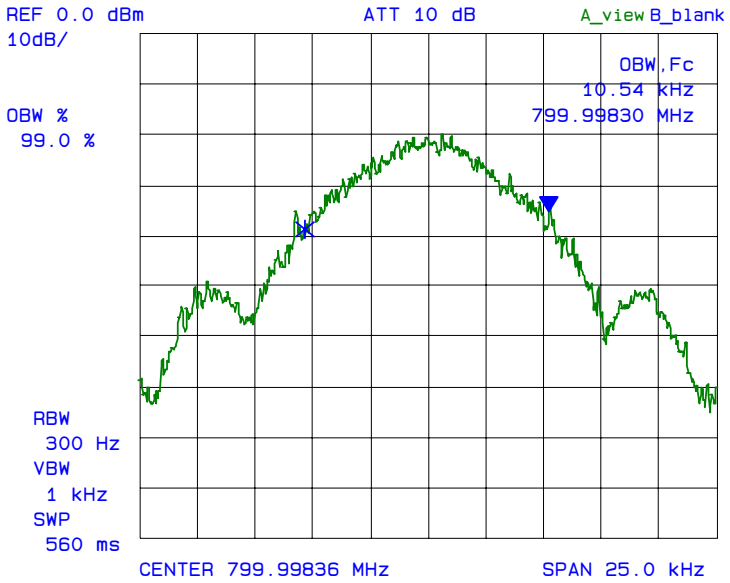
Plot 6.7.5.2.2.17: 99% Occupied Bandwidth (Input)
Fc: 800 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



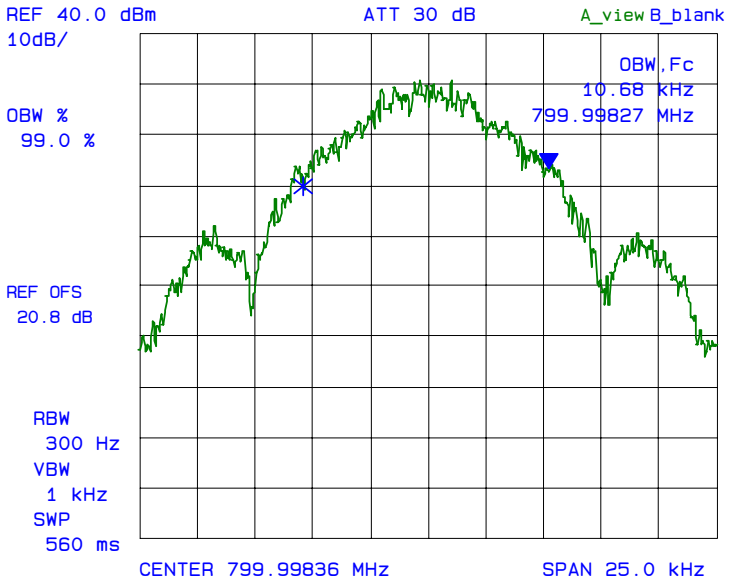

Plot 6.7.5.2.2.18: 99% Occupied Bandwidth (Output)
Fc: 800 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



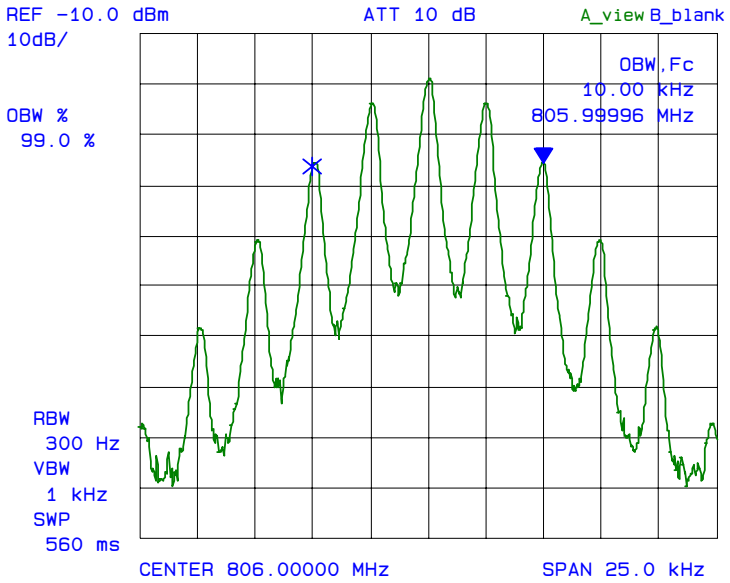
Plot 6.7.5.2.2.19: 99% Occupied Bandwidth (Input)
Fc: 800 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



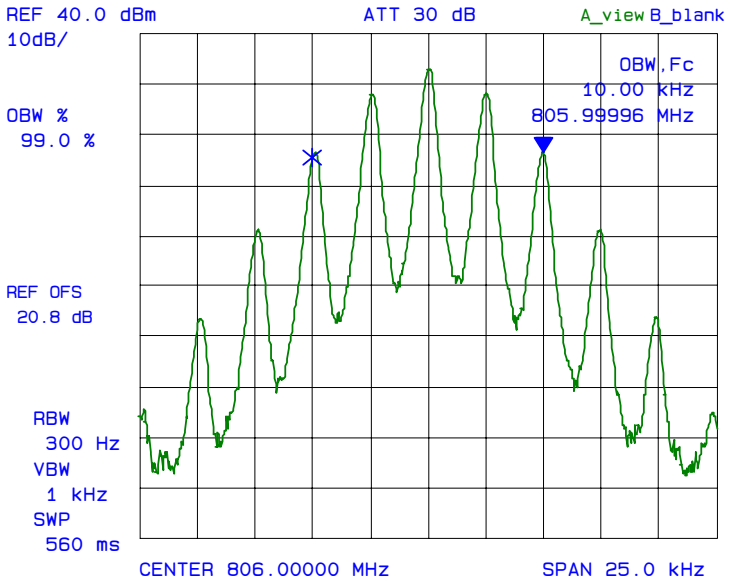

Plot 6.7.5.2.2.20: 99% Occupied Bandwidth (Output)
Fc: 800 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source.



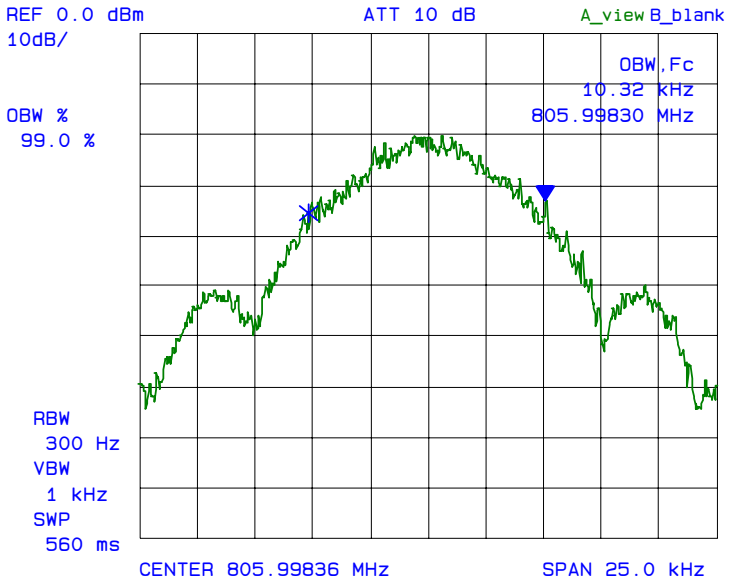
Plot 6.7.5.2.2.21: 99% Occupied Bandwidth (Input)
Fc: 806 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



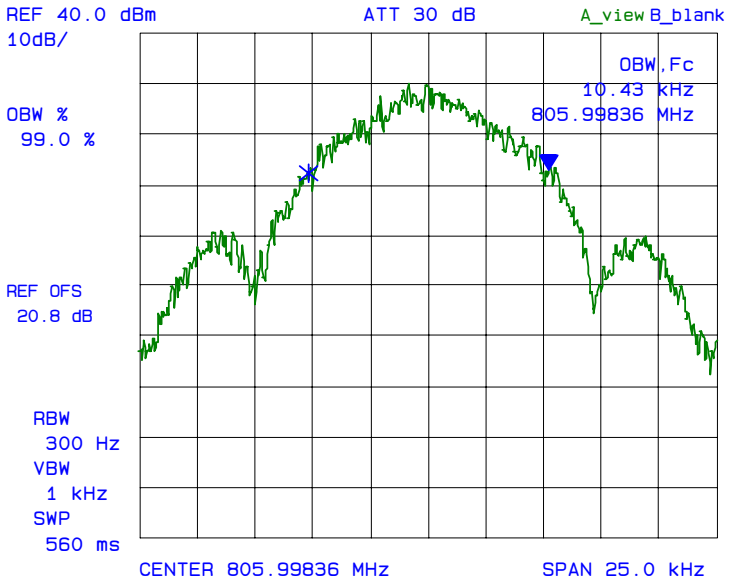

Plot 6.7.5.2.2.22: 99% Occupied Bandwidth (Output)
Fc: 806 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal.



Plot 6.7.5.2.2.23: 99% Occupied Bandwidth (Input)
Fc: 806 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source

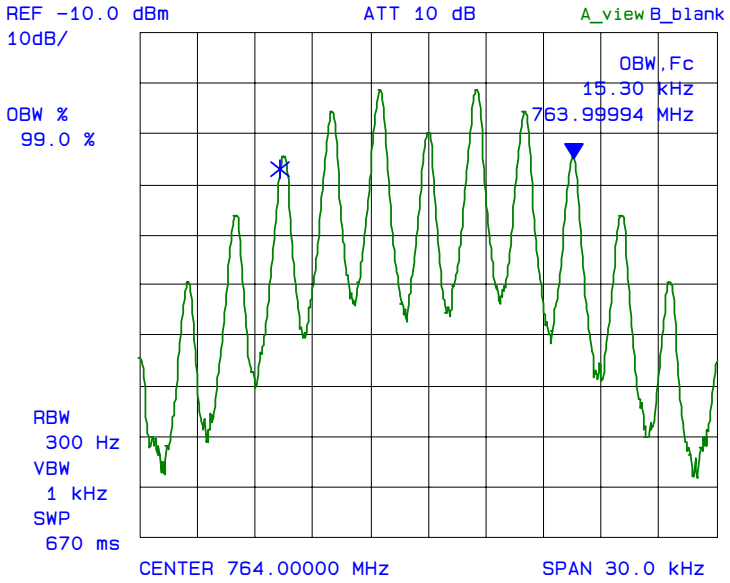



Plot 6.7.5.2.2.24: 99% Occupied Bandwidth (Output)
Fc: 806 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source

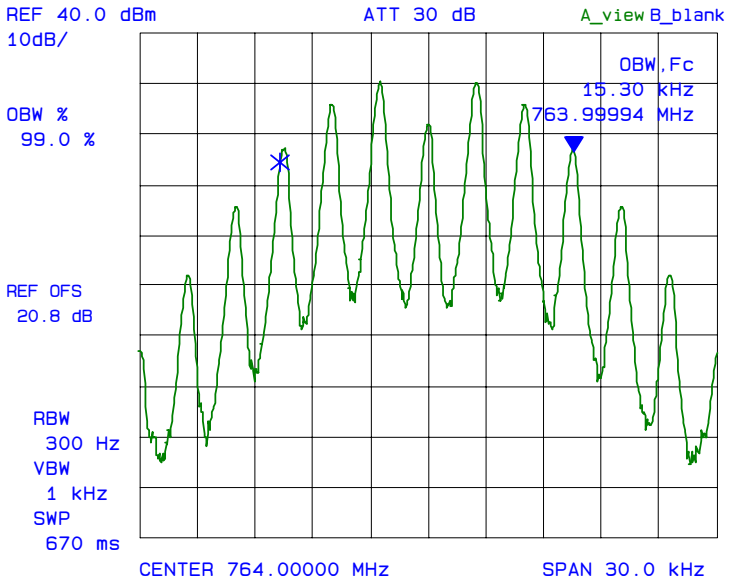


### *6.7.5.2.3. 25 kHz Channel Spacing*

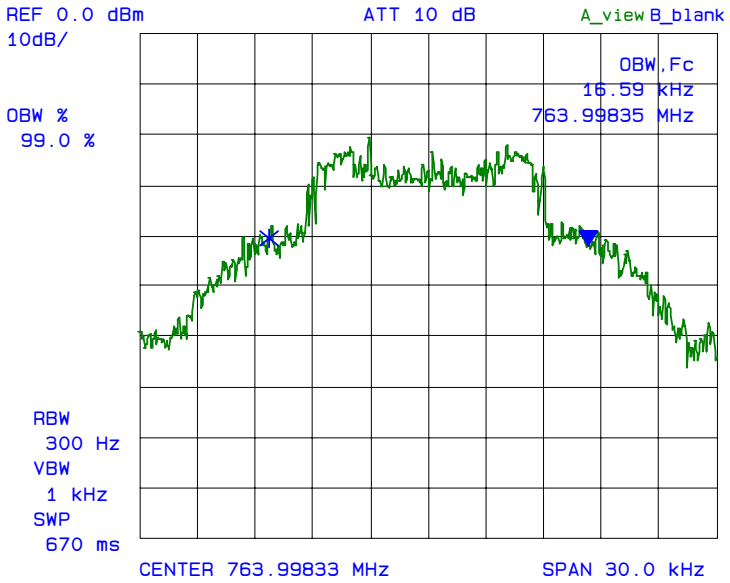
Plot 6.7.5.2.3.1: 99% Occupied Bandwidth (Input)
Fc: 764 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



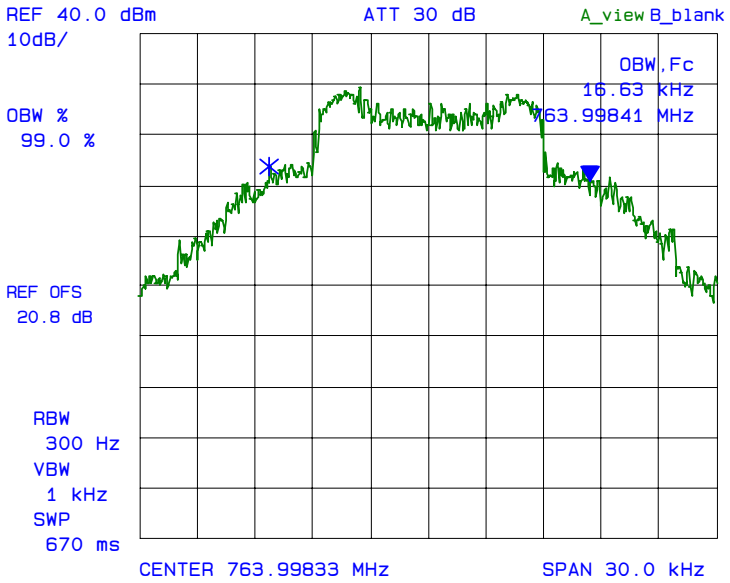

Plot 6.7.5.2.3.2: 99% Occupied Bandwidth (Output)
Fc: 764 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



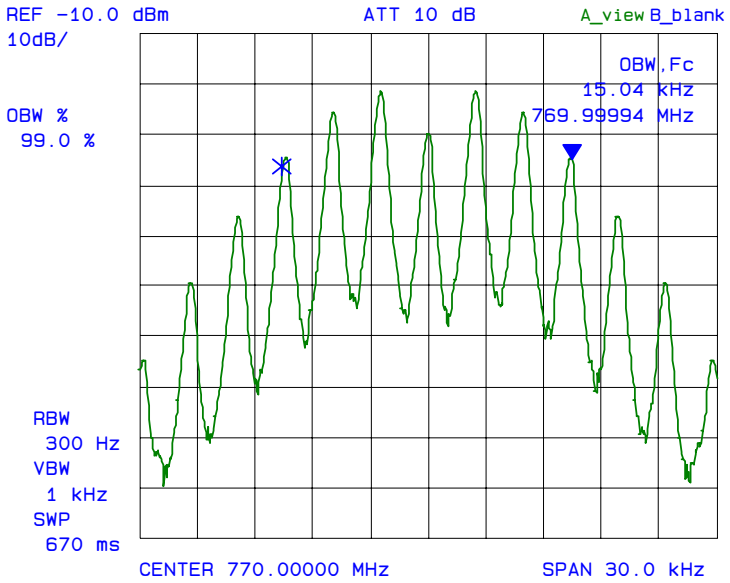
Plot 6.7.5.2.3.3: 99% Occupied Bandwidth (Input)
Fc: 764 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source.



