# ENGINEERING TEST REPORT

## RF Broadband Amplifier Module
## Model No.: ASY00116
## FCC ID: E675JS0080

*Applicant:*

**Powerwave Technologies Inc.**
*1805 East St. Andrew Place*
*Santa Ana, CA*
*USA, 92705*

***Tested in Accordance With***

**Federal Communications Commission (FCC)**
**47 CFR, Parts 2, 27 and 90 (Subpart I & R)**

**UltraTech's File No.: KTI044_FCC90**

| | |
|---|---|
| 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 10, 2005 |  |
| Report Prepared by: Dharmajit Solanki<br><br>Issued Date: October 10, 2005 | Tested by: Wayne Wu, EMI/RFI Technician<br><br>Test Dates: Sep. 02 – 10, 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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| | | | | | | |
|---|---|---|---|---|---|---|
| FC | VCCI | Canada | NVLAP | BSMI | IT | UL |
| 31040/SIT | C-1376 | 46390-2049 | 200093-0 | SL2-IN-E-1119R | 00-034 | |

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# EXHIBIT 1. INTRODUCTION

## 1.1. SCOPE

| | |
|---|---|
| **Reference:** | FCC Parts 2, 27 and 90 (Subpart I & R) |
| **Title:** | Telecommunication - Code of Federal Regulations, CFR 47, Parts 2, 27 and 90 (Subpart I & R) |
| **Purpose of Test:** | To gain FCC Certification Authorization for Radio Amplifier operating in the frequency 746-944 MHz. |
| **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. |
| **Limited Modular Approval:** | The applicant has requested for limited modular approval and this module will be exclusively used in manufacturer's end products. The end product should comply with FCC Part 15B AC Power line Conducted & Radiated Emission requirement. |

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

None

## 1.3. 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 |
| CISPR 16-1-1 | 2004 | Specification for Radio Disturbance and Immunity measuring apparatus and methods |
| TIA/EIA 603, Edition B | Nov-2002 | Land Mobile FM or PM Communications Equipment Measurement and Performance Standards |

# EXHIBIT 2. PERFORMANCE ASSESSMENT

## 2.1. CLIENT INFORMATION

| APPLICANT | |
|---|---|
| **Name:** | Powerwave Technologies Inc. |
| **Address:** | 1801 East St. Andrew Place<br>Santa Ana, CA<br>USA, 92705 |
| **Contact Person:** | Mr. Robert Biedka<br>Phone #: 714-466-1433<br>Fax #: 714-466-5807<br>Email Address: rbiedka@pwav.com |

| MANUFACTURER | |
|---|---|
| **Name:** | Powerwave Technologies, Canada Ltd. |
| **Address:** | 15 Allstate Parkway, Suite 300,<br>Markham, Ontario<br>Canada, L3R 5B4 |
| **Contact Person:** | Mr. Stan Habinski<br>Phone #: 905-946-3360<br>Fax #: 905-946-3392<br>Email Address: shabinski@pwav.com |

## 2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

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

| | |
|---|---|
| **Brand Name:** | Powerwave Technologies Inc. |
| **Product Name:** | RF Broadband Amplifier Module |
| **Model Name or Number:** | ASY00116 |
| **Type of Equipment:** | Non-broadcast RF Broadband Linear Amplifier |
| **External Power Supply:** | 12 & 28 V DC |
| **Transmitting/Receiving Antenna Type:** | Non-Integral |
| **Application of EUT** | RF Coverage extension in the frequency range of 746-944 MHz |

## 2.3. EUT'S TECHNICAL SPECIFICATIONS

| TRANSMITTER | |
|---|---|
| Equipment Type: | Base station (fixed use) |
| Intended Operating Environment: | Commercial, Light Industry & Heavy Industry |
| Power Supply Requirement: | 12 & 28 VDC |
| RF Input Power Rating: | +3 dBm with Min Gain & Max RF output |
| RF Output Power Rating: | • 1.93 Watts max. (conducted) @ 746 MHz<br>• 1.82 Watts max. (conducted) @ 845 MHz<br>• 1.41 Watts max. (conducted) @ 944 MHz |
| Operating Frequency Range: | • 746-944 MHz |
| RF Output Impedance: | 50 Ohms |
| Channel Spacing: | EXTENDER |
| RF Gain Adjustment Range | +34 to +84 dB |
| 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*: | EXTENDER<br>(The emission designation of the rf output signal is the same as that of the rf input signal from a FCC certified transmitter) |
| Antenna Connector Type: | SMA Jack |
| Antenna Description: | ▪ Outdoor/Top-Roof Antenna: The Antenna Gain Limit is 10 dBI for Cellular Mobile Band 824-849 MHz and 20 dBi for other bands<br>▪ In-building Antenna: ¼ Wavelength (0 dB Gain) for all the frequency bands. |

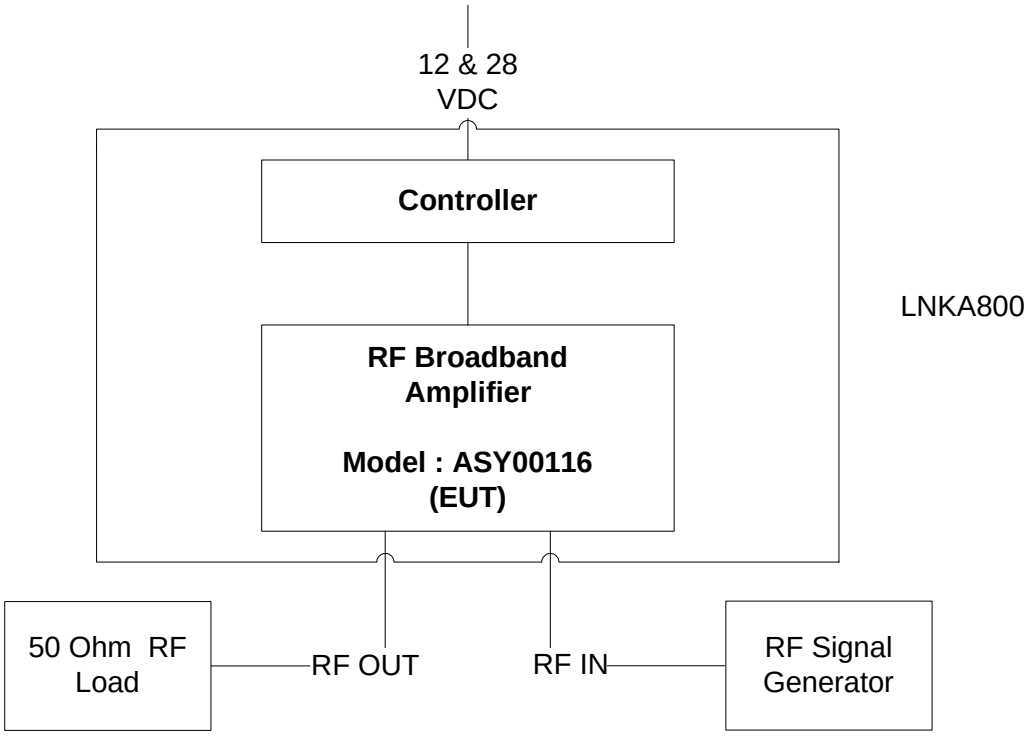
## 2.4. LIST OF EUT'S PORTS

| Port Number | EUT's Port Description | Number of Identical Ports | Connector Type | Cable Type (Shielded/Non-shielded) |
|---|---|---|---|---|
| 1 | Back Plane Control | 1 | Card Edge | Non-shielded |
| 2 | RF In Port (DownLink) | 1 | SMA | Shielded |
| 3 | RF Out Port (uplink) | 1 | SMA | Shielded |

## 2.5. ANCILLARY EQUIPMENT

None

## 2.6. DRAWING OF TEST SETUP



# EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

## 3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

| | |
|---|---|
| Temperature: | 21°C |
| Humidity: | 51% |
| Pressure: | 102 kPa |
| Power input source: | 12 & 28 V DC |