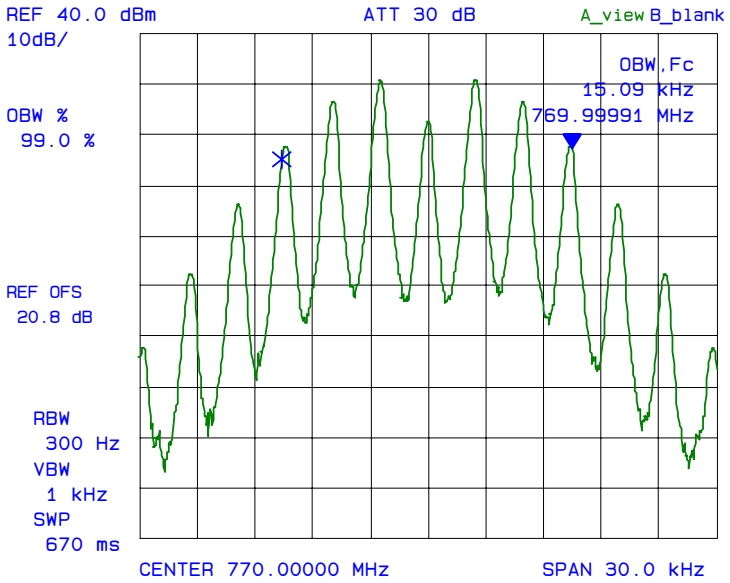

Plot 6.7.5.2.3.4: 99% Occupied Bandwidth (Output)
Fc: 764 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



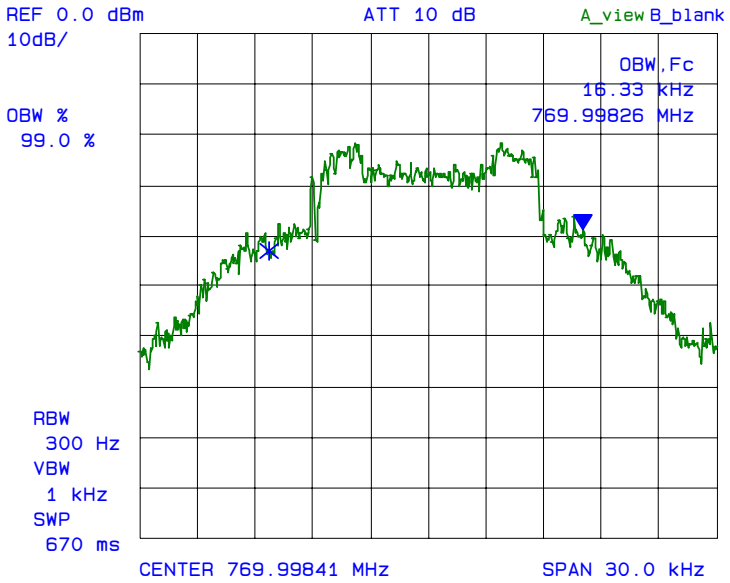
Plot 6.7.5.2.3.5: 99% Occupied Bandwidth (Input)
Fc: 770 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



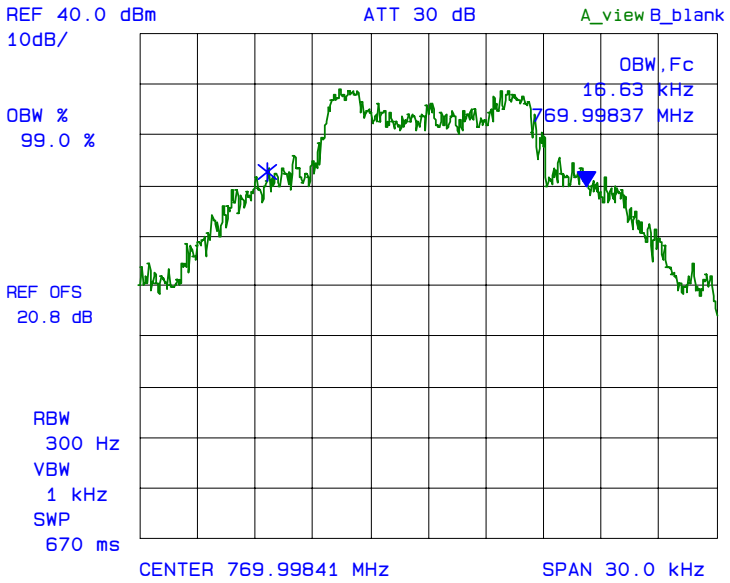

Plot 6.7.5.2.3.6: 99% Occupied Bandwidth (Output)
Fc: 770 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



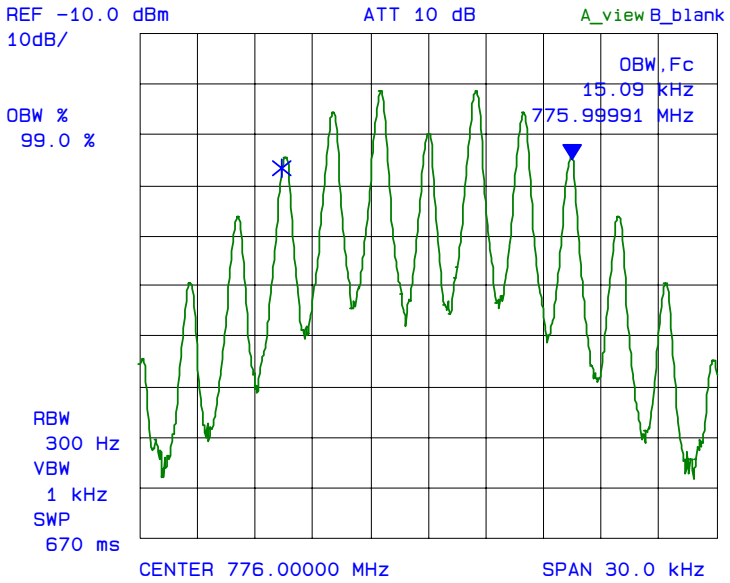
Plot 6.7.5.2.3.7: 99% Occupied Bandwidth (Input)
Fc: 770 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



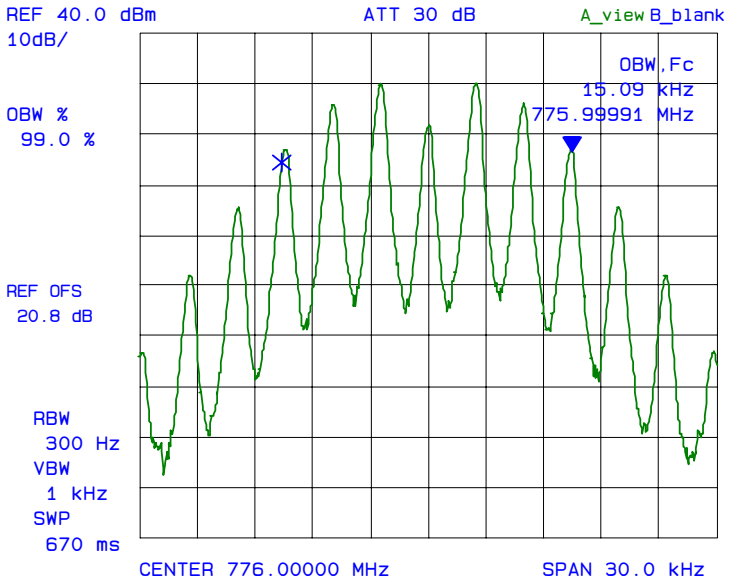

Plot 6.7.5.2.3.8: 99% Occupied Bandwidth (Output)
Fc: 770 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



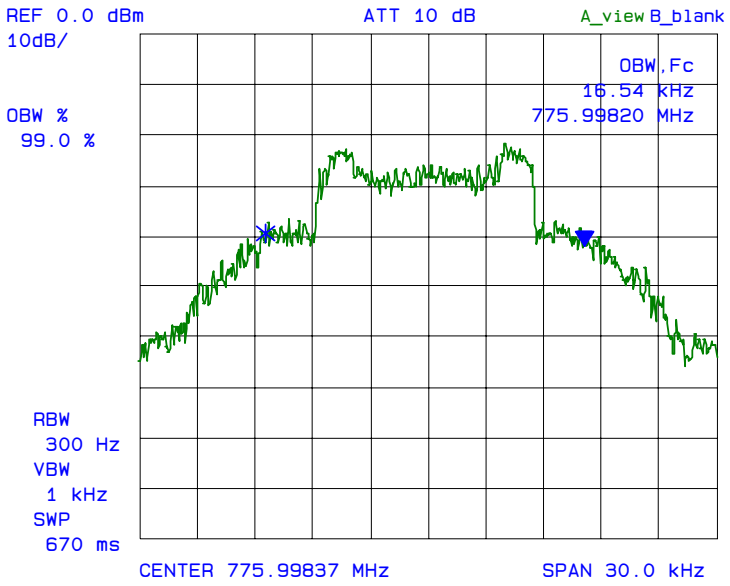
Plot 6.7.5.2.3.9: 99% Occupied Bandwidth (Input)
Fc: 776 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



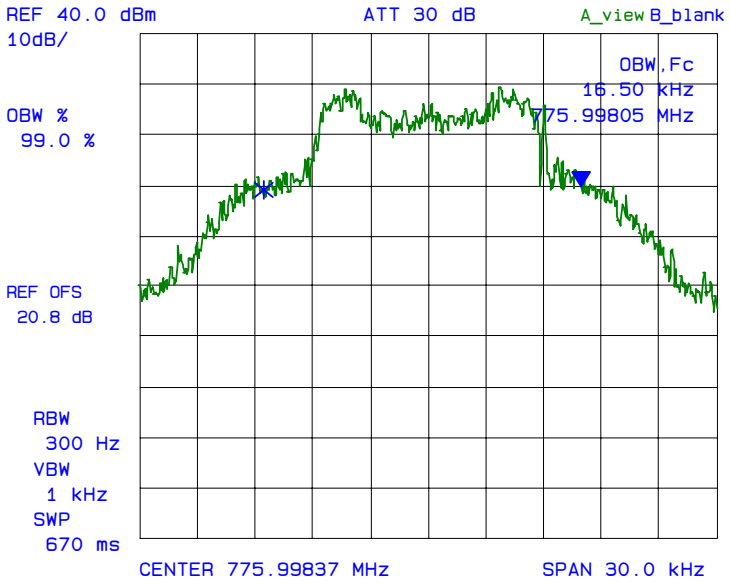

Plot 6.7.5.2.3.10: 99% Occupied Bandwidth (Output)
Fc: 776 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



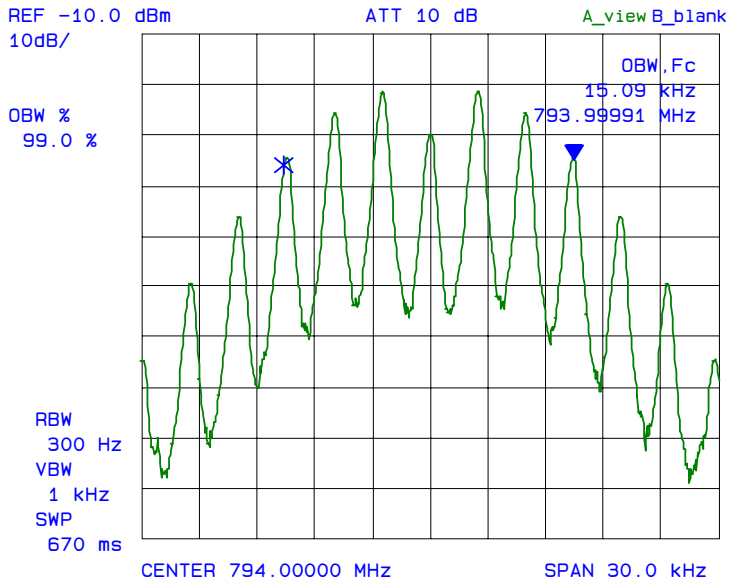
Plot 6.7.5.2.3.11: 99% Occupied Bandwidth (Input)
Fc: 776 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



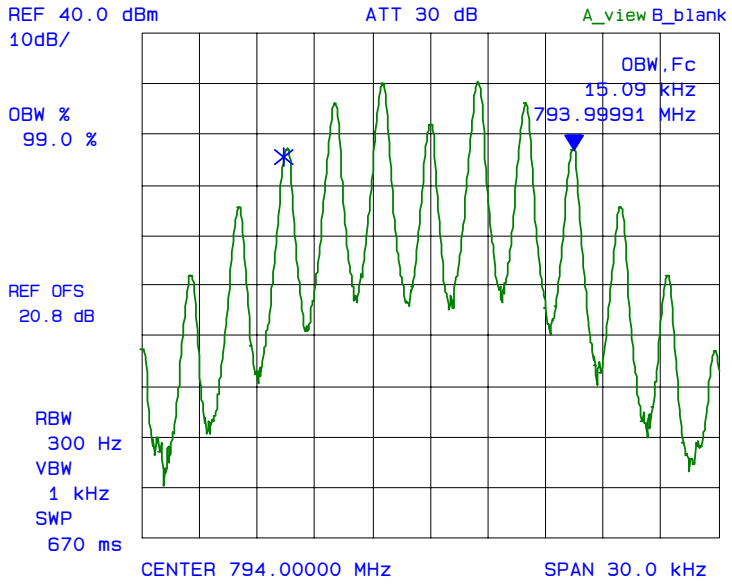

Plot 6.7.5.2.3.12: 99% Occupied Bandwidth (Output)
Fc: 776 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



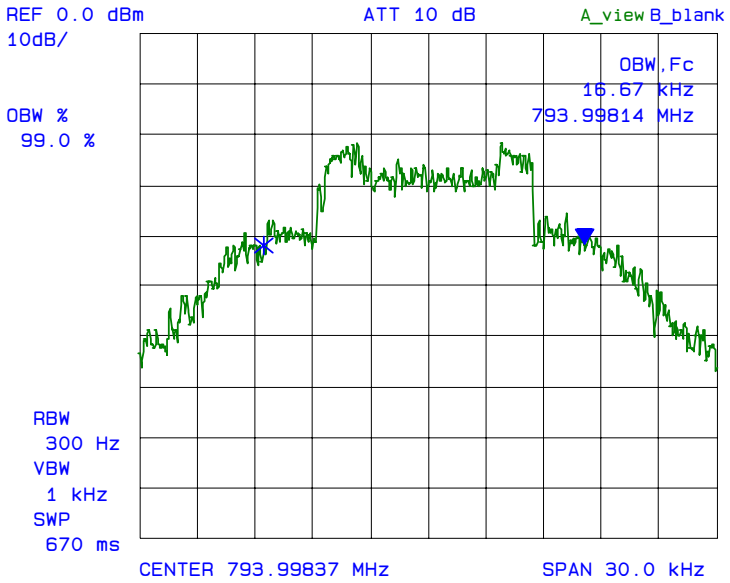
Plot 6.7.5.2.3.13: 99% Occupied Bandwidth (Input)
Fc: 794 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



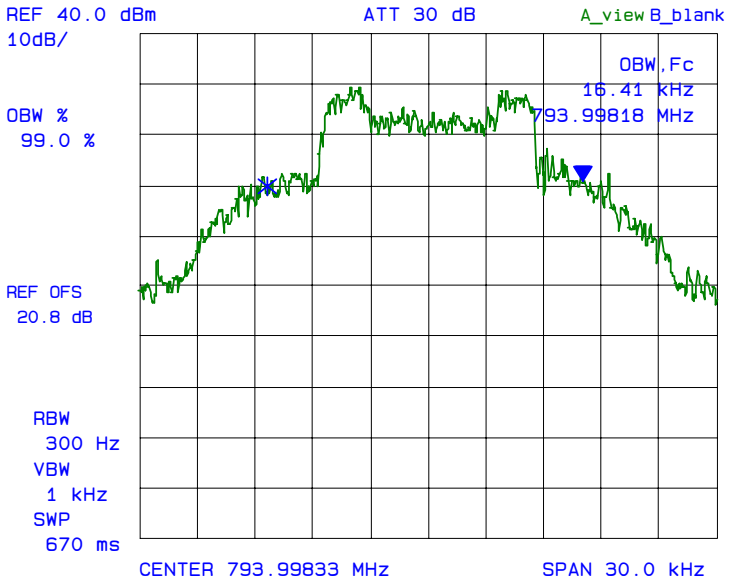

Plot 6.7.5.2.3.14: 99% Occupied Bandwidth (Output)
Fc: 794 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



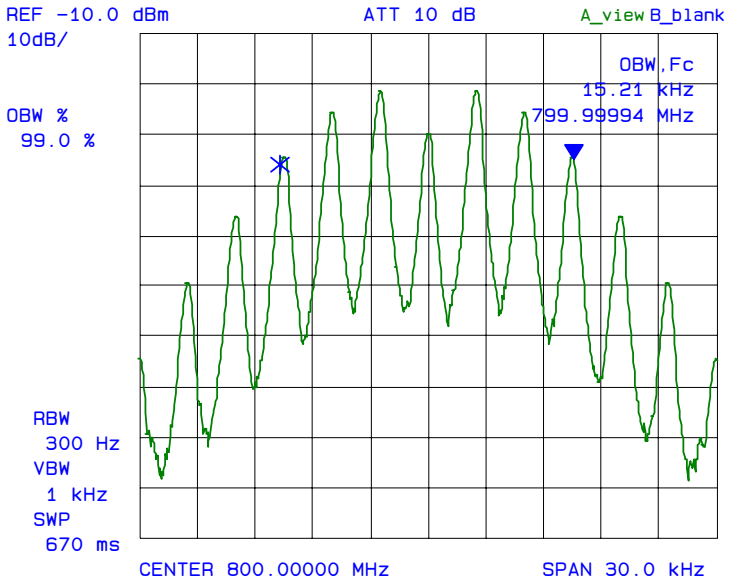
Plot 6.7.5.2.3.15: 99% Occupied Bandwidth (Input)
Fc: 794 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