## 3.2. 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:** | LNKA800 was tested using the amplifier module ASY00116. |
| **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):<br><br>▪ 746-944 MHz | Near lowest, near middle & near highest frequencies in each frequency bands that the transmitter covers:<br><br>▪ 746, 845 & 944 MHz |
| Transmitter Wanted Output Test Signals:<br><br>RF Power Output (measured maximum output power):<br><br>Normal Test Modulation:<br><br>Modulating signal source: | <br><br>Maximum RF Output Power wrt. maximum RF input of +3 dBm. = +33 dBm<br><br>F3E, F1D, F1E & F2D<br><br>External |

# EXHIBIT 4. SUMMARY OF TEST RESULTS

## 4.1. 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 Powerline Conducted Emissions were performed in Ultratech's shielded room, 16'(L) by 12'(W) by 12'(H).

- Radiated Emissions were performed at the Ultratech's 3-10 TDK Semi-Anechoic Chamber situated in the Town of Oakville, province of Ontario. This test site has 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 3-10 TDK Semi-Anechoic Chamber has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada File No.: IC2049-1). Last Date of Site Calibration: June 20, 2005.

## 4.2. APPLICABILITY & SUMMARY OF EMISSION TEST RESULTS @ FCC PART 2, 27 & 90 (SUBPART I & R)

| FCC PARAGRAPH. | TEST REQUIREMENTS | APPLICABILITY (YES/NO) |
|---|---|---|
| **27.50(b), 90.541, 90.635 & 2.1046** | RF Power Output & Intermodulation | Yes |
| **1.1307, 1.1310, 2.1091, 2.1093, 27.52** | RF Exposure Limit | Yes |
| **27.54, 90.213 & 2.1055** | Frequency Stability | N/A for Amplifier |
| **90.242(b)(8) & 2.1047(a)** | Audio Frequency Response | Not applicable for an Amplifier |
| **90.210 & 2.1047(b)** | Modulation Limiting | Not applicable for an Amplifier |
| **90.210 & 2.1049** | Occupied Bandwidth | Yes |
| **27.53(c)&(d), 90.210, 90.543(c), 2.1057 & 2.1051** | Emission Limits - Spurious Emissions at Antenna Terminal | Yes |
| **27.53(c)&(d), 90.210, 90.543(c), 2.1057 & 2.1053** | Emission Limits - Field Strength of Spurious Emissions | Yes |

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

None

## 4.4. DEVIATION OF STANDARD TEST PROCEDURES

None

# EXHIBIT 5. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

## 5.1. TEST PROCEDURES

This section contains test results only. Details of test methods and procedures can be found in Exhibit 8 of this report

## 5.2. 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.

## 5.3. MEASUREMENT EQUIPMENT USED:

The measurement equipment used complied with the requirements of the Standards referenced in the Methods & Procedures ANSI C63.4:2003 and CISPR 16-1-1.

## 5.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUFACTURER:

The essential function of the EUT is to correctly communicate data to and from radios over RF link.

# 5.5. RF POWER OUTPUT & INTERMODULATION @ FCC 2.1046, 27.50(B), 90.541 & 90.635

## 5.5.1. Limits

**FCC 90.635:-** The effective radiated power (ERP) and antenna height for base station transmitters must not exceed the limits in this section as per below:

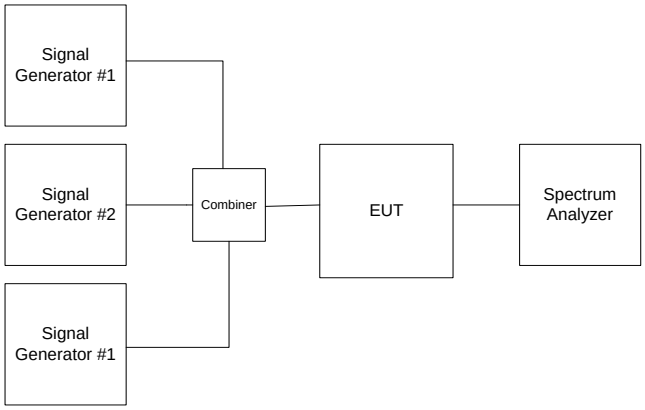
| Base Station Transmitters | Maximum ERP (Watts) |
|---|---|
| Operating frequency range:<br>(764-776, 794-806, 806-824, 851-869, 896-901, 935-940MHz) | 500 Watts and 152 meters (AAT) in Suburban Area<br><br>1 Kilowatts and 304 meters (304) in Urban Area |

**FCC 90.205**:- Please refer to FCC CFR 47, Part 90, Subpart I, Para. 90.205 for specification details.

## 5.5.2. Method of Measurements

Refer to Exhibit 8, § 8.1 (Conducted) of this report for measurement details

## 5.5.3. Test Arrangement



## 5.5.4. Test Data

### *5.5.4.1. RF Conducted Output Power*

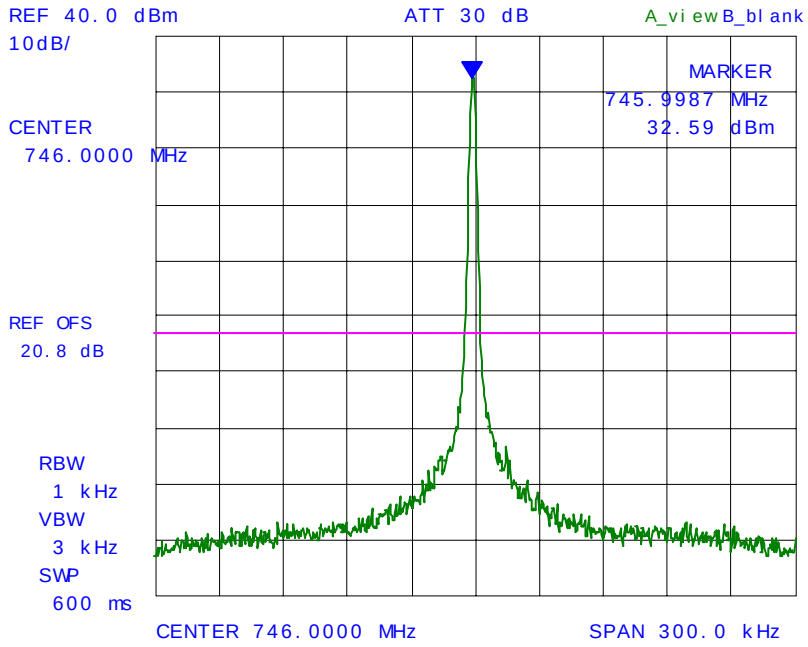
| Test Frequency (MHz) | Total RF Output Power at Antenna Port (dBm) | Total RF Output Power at Antenna Port (Watts) |
|---|---|---|
| 746.0 | 32.9 | 1.93 |
| 845.0 | 32.6 | 1.82 |
| 944.0 | 31.5 | 1.41 |