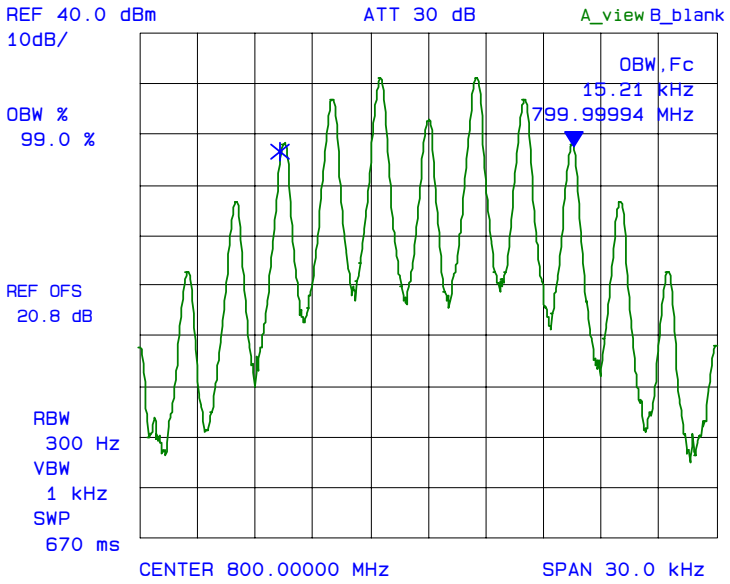

Plot 6.7.5.2.3.16: 99% Occupied Bandwidth (Output)
Fc: 794 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



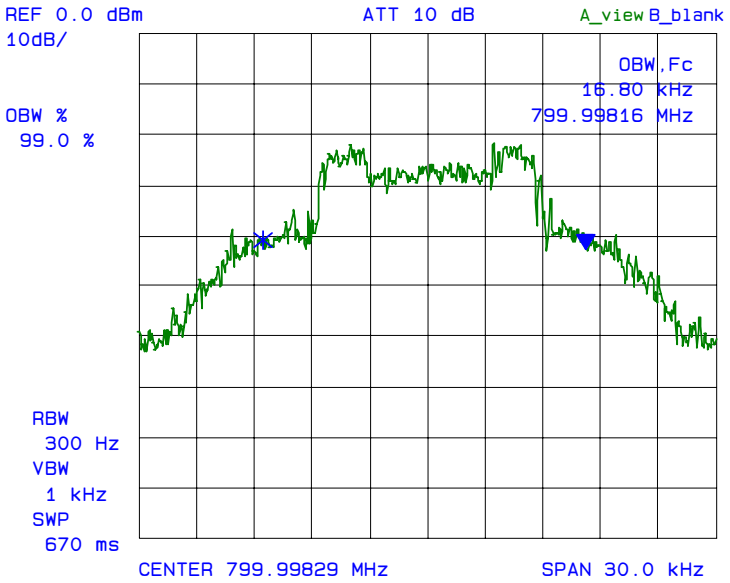
Plot 6.7.5.2.3.17: 99% Occupied Bandwidth (Input)
Fc: 800 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



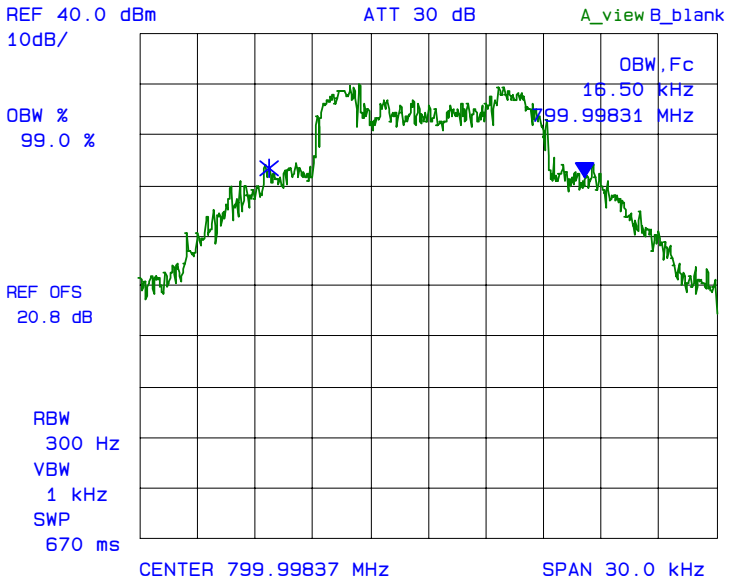

Plot 6.7.5.2.3.18: 99% Occupied Bandwidth (Output)
Fc: 800 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



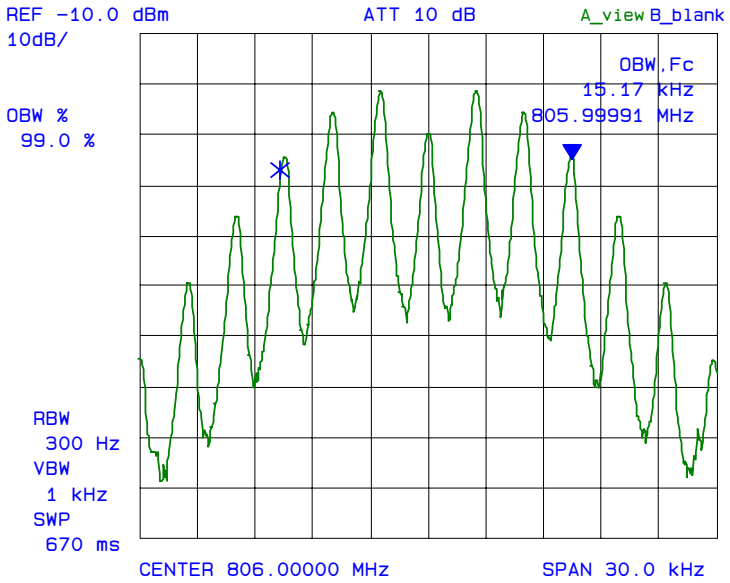
Plot 6.7.5.2.3.19: 99% Occupied Bandwidth (Input)
Fc: 800 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



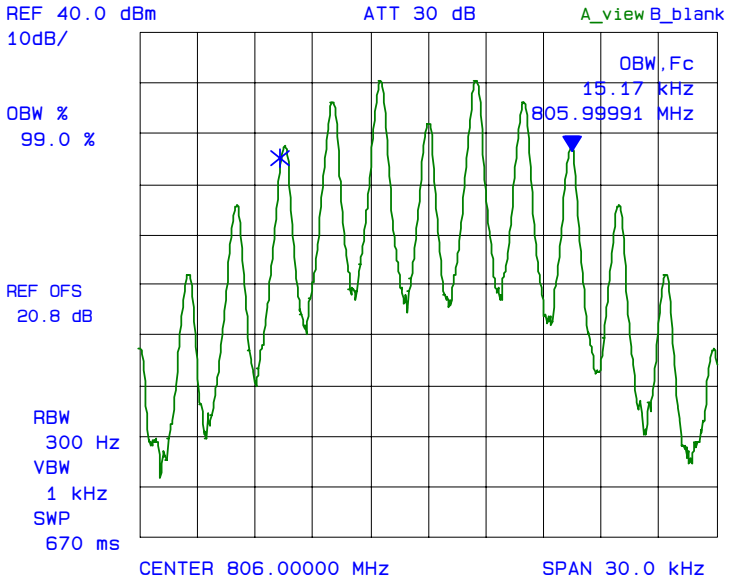

Plot 6.7.5.2.3.20: 99% Occupied Bandwidth (Output)
Fc: 800 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



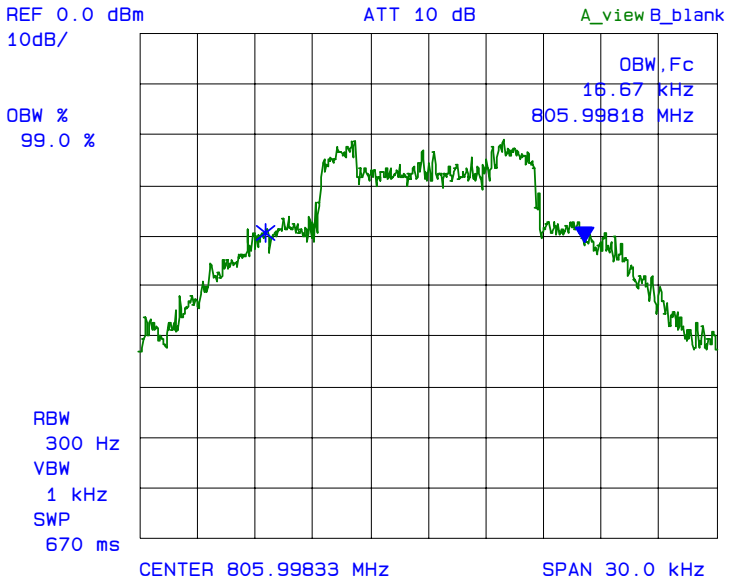
Plot 6.7.5.2.3.21: 99% Occupied Bandwidth (Input)
Fc: 806 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



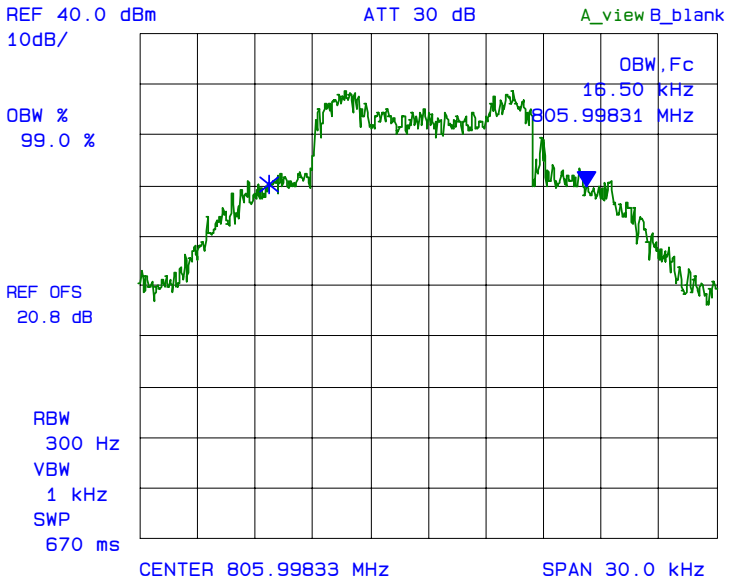

Plot 6.7.5.2.3.22: 99% Occupied Bandwidth (Output)
Fc: 806 MHz, Input Level: -15 dBm, Modulation: FM with 2.5 kHz sine wave signal



Plot 6.7.5.2.3.23: 99% Occupied Bandwidth (Input)
Fc: 806 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source




Plot 6.7.5.2.3.24: 99% Occupied Bandwidth (Output)
Fc: 806 MHz, Input Level: -15 dBm, Modulation: FM with an external 9600 bps random data source



## 6.8. SPURIOUS EMISSIONS AT ANTENNA TERMINAL [§§ 2.1051 & 90.543(c)]

### 6.8.1. Limits

The power of any emission must be reduced below the unmodulated carrier power (P) by at least 43 + 10 log (P) dB

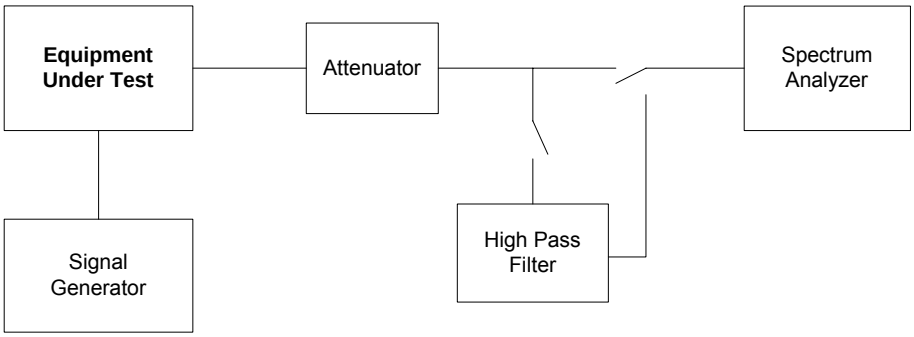
### 6.8.2. Method of Measurements

Refer to ULTRATECH Test Procedures, File # ULTR P001-2004.

### 6.8.3. Test Equipment List

| Test Instruments | Manufacturer | Model No. | Serial No. | Frequency Range |
|---|---|---|---|---|
| Spectrum Analyzer | Advantest | R3271 | 15050203 | 100Hz-26.5GHz |
| Attenuator | Weinschel Corp | 46-20-34 | BM1347 | DC - 18 GHz |
| High Pass Filter | Microphase | 5915-688-9088 | MT1000AB | 0.95 - 10 GHz |
| Signal Generator | Gigatronic | 6061A | 5130586 | 10 kHz - 1050 MHz |
| Signal Generator | Fluke | 6061A | 4770301 | 10 kHz - 1050 MHz |
| Signal Generator | Gigatronic | 6061A | 5130408 | 10 kHz - 1050 MHz |
| Combiner | Mini-Circuit | 15542 | 0105 | 1 MHz – 1 GHz |

### 6.8.4. Test Arrangement



## 6.8.5. Test Data

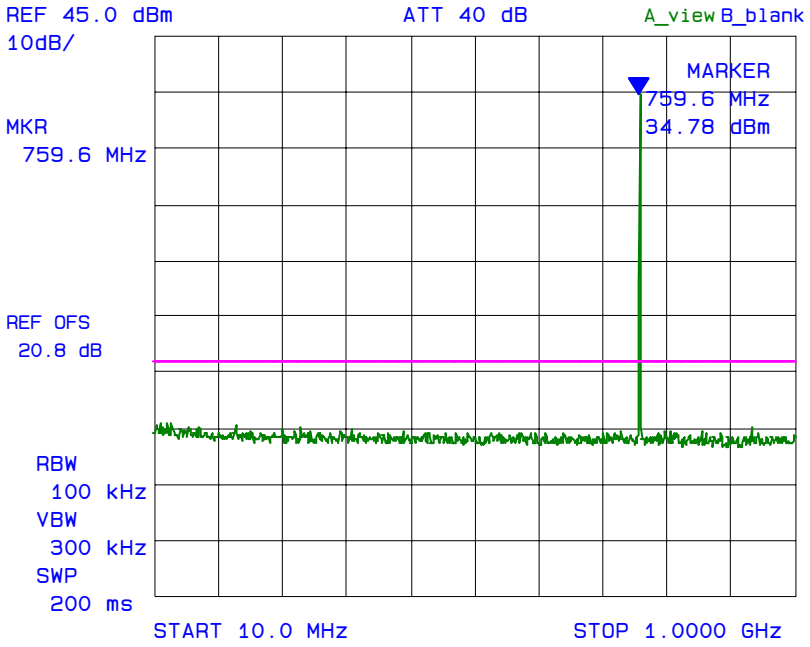
**Remarks:**

(1) There was no difference in spurious/harmonic emissions on pre-scans for all different modulations. Therefore, the rf spurious/harmonic emissions in this section would be performed without modulation and it shall represent for all different modulations required.
(2) The emissions were scanned from 10 MHz to 8.5 GHz.

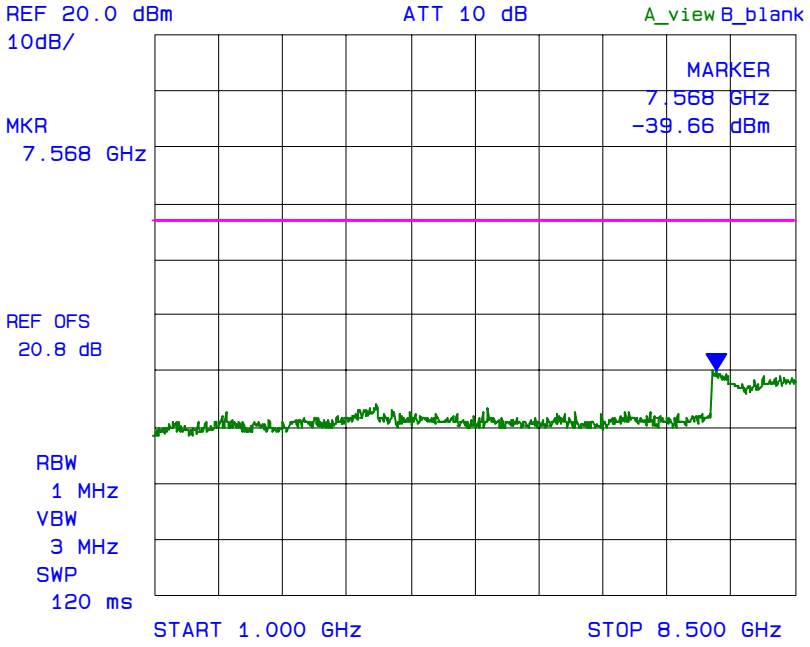
| | |
|---|---|
| Fundamental Frequency: | 764 MHz (1 RF Signal input/output) |
| RF Output Power: | 35.75 dBm (conducted) |
| Modulation: | Unmodulated |

See the following plots for details:

Plot 6.8.5.1
Spurious Emissions at Antenna Terminal with 1 RF signal input/output
Fc: 764 MHz



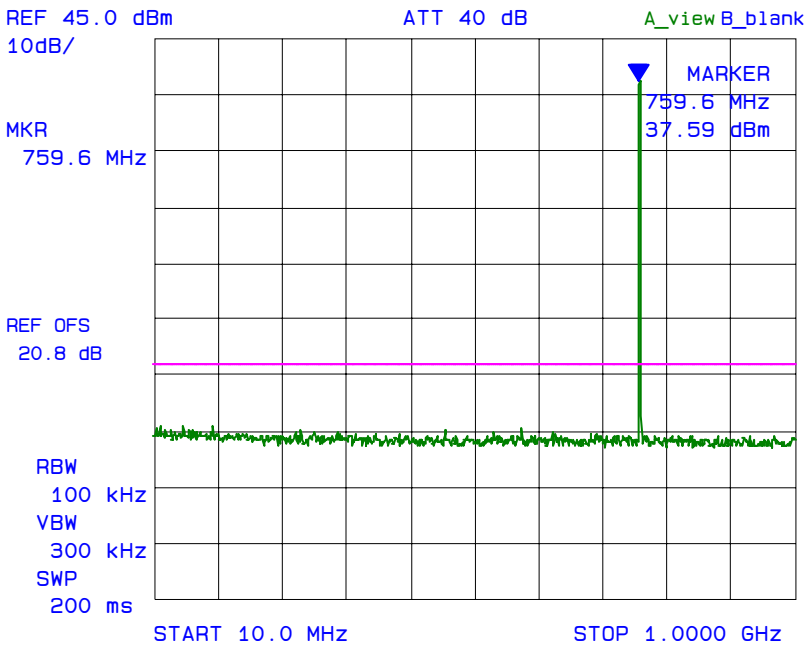
Plot 6.8.5.2
Spurious Emissions at Antenna Terminal with 1 RF signal input/output
Fc: 764 MHz



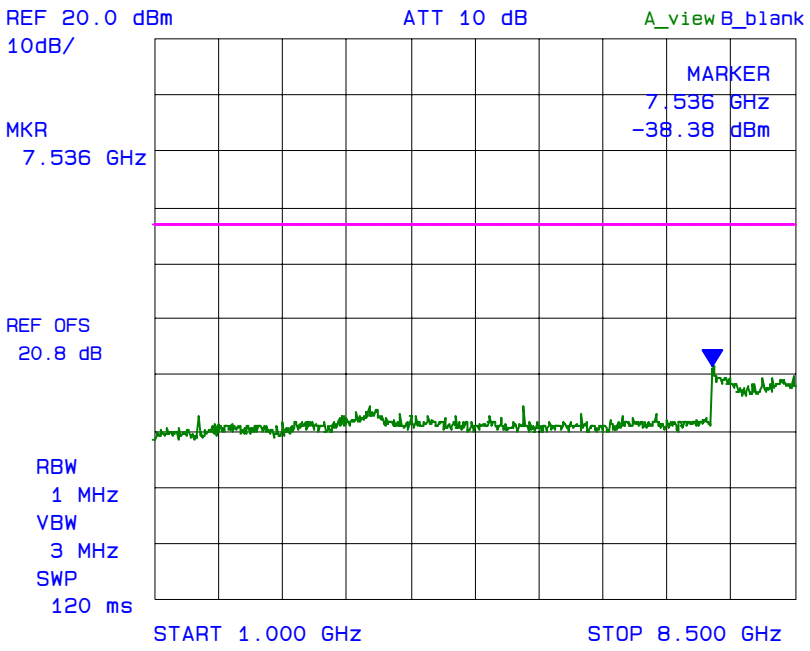
| | |
|---|---|
| Fundamental Frequency: | 764 MHz & 764.025 MHz (2 channel inputs/outputs) |
| RF Output Power: | 31.75 dBm (conducted) |
| Modulation: | Unmodulated |

See the following plots for details:

Plot 6.8.5.3
Spurious Emissions at Antenna Terminal with 2 RF signal inputs/outputs
Fc: 764 MHz, Fc + 25 kHz



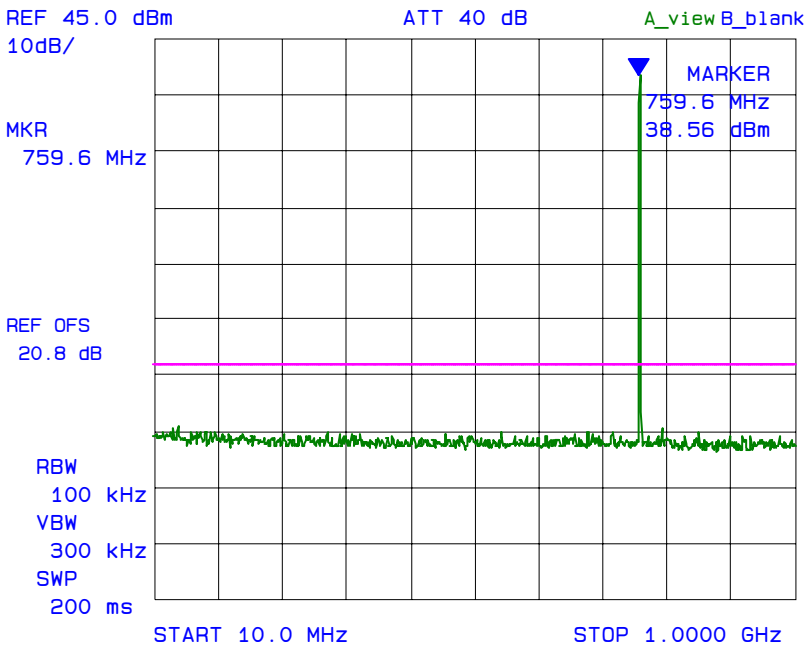
Plot 6.8.5.4
Spurious Emissions at Antenna Terminal with 2 RF signal inputs/outputs
Fc: 764 MHz, Fc + 25 kHz



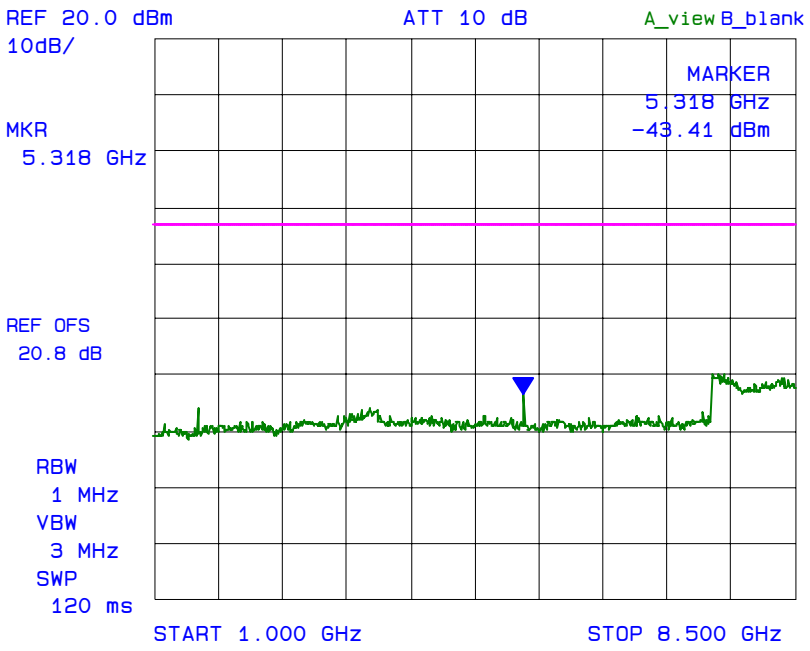
| | |
|---|---|
| Fundamental Frequency: | 764 MHz, 764.025 MHz & 764.050 MHz (3 channel inputs/outputs) |
| RF Output Power: | 31.00 dBm (conducted) |
| Modulation: | Unmodulated |

See the following plots for details:

Plot 6.8.5.5
Spurious Emissions at Antenna Terminal with 3 RF signal inputs/outputs
Fc: 764 MHz, Fc + 25 kHz, Fc + 50 kHz



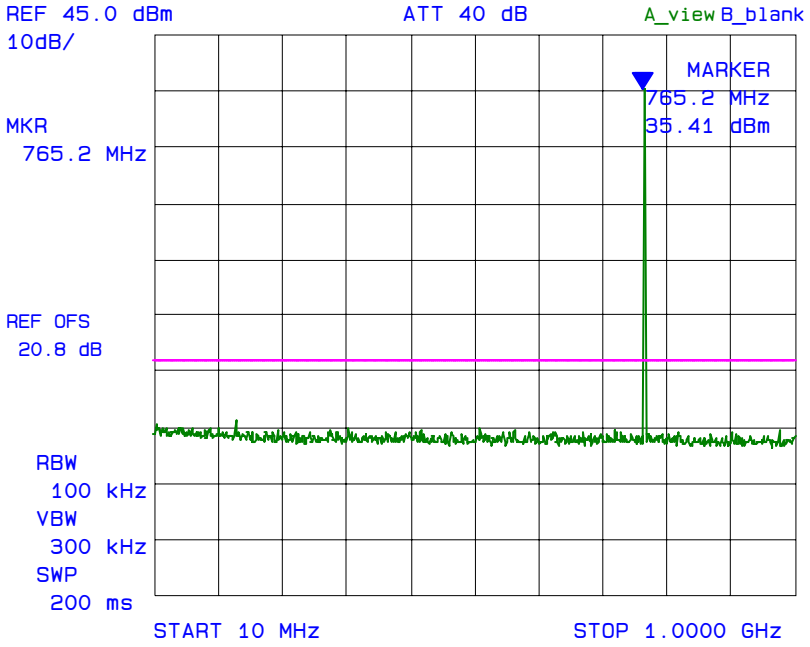
Plot 6.8.5.6
Spurious Emissions at Antenna Terminal with 3 RF signal inputs/outputs
Fc: 764 MHz, Fc + 25 kHz, Fc + 50 kHz



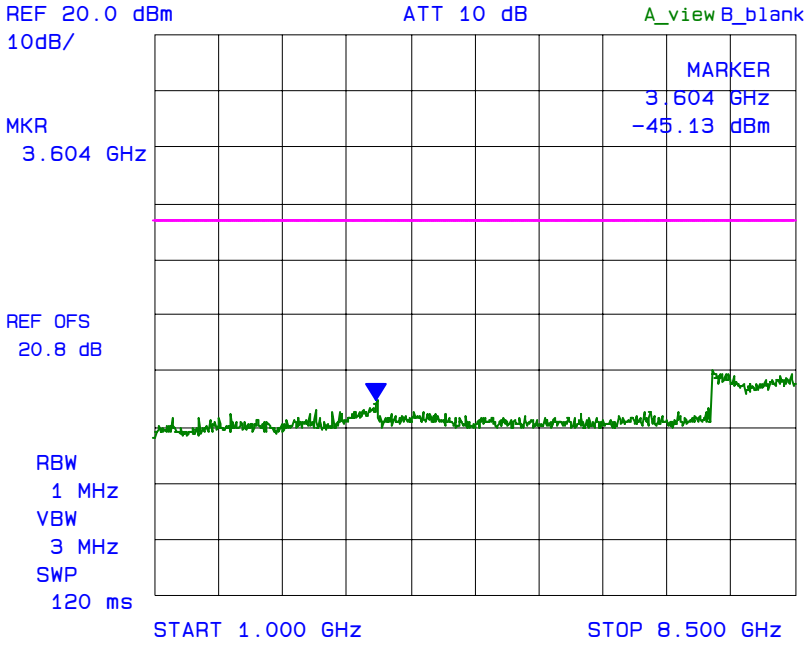
| | |
|---|---|
| Fundamental Frequency: | 770 MHz (1 RF Signal input/output) |
| RF Output Power: | 35.31 dBm (conducted) |
| Modulation: | Unmodulated |

See the following plots for details:

Plot 6.8.5.7
Spurious Emissions at Antenna Terminal with 1 RF signal input/output
Fc: 770 MHz



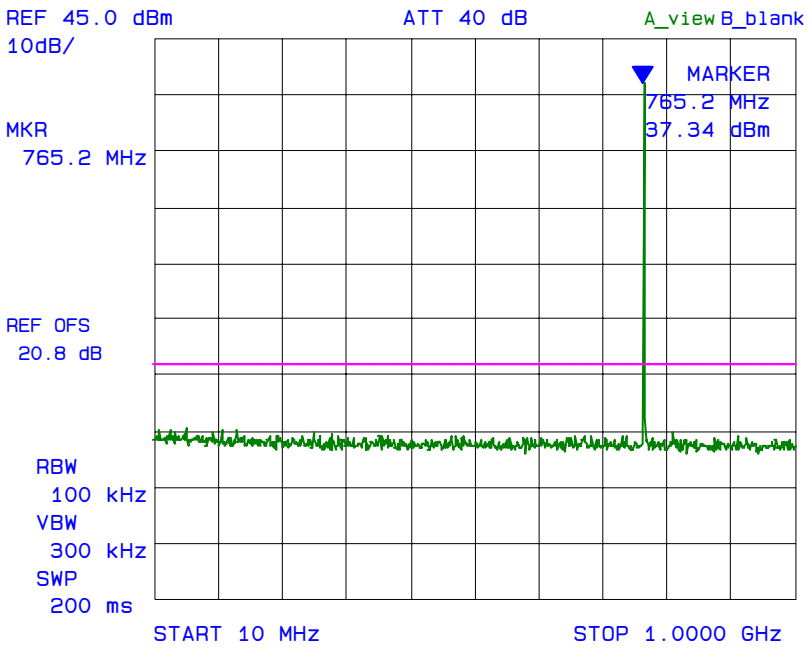
Plot 6.8.5.8
Spurious Emissions at Antenna Terminal with 1 RF signal input/output
Fc: 770 MHz



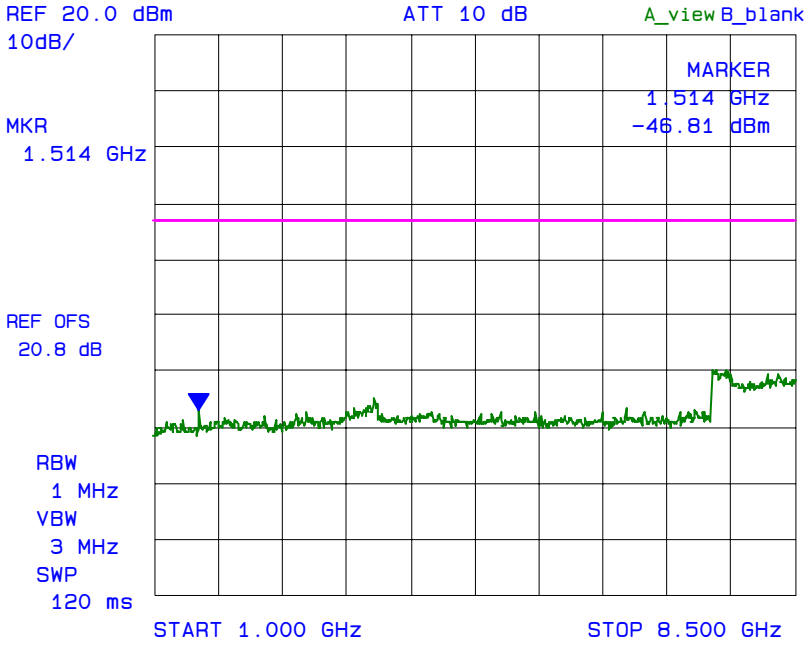
| | |
|---|---|
| Fundamental Frequency: | 770 MHz, 770.025 MHz (2 channel inputs/outputs) |
| RF Output Power: | 32.19 dBm (conducted) |
| Modulation: | Unmodulated |

See the following plots for details:

Plot 6.8.5.9
Spurious Emissions at Antenna Terminal with 2 RF signal inputs/outputs
Fc: 770 MHz, Fc + 25 kHz



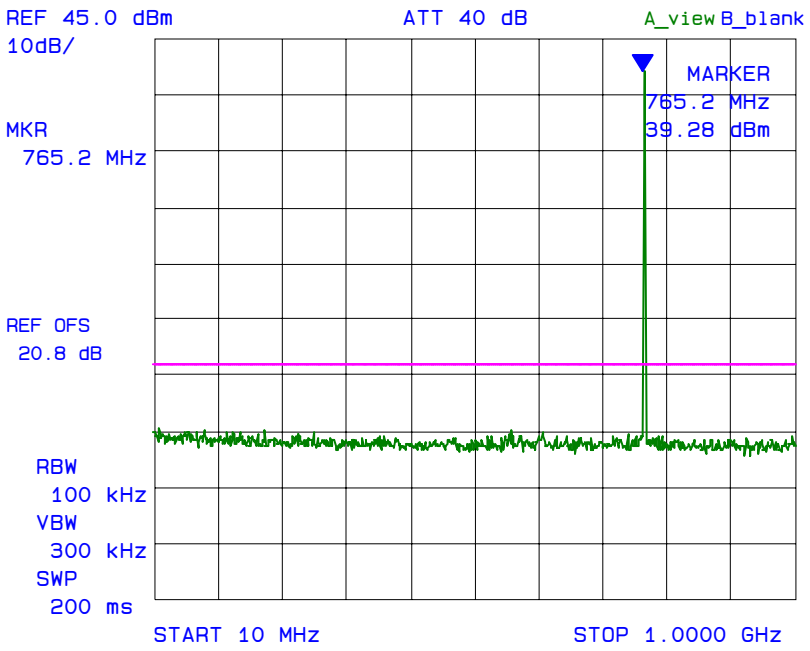
Plot 6.8.5.10
Spurious Emissions at Antenna Terminal with 2 RF signal inputs/outputs
Fc: 770 MHz, Fc + 25 kHz