### *5.5.4.2. Inter-modulation Measurements*

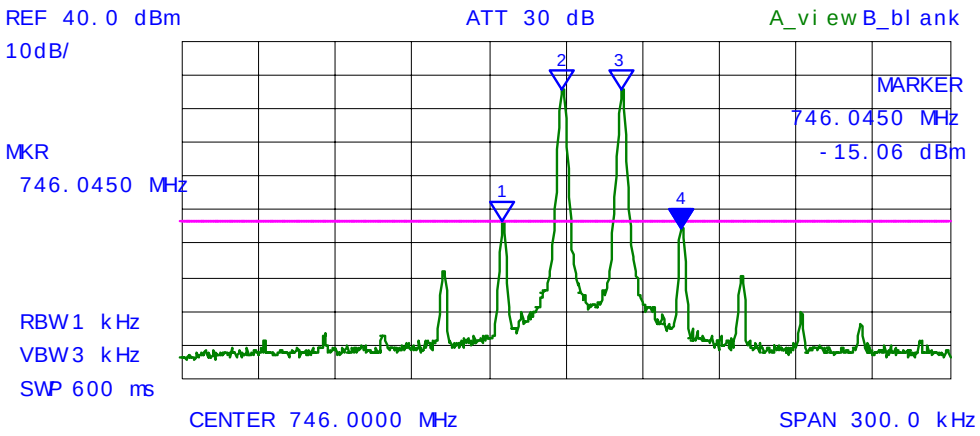
| Frequency (MHz) | Number of In/Out Channels | Modulation | Maximum RF Input (conducted) (dBm) | Maximum RF Output (conducted) (dBm) | Manufacturer's Maximum RF Output Rating (conducted) (dBm) |
|---|---|---|---|---|---|
| 746.0 | 1 | unmodulated | -1.0 | 32.6 | 33 |
| 746.0, 746.025 | 2 | unmodulated | -8.0 | 25.7 | 33 |
| 746.0, 746.025, 746.050 | 3 | unmodulated | -10.3, -10.4 & -10.5 | 23.2 | 33 |
| 845.0 | 1 | unmodulated | -1.0 | 32.8 | 33 |
| 845.0, 845.025, | 2 | unmodulated | -7.6 & -8.1 | 26.2 | 33 |
| 845.0, 845.025, 845.050 | 3 | unmodulated | -10.3, -10.4 & -10.5 | 23.8 | 33 |
| 944.0 | 1 | unmodulated | -1.0 | 30.5 | 33 |
| 944.0 943.975, | 2 | unmodulated | -5.6 & -6.1 | 26.1 | 33 |
| 944.0, 943.975, 943.950 | 3 | unmodulated | -7.8, -8.3 & -8.5 | 23.5 | 33 |

**Please Refer to Plots # 1-9 for Intermodulation in the frequency range 746-945 MHz.**

## PLOT#: 1 Intermodulation with 1 RF signal input/output
## Fc: 746 MHz, RF Input: -1.0 dBm



## PLOT#: 2 Intermodulation with 2 RF signal inputs/outputs
## Fc: 746 MHz & Fc + 25.0 kHz, RF Input: (1) –8.0 dBm, (2) –8.0 dBm



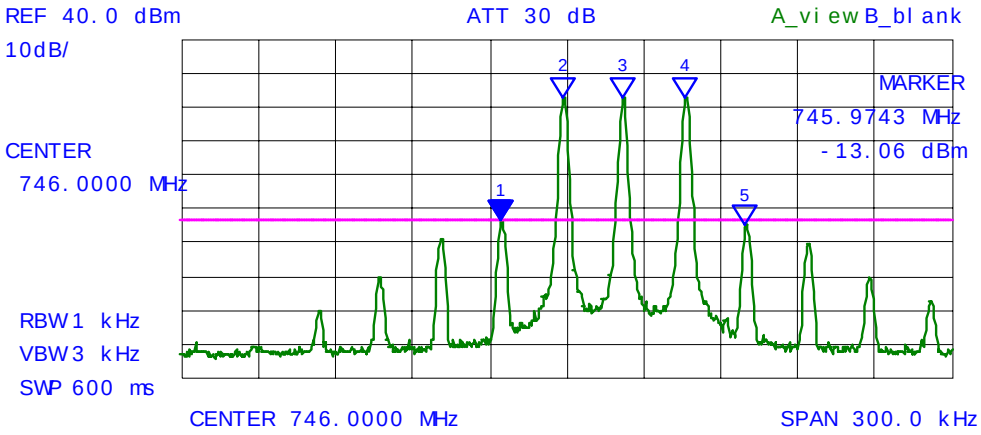

*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No. 1: | 745.9751 MHz | -13.13 dBm | A |
| No. 2: | 745.9983 MHz | 25.72 dBm | A |
| No. 3: | 746.0214 MHz | 25.72 dBm | A |
| No. 4: | 746.0450 MHz | -15.06 dBm | A |
| No. 5: | | | |
| No. 6: | | | |
| No. 7: | | | |
| No. 8: | | | |



- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

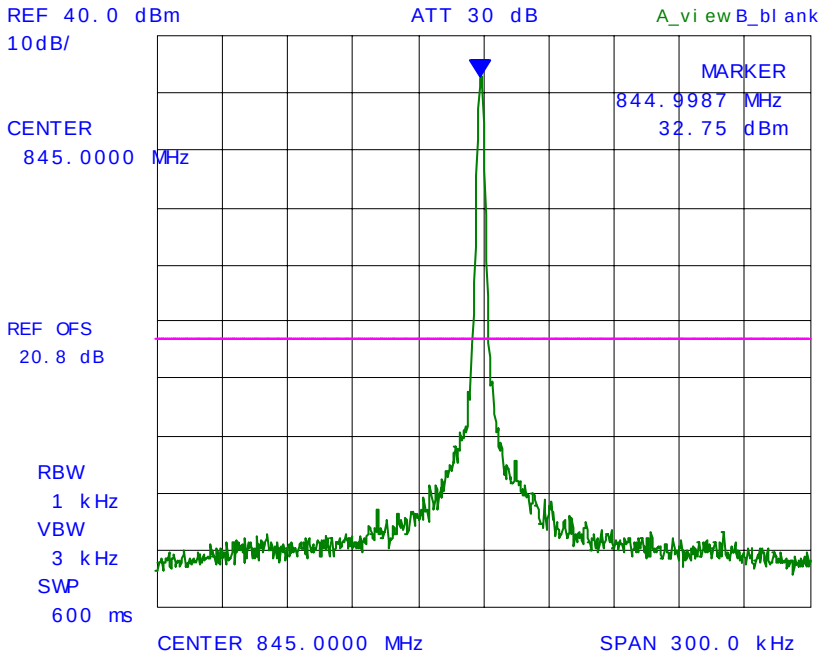
## PLOT #: 3 Intermodulation with 3 RF signal inputs/outputs
## Fc: 746 MHz, Fc + 25.0 kHz & Fc + 50 kHz
## RF Input: (1) –10.3 dBm, (2) –10.4 dBm, (3) –10.5 dBm




*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No. 1: | 745.9743 MHz | -13.06 dBm | A |
| No. 2: | 745.9987 MHz | 23.16 dBm | A |
| No. 3: | 746.0219 MHz | 23.00 dBm | A |
| No. 4: | 746.0463 MHz | 23.09 dBm | A |
| No. 5: | 746.0694 MHz | -14.81 dBm | A |
| No. 6: | | | |
| No. 7: | | | |
| No. 8: | | | |
| : | | | |

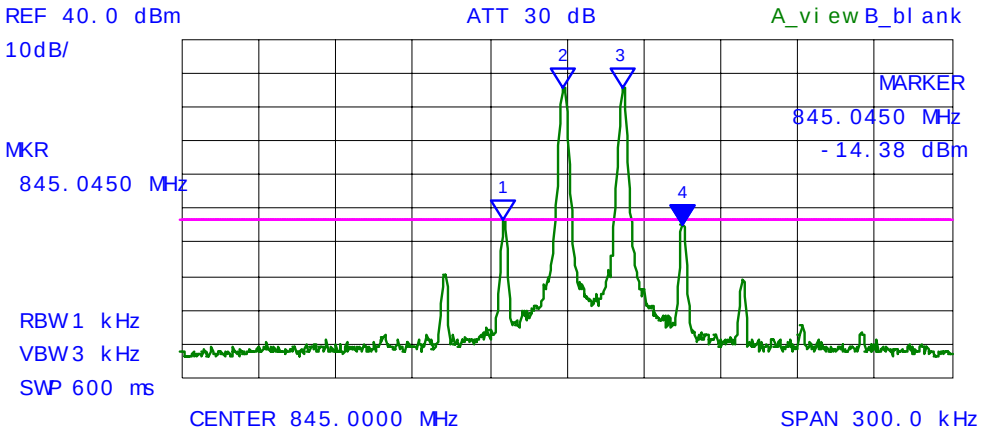
## PLOT #: 4 Intermodulation with 1 RF signal input/output
## Fc: 845 MHz, RF Input: -1.0 dBm






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

## PLOT #: 5 Intermodulation with 2 RF signal inputs/outputs
## Fc: 845 MHz & Fc + 25.0 kHz
## RF Input: (1) –7.6 dBm, (2) –8.1 dBm



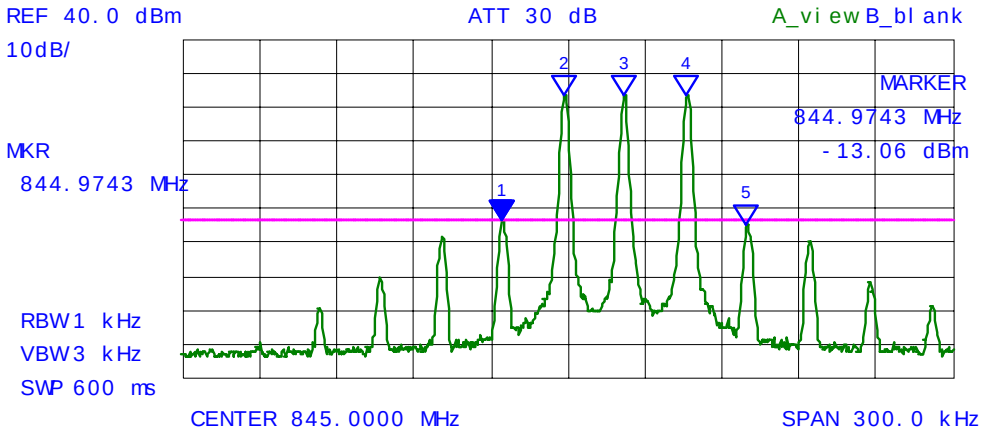

*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No. 1: | 844.9751 MHz | -13.00 dBm | A |
| No. 2: | 844.9987 MHz | 26.13 dBm | A |
| No. 3: | 845.0214 MHz | 26.22 dBm | A |
| No. 4: | 845.0450 MHz | -14.38 dBm | A |
| No. 5: | | | |
| No. 6: | | | |
| No. 7: | | | |
| No. 8: | | | |
| : | | | |



- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

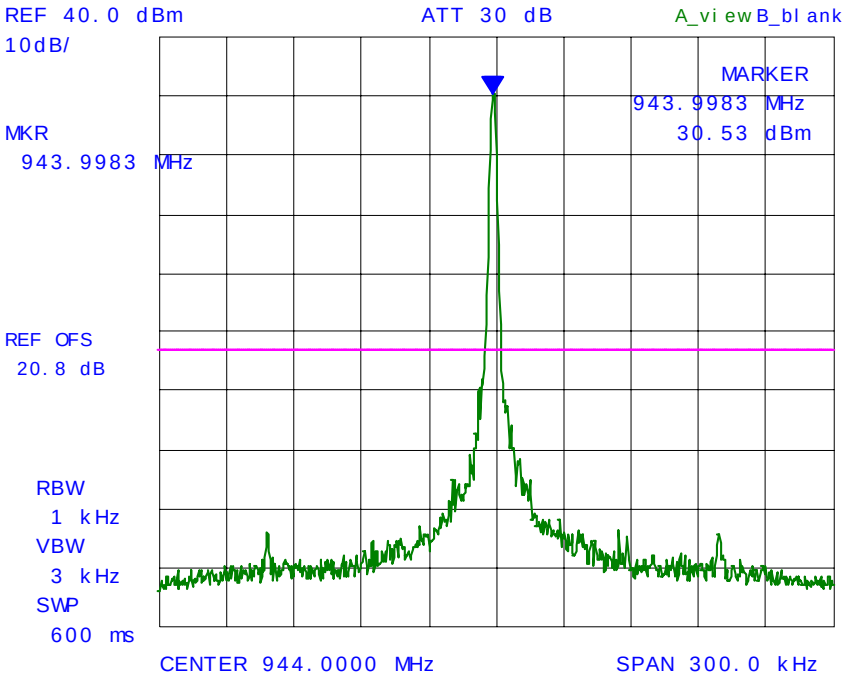
## PLOT #: 6 Intermodulation with 3 RF signal inputs/outputs
## Fc: 845.0 MHz, Fc + 25.0 kHz & Fc + 50 kHz
## RF Input: (1) –9.7 dBm, (2) –10.4 dBm, (3) –10.2 dBm