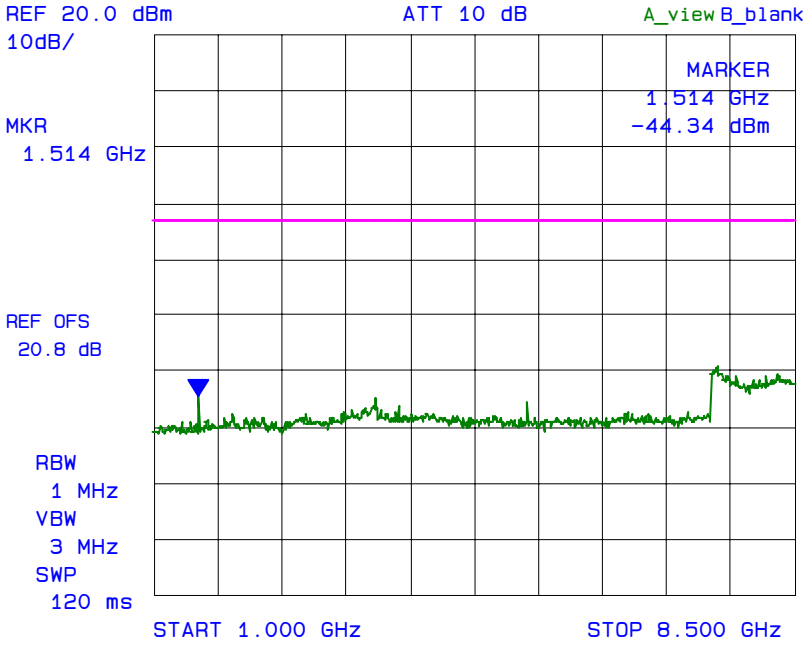
| | |
|---|---|
| Fundamental Frequency: | 770 MHz, 770.025, 770.050 MHz (3 channel inputs/outputs) |
| RF Output Power: | 31.28 dBm (conducted) |
| Modulation: | Unmodulated |

See the following plots for details:

Plot 6.8.5.11
Spurious Emissions at Antenna Terminal with 3 RF signal inputs/outputs
Fc: 770 MHz, Fc + 25 kHz, Fc + 50 kHz



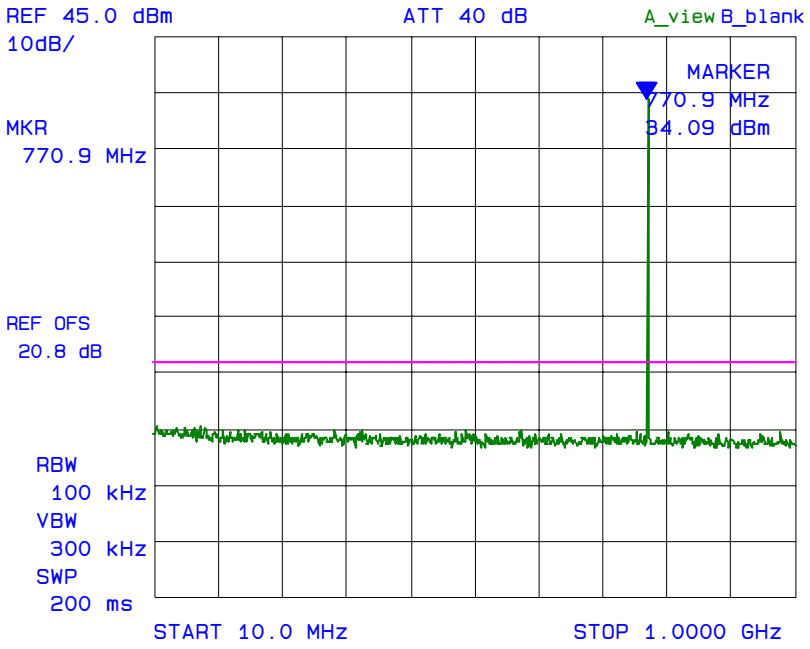
Plot 6.8.5.12
Spurious Emissions at Antenna Terminal with 3 RF signal inputs/outputs
Fc: 770 MHz, Fc + 25 kHz, Fc + 50 kHz



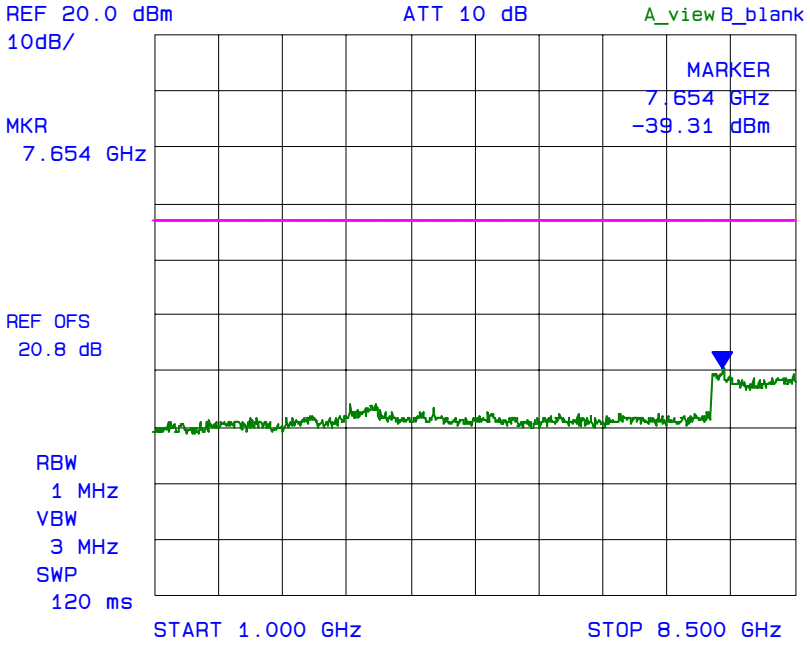
| | |
|---|---|
| Fundamental Frequency: | 776 MHz (1 RF Signal input/output) |
| RF Output Power: | 34.72 dBm (conducted) |
| Modulation: | Unmodulated |

See the following plots for details:

Plot 6.8.5.13
Spurious Emissions at Antenna Terminal with 1 RF signal input/output
Fc: 776 MHz



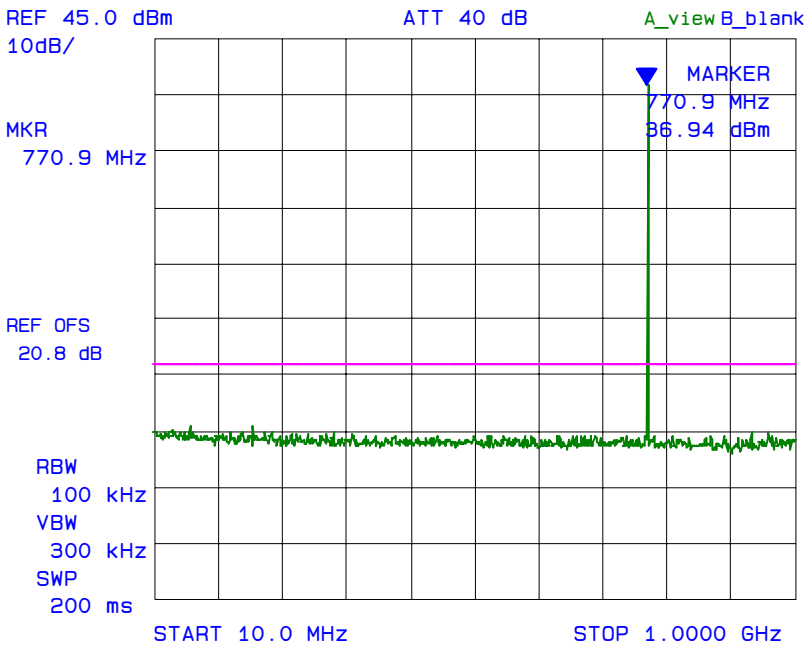
Plot 6.8.5.14
Spurious Emissions at Antenna Terminal with 1 RF signal input/output
Fc: 776 MHz



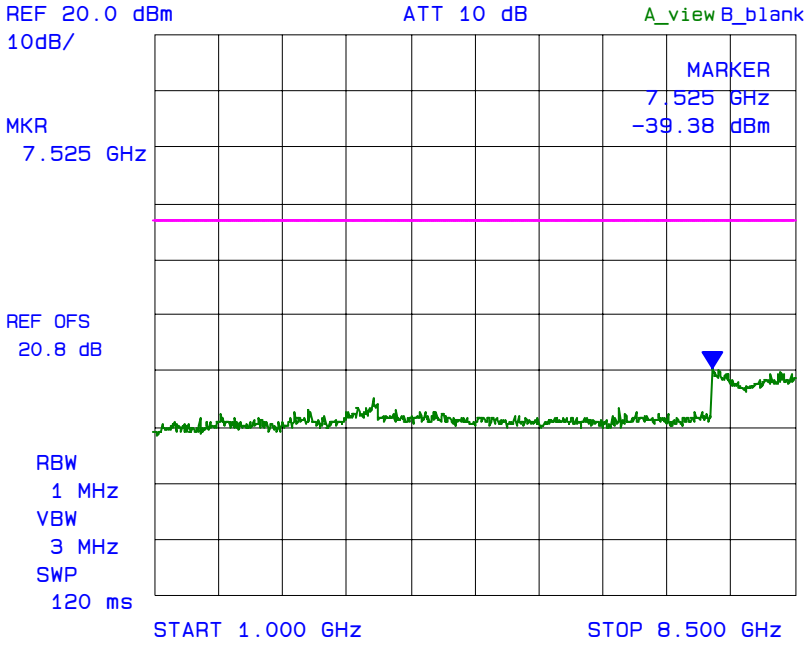
| | |
|---|---|
| undamental Frequency: | 776 MHz & 775.975 MHz, (2 channel inputs/outputs) |
| RF Output Power: | 31.75 dBm (conducted) |
| Modulation: | Unmodulated |

See the following plots for details:

Plot 6.8.5.15
Spurious Emissions at Antenna Terminal with 2 RF signal inputs/outputs
Fc: 776 MHz, Fc - 25 kHz



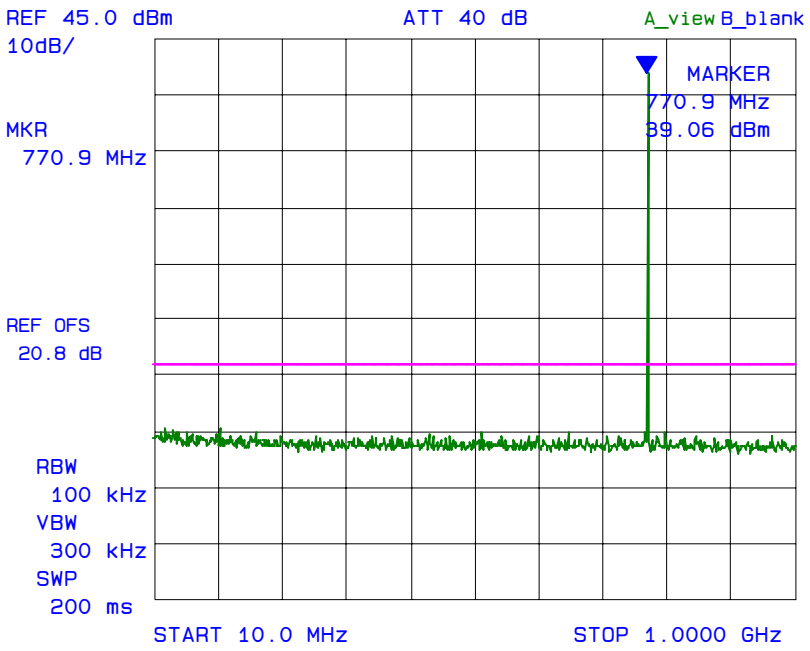
Plot 6.8.5.16
Spurious Emissions at Antenna Terminal with 2 RF signal inputs/outputs
Fc: 776 MHz, Fc - 25 kHz



| | |
|---|---|
| Fundamental Frequency: | 776 MHz, 776.975 MHz & 776.950 MHz (3 channel inputs/outputs) |
| RF Output Power: | 30.72 dBm (conducted) |
| Modulation: | Unmodulated |

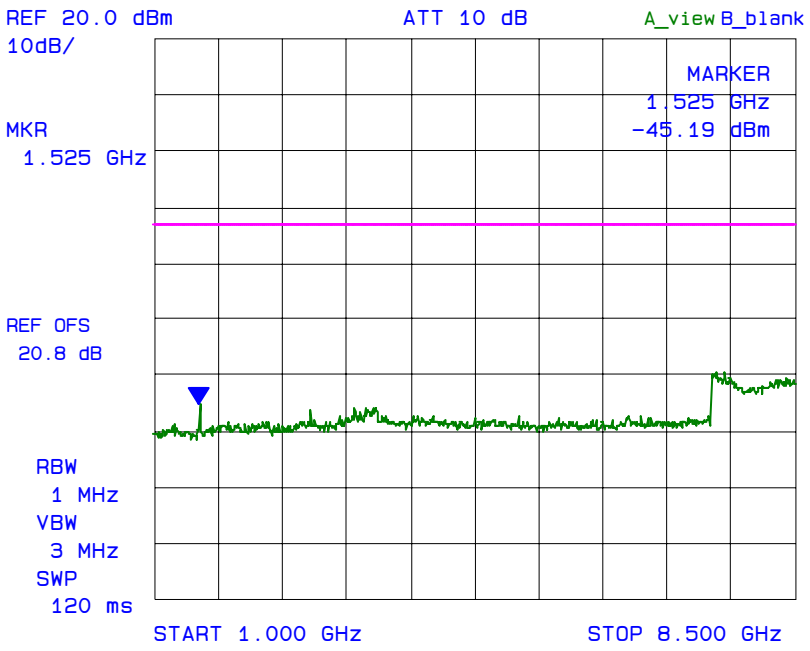
See the following plots for details:

Plot 6.8.5.17
Spurious Emissions at Antenna Terminal with 3 RF signal inputs/outputs
Fc: 776 MHz, Fc - 25 kHz, Fc - 50 kHz



Plot 6.8.5.18
Spurious Emissions at Antenna Terminal with 3 RF signal inputs/outputs
Fc: 776 MHz, Fc - 25 kHz, Fc - 50 kHz

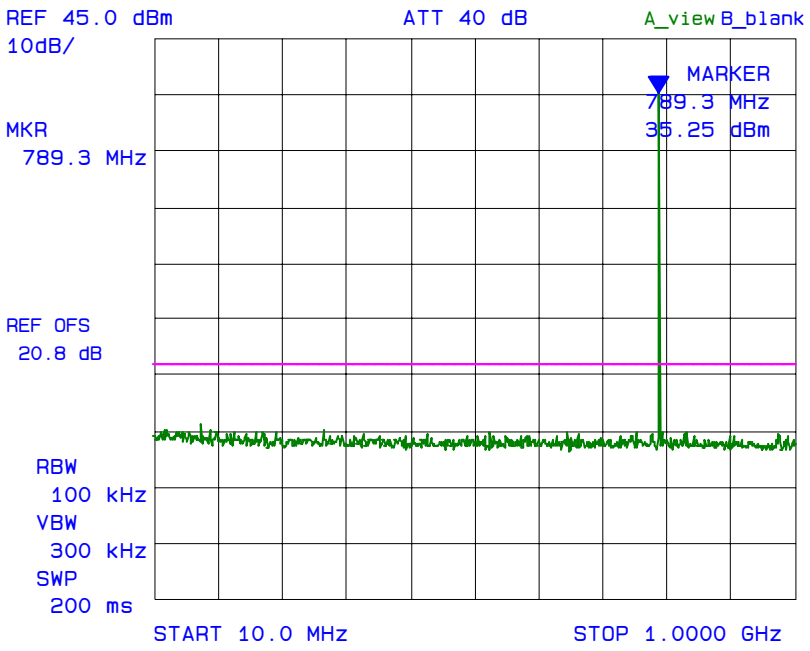
.



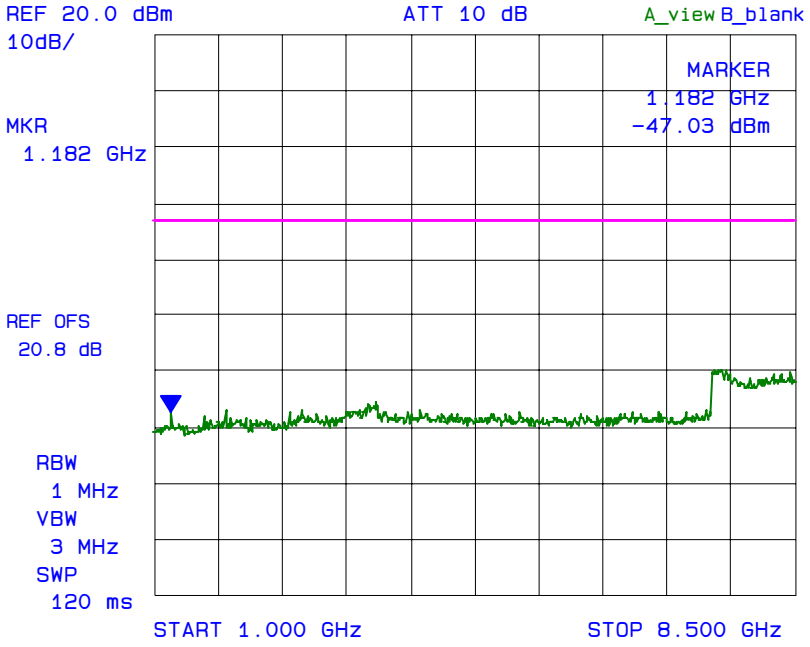
| | |
|---|---|
| Fundamental Frequency: | 794 MHz (1 RF Signal input/output) |
| RF Output Power: | 35.06 dBm (conducted) |
| Modulation: | Unmodulated |

See the following plots for details:

Plot 6.8.5.19
Spurious Emissions at Antenna Terminal with 1 RF signal input/output
Fc: 794 MHz



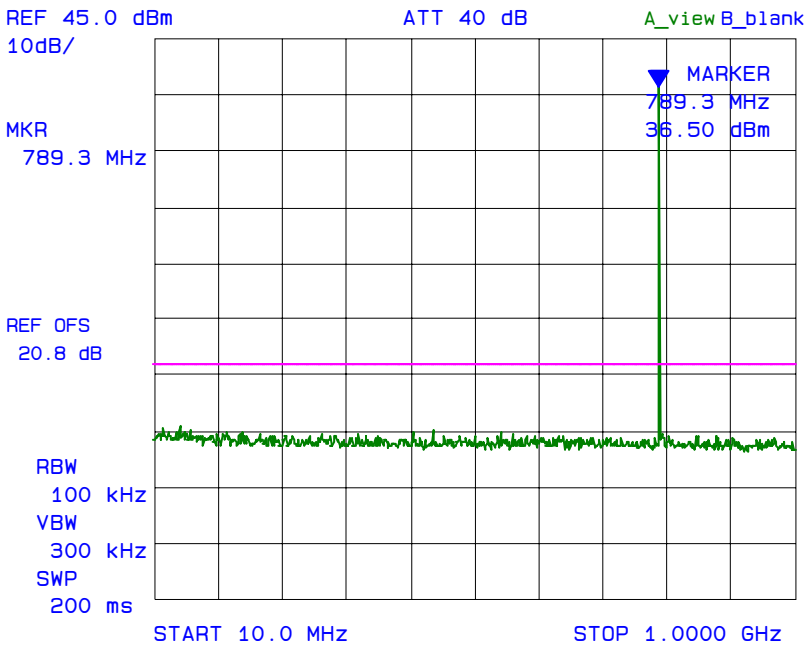
Plot 6.8.5.20
Spurious Emissions at Antenna Terminal with 1 RF signal input/output
Fc: 794 MHz



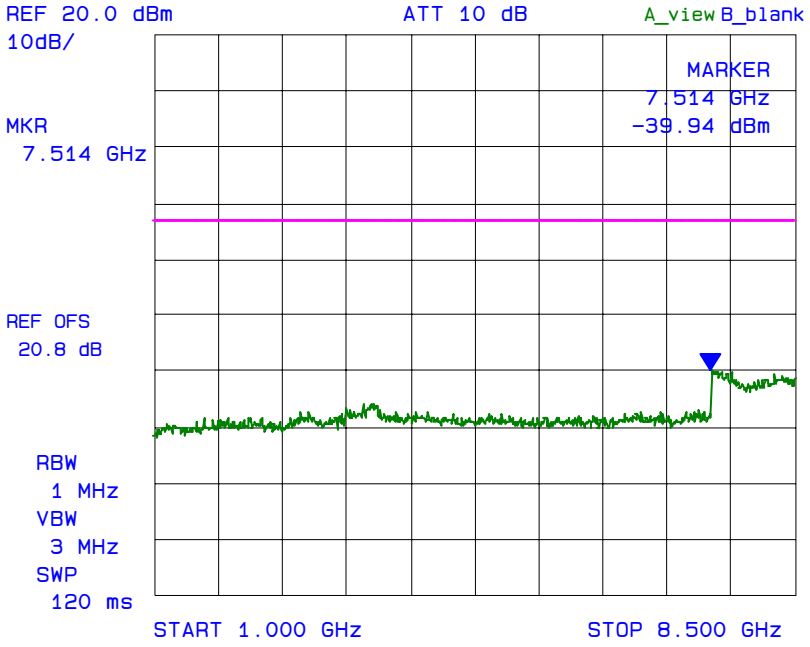
| | |
|---|---|
| Fundamental Frequency: | 794 MHz & 794.025 MHz (2 channel inputs/outputs) |
| RF Output Power: | 31.72 dBm (conducted) |
| Modulation: | Unmodulated |

See the following plots for details:

Plot 6.8.5.21
Spurious Emissions at Antenna Terminal with 2 RF signal inputs/outputs
Fc: 794 MHz, Fc + 25 kHz



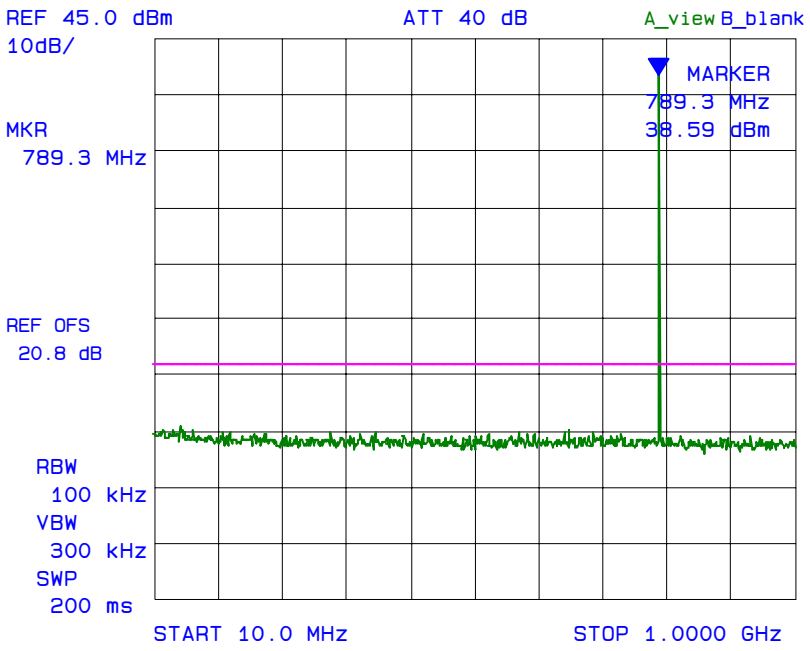
Plot 6.8.5.22
Spurious Emissions at Antenna Terminal with 2 RF signal inputs/outputs
Fc: 794 MHz, Fc + 25 kHz



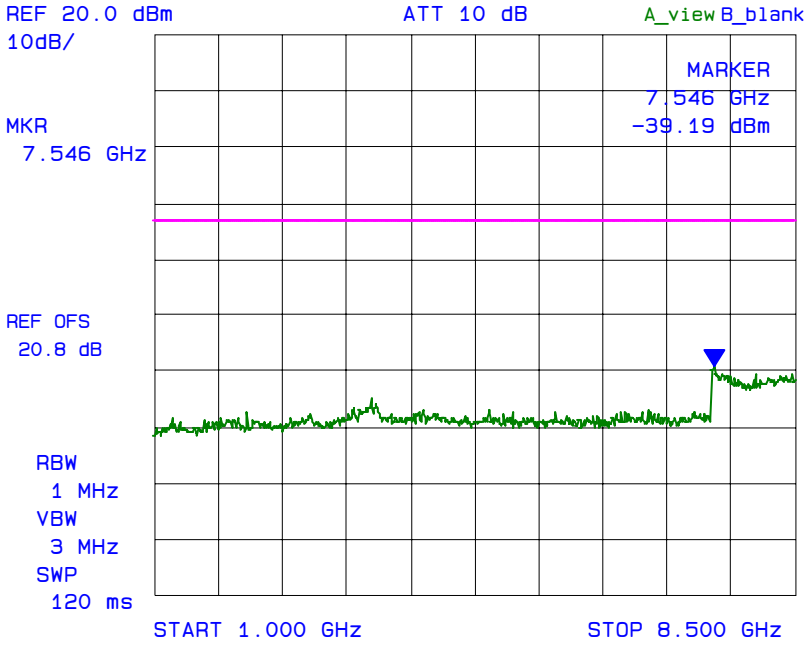
| | |
|---|---|
| Fundamental Frequency: | 794 MHz, 794.025 MHz 794.050 MHz (3 channel inputs/outputs) |
| RF Output Power: | 30.75 dBm (conducted) |
| Modulation: | Unmodulated |

See the following plots for details:

Plot 6.8.5.23
Spurious Emissions at Antenna Terminal with 3 RF signal inputs/outputs
Fc: 794 MHz, Fc + 25 kHz, Fc + 50 kHz



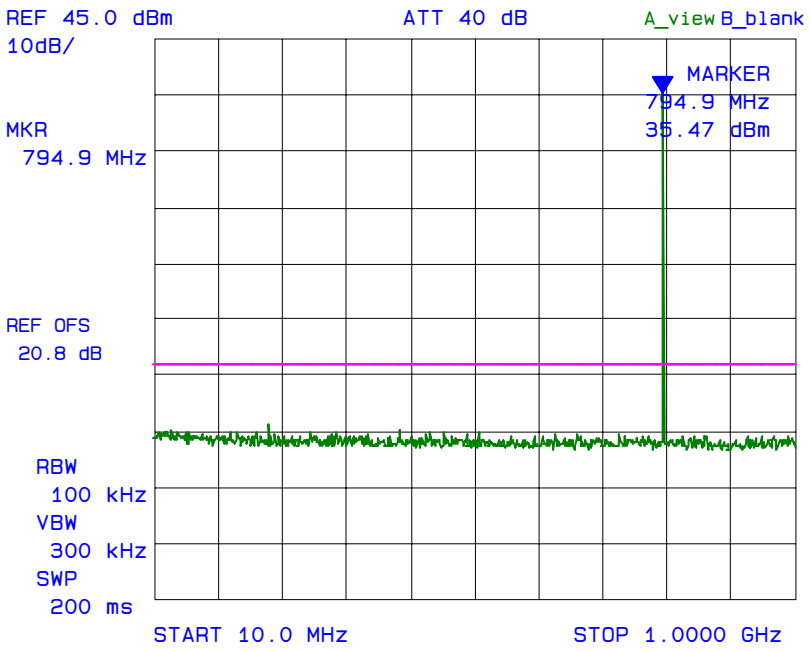
Plot 6.8.5.24
Spurious Emissions at Antenna Terminal with 3 RF signal inputs/outputs
Fc: 794 MHz, Fc + 25 kHz, Fc + 50 kHz



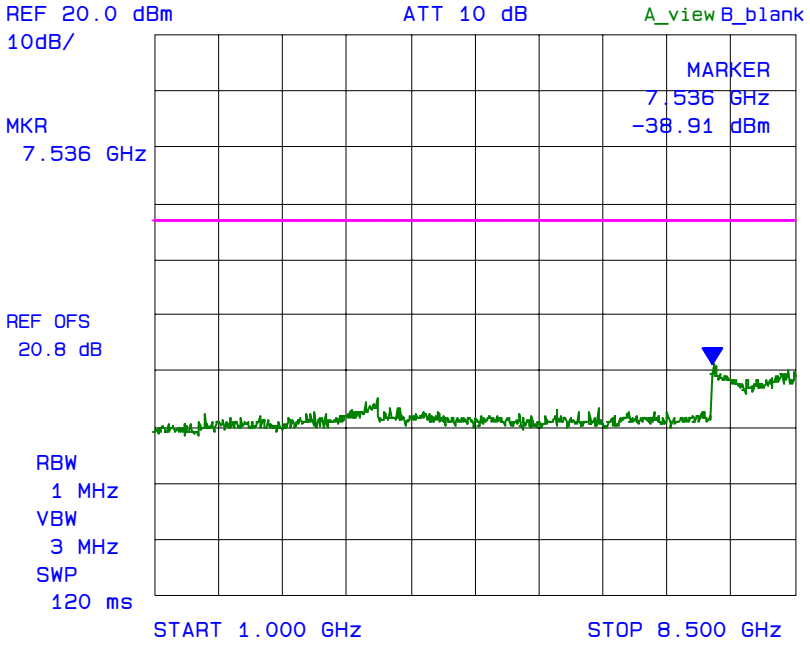
| | |
|---|---|
| Fundamental Frequency: | 800 MHz (1 RF Signal input/output) |
| RF Output Power: | 35.97 dBm (conducted) |
| Modulation: | Unmodulated |

See the following plots for details:

Plot 6.8.5.25
Spurious Emissions at Antenna Terminal with 1 RF signal input/output
Fc: 800 MHz



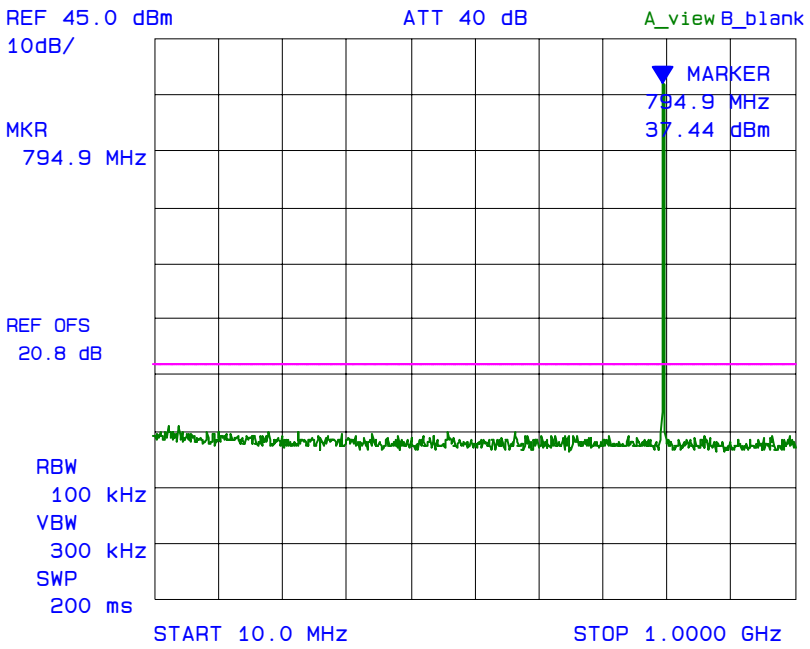
Plot 6.8.5.26
Spurious Emissions at Antenna Terminal with 1 RF signal input/output
Fc: 800 MHz



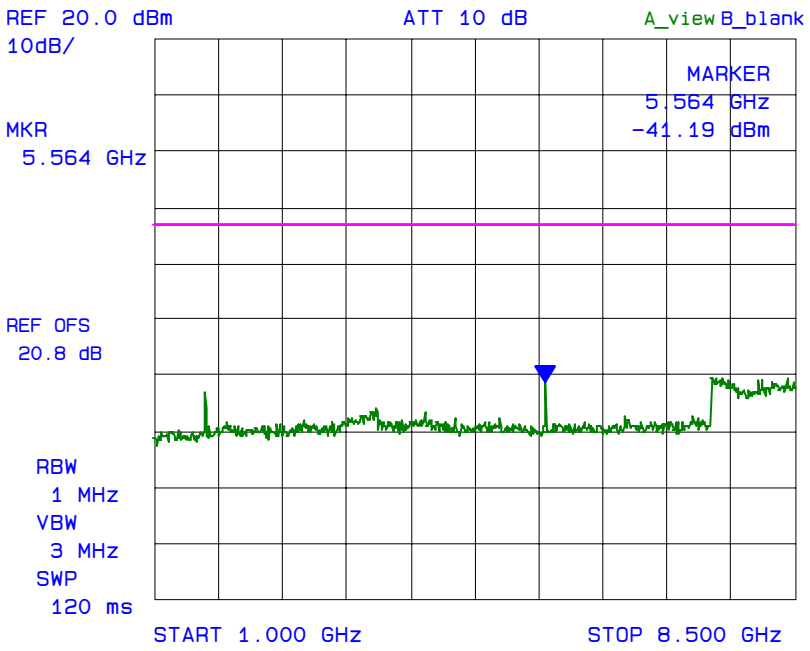
| | |
|---|---|
| Fundamental Frequency: | 800 MHz & 800.025 MHz (2 channel inputs/outputs) |
| RF Output Power: | 32.06 dBm (conducted) |
| Modulation: | Unmodulated |

See the following plots for details:

Plot 6.8.5.27
Spurious Emissions at Antenna Terminal with 2 RF signal inputs/outputs
Fc: 800 MHz, Fc + 25 kHz



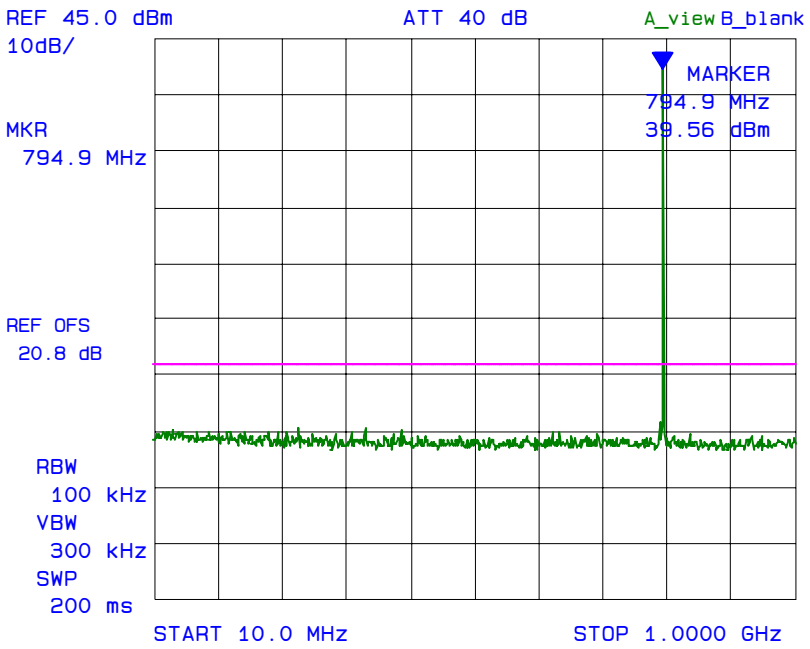
Plot 6.8.5.28
Spurious Emissions at Antenna Terminal with 2 RF signal inputs/outputs
Fc: 800 MHz, Fc + 25 kHz



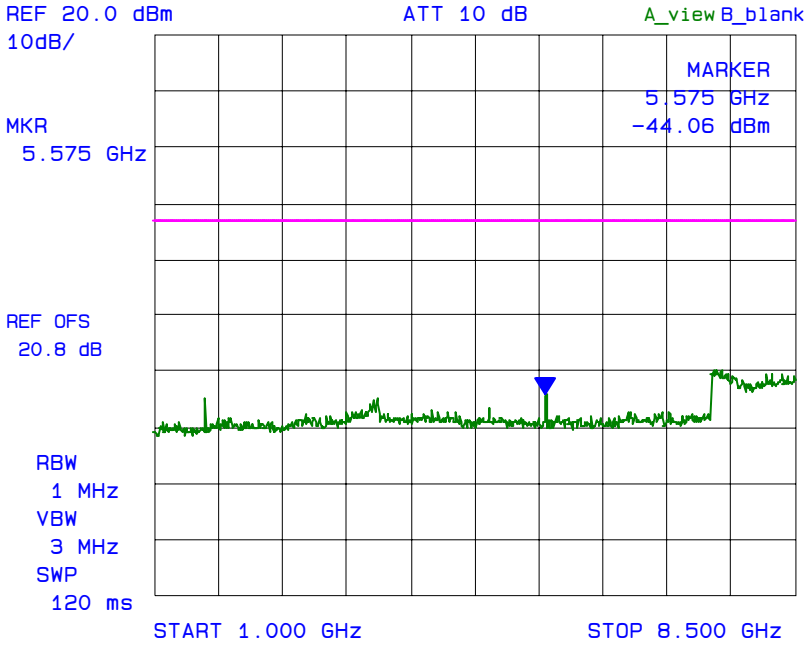
| | |
|---|---|
| Fundamental Frequency: | 800 MHz, 800.025 MHz & 800.050 MHz (3 channel inputs/outputs) |
| RF Output Power: | 30.88 dBm (conducted) |
| Modulation: | Unmodulated |

See the following plots for details:

Plot 6.8.5.29
Spurious Emissions at Antenna Terminal with 3 RF signal inputs/outputs
Fc: 800 MHz, Fc + 25 kHz, Fc + 50 kHz



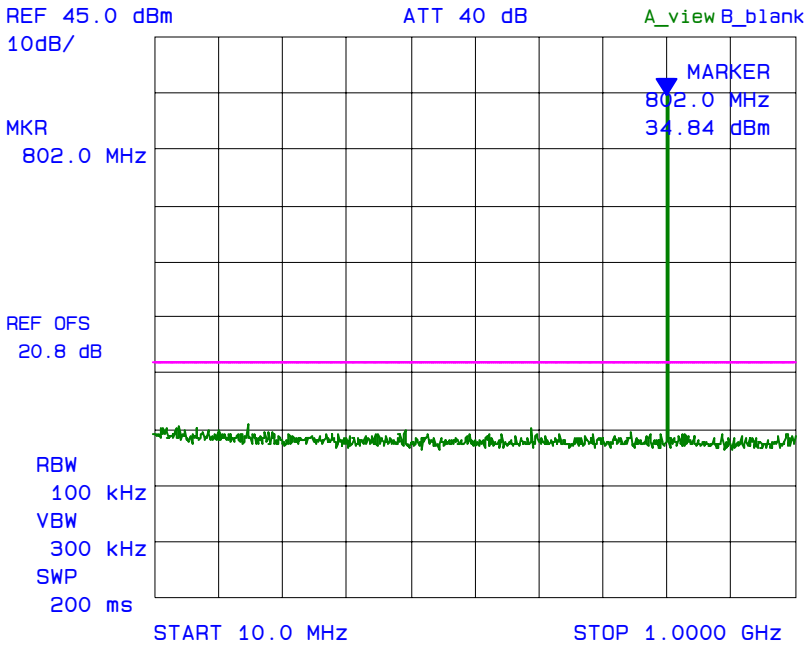
Plot 6.8.5.30
Spurious Emissions at Antenna Terminal with 3 RF signal inputs/outputs
Fc: 800 MHz, Fc + 25 kHz, Fc + 50 kHz



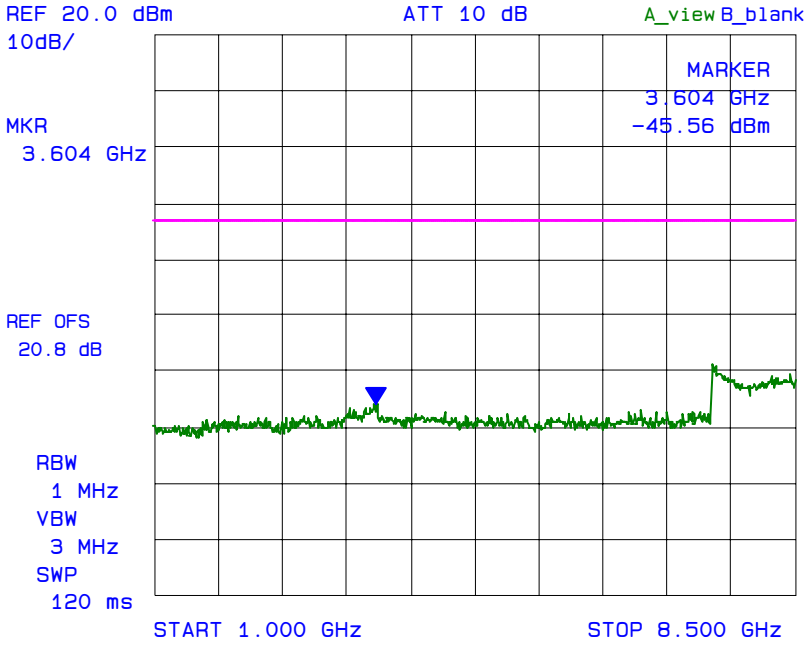
| | |
|---|---|
| Fundamental Frequency: | 806 MHz (1 RF Signal input/output) |
| RF Output Power: | 35.41 dBm (conducted) |
| Modulation: | Unmodulated |

See the following plots for details:

Plot 6.8.5.31
Spurious Emissions at Antenna Terminal with with 1 RF signal input/output
Fc: 806 MHz



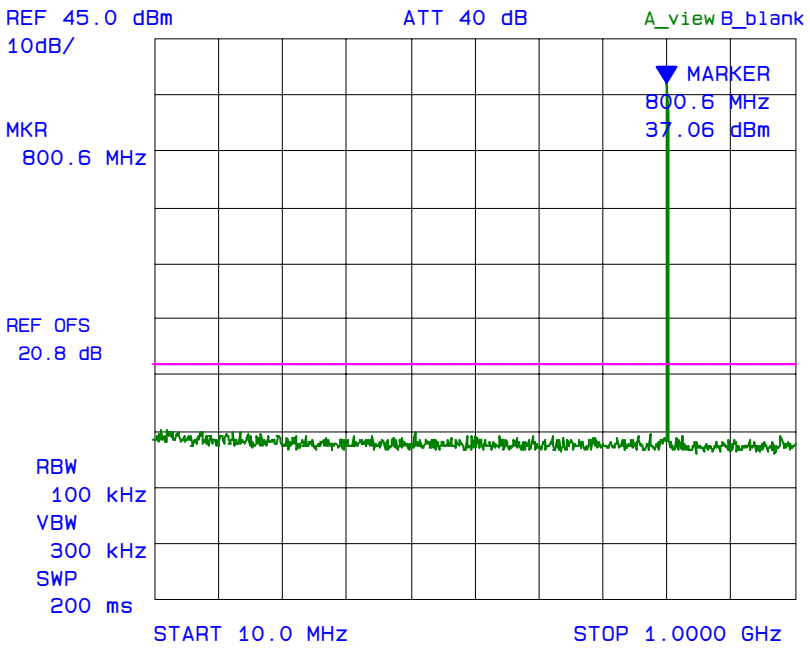
Plot 6.8.5.32
Spurious Emissions at Antenna Terminal with with 1 RF signal input/output
Fc: 806 MHz



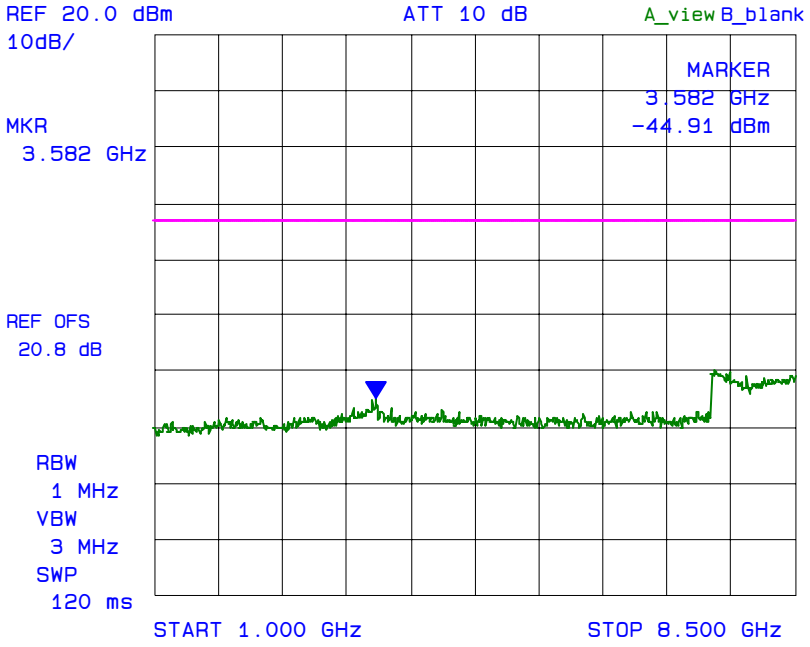
| | |
|---|---|
| Fundamental Frequency: | 806 MHz & 805.975 MHz, (2 channel inputs/outputs) |
| RF Output Power: | 31.25 dBm (conducted) |
| Modulation: | Unmodulated |

See the following plots for details:

Plot 6.8.5.33
Spurious Emissions at Antenna Terminal with 2 RF signal inputs/outputs
Fc: 806 MHz, Fc - 25 kHz



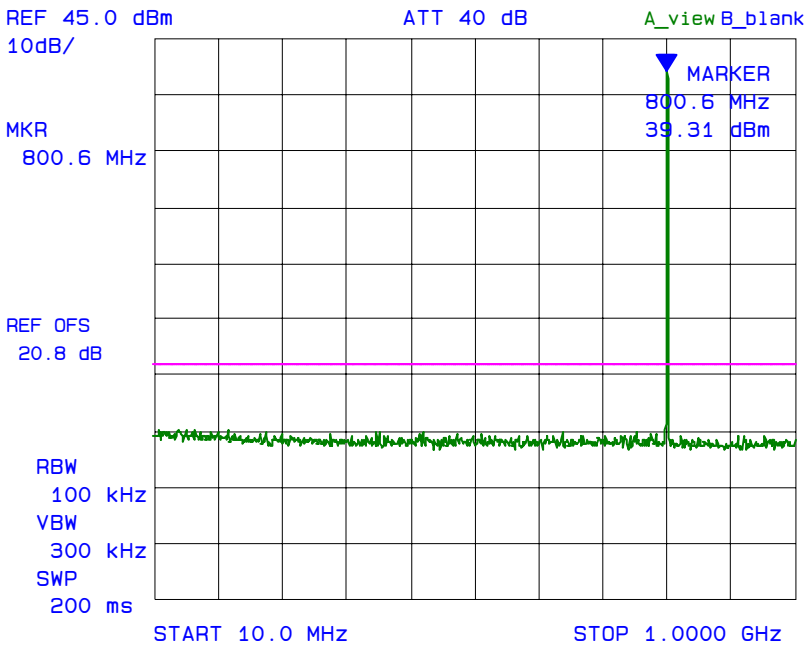
Plot 6.8.5.34
Spurious Emissions at Antenna Terminal with 2 RF signal inputs/outputs
Fc: 806 MHz, Fc - 25 kHz



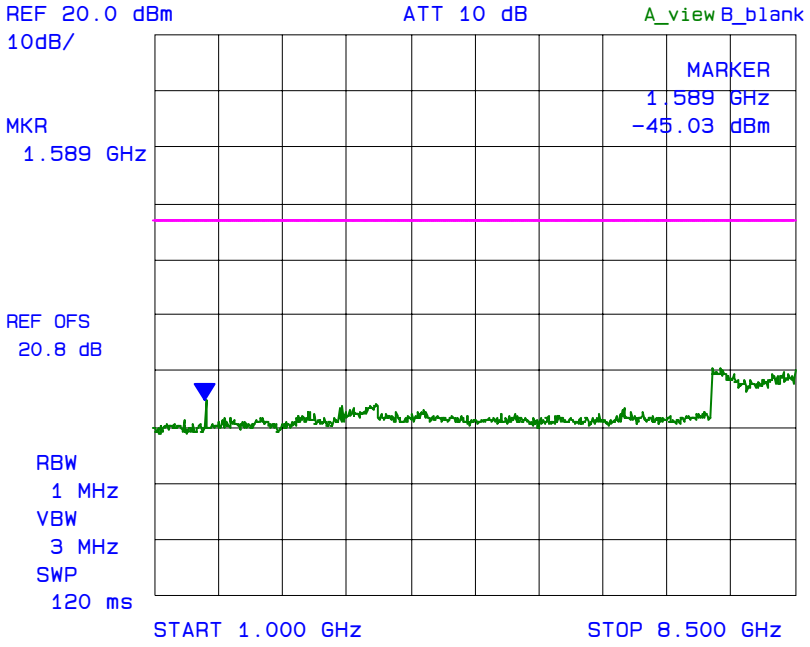
| | |
|---|---|
| Fundamental Frequency: | 806 MHz, 805.975 MHz & 805.950 MHz (3 channel inputs/outputs) |
| RF Output Power: | 30.31 dBm (conducted) |
| Modulation: | Unmodulated |

See the following plots for details:

Plot 6.8.5.35
Spurious Emissions at Antenna Terminal with 3 RF signal inputs/outputs
Fc: 806 MHz, Fc - 25 kHz, Fc - 50 kHz



Plot 6.8.5.36
Spurious Emissions at Antenna Terminal with 3 RF signal inputs/outputs
Fc: 806 MHz, Fc - 25 kHz, Fc - 50 kHz



## 6.9. FIELD STRENGHT OF SPURIOUS EMISSIONS [§§ 2.1053 & 90.543(c)]

### 6.9.1. Limits

The power of any emission must be reduced below the unmodulated carrier power (P) by at least 43 + 10 log (P) dB.

90.543(e) - For operations in the 764 to 776 MHz and 794 to 806 MHz bands, all emissions including harmonics in the band 1559-1610 MHz shall be limited to -70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and -80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

### 6.9.2. Method of Measurements

The spurious/harmonic ERP measurements are using substitution method specified in Exhibit 8, Section 8.2 of this report and its value in dBc is calculated as follows:

(1) If the transmitter's antenna is an integral part of the EUT, the ERP is measured using substitution method.
(2) If the transmitter's antenna is non-integral and diverse, the lowest ERP of the carrier with 0 dBi antenna gain is used for calculation of the spurious/harmonic emissions in dBc:
Lowest ERP of the carrier = EIRP – 2.15 dB = Pc + G - 2.15 dB = Pc dBm (conducted) + 0 dBi – 2.15 dB
(3) Spurious /harmonic emissions levels expressed in dBc (dB below carrier) are as follows:

**ERP of spurious/harmonic (dBc) = ERP of carrier (dBm) – ERP of spurious/harmonic emission (dBm)**

### 6.9.3. Test Equipment List

| Test Instruments | Manufacturer | Model No. | Serial No. | Frequency Range |
|---|---|---|---|---|
| Spectrum Analyzer | Rohde & Schwarz | FSEK20/B4/B21 | 834157/005 | 9 kHz – 40 GHz |
| RF Amplifier | Com-Power | PA-102 | | 1 MHz to 1 GHz, 30 dB gain nominal |
| Microwave Amplifier | Hewlett Packard | HP 83017A | | 1 GHz to 26.5 GHz, 30 dB nominal |
| Biconilog Antenna | EMCO | 3142 | 10005 | 30 MHz to 2 GHz |
| Dipole Antenna | EMCO | 3121C | 8907-434 | 30 GHz – 1 GHz |
| Dipole Antenna | EMCO | 3121C | 8907-440 | 30 GHz – 1 GHz |
| Horn Antenna | EMCO | 3155 | 9701-5061 | 1 GHz – 18 GHz |
| Horn Antenna | EMCO | 3155 | 9911-5955 | 1 GHz – 18 GHz |
| RF Signal Generator | Hewlett Packard | HP 83752B | 3610A00457 | 0.01 – 20 GHz |

## 6.9.4. Test Data

**Remarks:**

- § 90.543(e) is not applicable for this device.
- Modulation used: CW signal at low, middle and high frequency of each frequency bands.
- The radiated emissions were performed at 3 meters distance. At its maximum power for worst case.
- The emissions were scanned from 30 MHz to 8.5 GHz; all emissions that are within 20 dB below the limit are recorded.

### 6.9.4.1. 764-776 MHz Band

#### *6.9.4.1.1. Lowest Frequency (764 MHz)*

| | |
|---|---|
| Carrier Frequency (MHz): | 764 |
| Power (dBm): | 35.47 |
| Limit (dBc): | -48.47 |

All emissions are more than 20 dB below the limit.

#### *6.9.4.1.2. Middle Frequency (770 MHz)*

| | |
|---|---|
| Carrier Frequency (MHz): | 770 |
| Power (dBm): | 36.21 |
| Limit (dBc): | -49.21 |

| Frequency (MHz) | E-Field (dBµV/m) | EMI Detector (Peak/QP) | Antenna Polarization (H/V) | ERP measured by Substitution Method (dBm) | (dBc) | Limit (dBc) | Margin (dB) |
|---|---|---|---|---|---|---|---|
| 2310 | 73.28 | Peak | V | -28.85 | -65.1 | -49.21 | -15.9 |
| 2310 | 71.64 | Peak | H | -31.17 | -67.4 | -49.21 | -18.2 |

#### *6.9.4.1.3. Highest Frequency (776 MHz)*

| | |
|---|---|
| Carrier Frequency (MHz): | 776 |
| Power (dBm): | 35.41 |
| Limit (dBc): | -48.41 |

| Frequency (MHz) | E-Field (dBµV/m) | EMI Detector (Peak/QP) | Antenna Polarization (H/V) | ERP measured by Substitution Method (dBm) | (dBc) | Limit (dBc) | Margin (dB) |
|---|---|---|---|---|---|---|---|
| 2328 | 75.08 | Peak | V | -25.53 | -60.9 | -48.41 | -12.5 |
| 2328 | 75.41 | Peak | H | -26.98 | -62.4 | -48.41 | -14.0 |

### 6.9.4.2. 794-806 MHz Band

#### *6.9.4.2.1. Highest Frequency (794 MHz)*

Carrier Frequency (MHz): 794
Power (dBm): 36.21
Limit (dBc): -49.21

| Frequency (MHz) | E-Field (dBµV/m) | EMI Detector (Peak/QP) | Antenna Polarization (H/V) | ERP measured by Substitution Method (dBm) | (dBc) | Limit (dBc) | Margin (dB) |
|---|---|---|---|---|---|---|---|
| 2382 | 77.06 | Peak | V | -24.07 | -60.3 | -49.21 | -11.1 |
| 2382 | 77.41 | Peak | H | -24.76 | -61.0 | -49.21 | -11.8 |

#### *6.9.4.2.2. Highest Frequency (800 MHz)*

Carrier Frequency (MHz): 800
Power (dBm): 36.19
Limit (dBc): -49.19

| Frequency (MHz) | E-Field (dBµV/m) | EMI Detector (Peak/QP) | Antenna Polarization (H/V) | ERP measured by Substitution Method (dBm) | (dBc) | Limit (dBc) | Margin (dB) |
|---|---|---|---|---|---|---|---|
| 2400 | 72.95 | Peak | V | -27.85 | -64.0 | -49.19 | -14.9 |
| 2400 | 70.97 | Peak | H | -31.84 | -68.0 | -49.19 | -18.8 |

#### *6.9.4.2.3. Highest Frequency (806 MHz)*

Carrier Frequency (MHz): 806
Power (dBm): 36.31
Limit (dBc): 49.31

| Frequency (MHz) | E-Field (dBµV/m) | EMI Detector (Peak/QP) | Antenna Polarization (H/V) | ERP measured by Substitution Method (dBm) | (dBc) | Limit (dBc) | Margin (dB) |
|---|---|---|---|---|---|---|---|
| 1612 | 70.03 | Peak | V | -30.98 | 67.3 | 49.31 | -18.0 |
| 1612 | 70.82 | Peak | H | -30.03 | 66.3 | 49.31 | -17.0 |

# EXHIBIT 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of NIST Technical Note 1297 and NIS 81 (1994)

## 7.1. RADIATED EMISSION MEASUREMENT UNCERTAINTY

| CONTRIBUTION (Radiated Emissions) | PROBABILITY DISTRIBUTION | UNCERTAINTY (± dB) | |
|---|---|---|---|
| | | 3 m | 10 m |
| Antenna Factor Calibration | Normal (k=2) | ±1.0 | ±1.0 |
| Cable Loss Calibration | Normal (k=2) | ±0.3 | ±0.5 |
| EMI Receiver specification | Rectangular | ±1.5 | ±1.5 |
| Antenna Directivity | Rectangular | +0.5 | +0.5 |
| Antenna factor variation with height | Rectangular | ±2.0 | ±0.5 |
| Antenna phase center variation | Rectangular | 0.0 | ±0.2 |
| Antenna factor frequency interpolation | Rectangular | ±0.25 | ±0.25 |
| Measurement distance variation | Rectangular | ±0.6 | ±0.4 |
| Site imperfections | Rectangular | ±2.0 | ±2.0 |
| Mismatch: Receiver VRC $\Gamma_1$ = 0.2<br>Antenna VRC $\Gamma_R$ = 0.67(Bi) 0.3 (Lp)<br>Uncertainty limits 20Log(1±$\Gamma_1\Gamma_R$) | U-Shaped | +1.1<br><br>-1.25 | ±0.5 |
| System repeatability | Std. Deviation | ±0.5 | ±0.5 |
| Repeatability of EUT | | - | - |
| Combined standard uncertainty | Normal | +2.19 / -2.21 | +1.74 / -1.72 |
| Expanded uncertainty U | Normal (k=2) | +4.38 / -4.42 | +3.48 / -3.44 |

Calculation for maximum uncertainty when 3m biconical antenna including a factor of k = 2 is used:

$U = 2u_c(y) = 2x(+2.19)= +4.38$ dB And $U = 2u_c(y) = 2x(-2.21)= -4.42$ dB

# EXHIBIT 8. MEASUREMENT METHODS

## 8.1. CONDUCTED POWER MEASUREMENTS

- The following shall be applied to the combination(s) of the radio device and its intended antenna(e).
- I f the RF level is user adjustable; all measurements shall be made with the highest power level available to the user for that combination.
- The following method of measurement shall apply to both conducted and radiated measurements.
- The radiated measurements are performed at the Ultratech Calibrated Open Field Test Site.
- The measurement shall be performed using normal operation of the equipment with modulation.

Test procedure shall be as follows:

**Step 1**: Duty Cycle measurements if the transmitter's transmission is transient

- Using a EMI Receiver with the frequency span set to 0 Hz and the sweep time set at a suitable value to capture the envelope peaks and the duty cycle of the transmitter output signal;
- The duty cycle of the transmitter, x = Tx on / (Tx on + Tx off) with 0<x<1, is measure and recorded in the test report. For the purpose of testing, the equipment shall be operated with a duty cycle that is equal or more than 0.1.

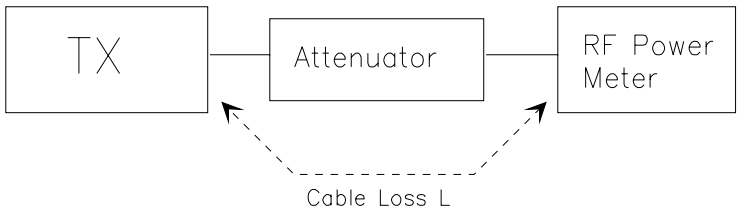
**Step 2**: Calculation of Average EIRP. See Figure 1

- The average output power of the transmitter shall be determined using a wideband, calibrated RF average power meter with the power sensor with an integration period that exceeds the repetition period of the transmitter by a factor 5 or more. The observed value shall be recorded as "A" (in dBm);
- The e.i.r.p. shall be calculated from the above measured power output "A", the observed duty cycle x, and the applicable antenna assembly gain "G" in dBi, according to the formula:

**EIRP = A + G + 10log(1/x)**

{ X = 1 for continuous transmission => 10log(1/x) = 0 dB }

**Figure 1.**



## 8.2. RADIATED POWER MEASUREMENTS (ERP & EIRP) USING SUBSTITUTION METHOD

### 8.2.1. Maximizing RF Emission Level (E-Field)

(a) The measurements was performed with full rf output power and modulation.
(b) Test was performed at listed 3m open area test site (listed with FCC, IC, ITI, NVLAP, ACA & VCCI).
(c) The transmitter under test was placed at the specified height on a non-conducting turntable (80 cm height)
(d) The BICONILOG antenna (20 MHz to 1 GHz) or HORN antenna (1 GHz to 18 GHz) was used for measuring.
(e) Load an appropriate correction factors file in EMI Receiver for correcting the field strength reading level

Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor
E (dBuV/m) = Reading (dBuV) + Total Correction Factor (dB/m)

(f) Set the EMI Receiver and #2 as follows:

| | |
|---|---|
| Center Frequency: | test frequency |
| Resolution BW: | 100 kHz |
| Video BW: | same |
| Detector Mode: | positive |
| Average: | off |
| Span: | 3 x the signal bandwidth |

(g) The test antenna was lowered or raised from 1 to 4 meters until the maximum signal level was detected.
(h) The transmitter was rotated through 360$^{o}$ about a vertical axis until a higher maximum signal was received.
(i) The test antenna was lowered or raised again from 1 to 4 meters until a maximum was obtained. This level was recorded.
(j) The recorded reading was corrected to the true field strength level by adding the antenna factor, cable loss and subtracting the pre-amplifier gain.
(k) The above steps were repeated with both transmitters' antenna and test receiving antenna placed in vertical and horizontal polarization. Both readings with the antennas placed in vertical and horizontal polarization shall be recorded.
(l) Repeat for all different test signal frequencies

### 8.2.2. Measuring the EIRP of Spurious/Harmonic Emissions using Substitution Method

(a) Set the EMI Receiver (for measuring E-Field) and Receiver #2 (for measuring EIRP) as follows:

| | |
|---|---|
| Center Frequency: | equal to the signal source |
| Resolution BW: | 10 kHz |
| Video BW: | same |
| Detector Mode: | positive |
| Average: | off |
| Span: | 3 x the signal bandwidth |

(b) Load an appropriate correction factors file in EMI Receiver for correcting the field strength reading level

Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor
E (dBuV/m) = Reading (dBuV) + Total Correction Factor (dB/m)

(c) Select the frequency and E-field levels obtained in the Section 8.2.1 for ERP/EIRP measurements.
(d) Substitute the EUT by a signal generator and one of the following transmitting antenna (substitution antenna):
- DIPOLE antenna for frequency from 30-1000 MHz or
- HORN antenna for frequency above 1 GHz }.

(e) Mount the transmitting antenna at 1.5 meter high from the ground plane.
(f) Use one of the following antenna as a receiving antenna:
- DIPOLE antenna for frequency from 30-1000 MHz or
- HORN antenna for frequency above 1 GHz }.

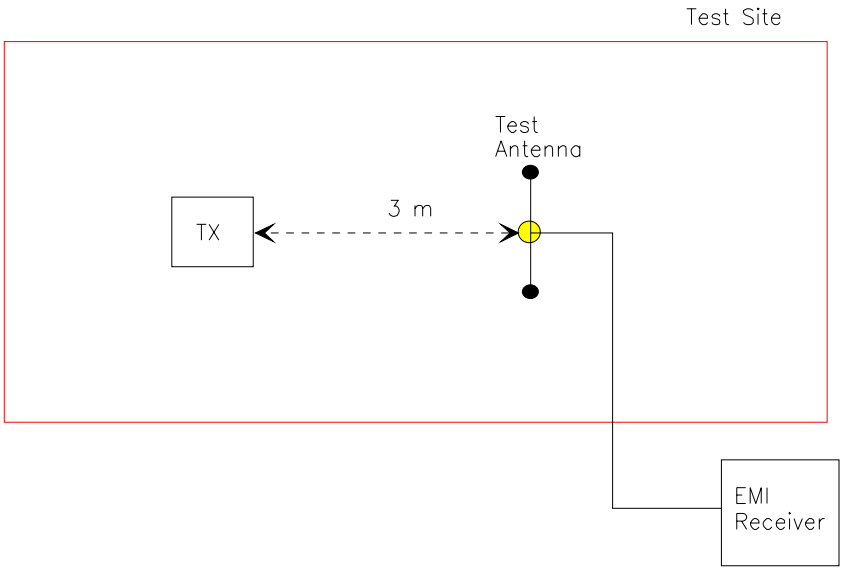
(g) If the DIPOLE antenna is used, tune it's elements to the frequency as specified in the calibration manual.
(h) Adjust both transmitting and receiving antenna in a VERTICAL polarization.
(i) Tune the EMI Receivers to the test frequency.
(j) Lower or raise the test antenna from 1 to 4 meters until the maximum signal level was detected.
(k) The transmitter was rotated through 360$^{o}$ about a vertical axis until a higher maximum signal was received.
(l) Lower or raise the test antenna from 1 to 4 meters until the maximum signal level was detected.
(m) Adjust input signal to the substitution antenna until an equal or a known related level to that detected from the transmitter was obtained in the test receiver.
(n) Record the power level read from the Average Power Meter and calculate the ERP/EIRP as follows:

**P = P1 - L1 = (P2 + L2) – L1 = P3 + A + L2 - L1**
**EIRP = P + G1 = P3 + L2 - L1 + A + G1**
**ERP = EIRP – 2.15 dB**
Total Correction factor in EMI Receiver # 2 = L2 – L1 + G1

| | | |
|---|---|---|
| Where: | P: | Actual RF Power fed into the substitution antenna port after corrected. |
| | P1: | Power output from the signal generator |
| | P2: | Power measured at attenuator A input |
| | P3: | Power reading on the Average Power Meter |
| | EIRP: | EIRP after correction |
| | ERP: | ERP after correction |

(o) Adjust both transmitting and receiving antenna in a HORIZONTAL polarization, then repeat step (k) to (o)
(p) Repeat step (d) to (o) for different test frequency
(q) Repeat steps (c) to (j) with the substitution antenna oriented in horizontal polarization.
(r) Actual gain of the EUT's antenna is the difference of the measured EIRP and measured RF power at the RF port. Correct the antenna gain if necessary.

**Figure 2**



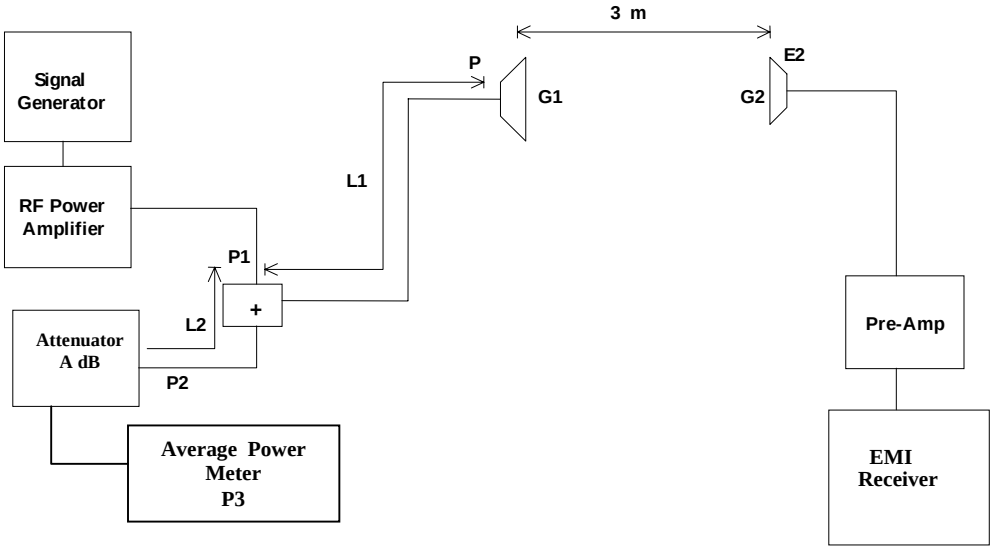


**Figure 3**