*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No. 1: | 844.9743 MHz | -13.06 dBm | A |
| No. 2: | 844.9987 MHz | 23.75 dBm | A |
| No. 3: | 845.0219 MHz | 23.59 dBm | A |
| No. 4: | 845.0463 MHz | 23.59 dBm | A |
| No. 5: | 845.0694 MHz | -14.41 dBm | A |
| No. 6: | | | |
| No. 7: | | | |
| No. 8: | | | |
| : | | | |

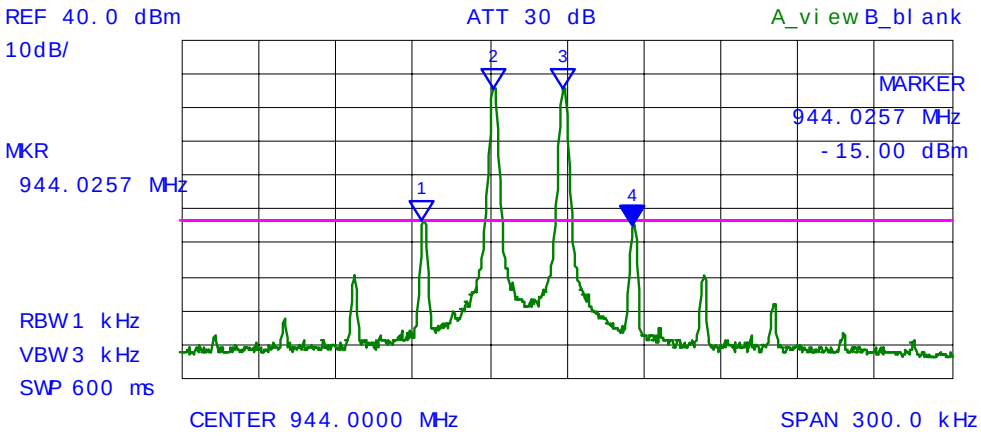
## PLOT #: 7 Intermodulation with 1 RF signal input/output
## Fc: 944 MHz, RF Input: -1.0 dBm






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

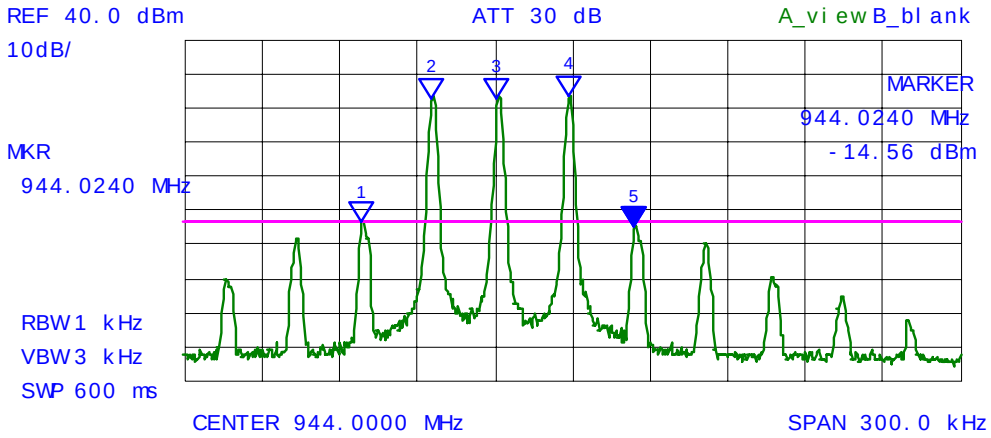
## PLOT #: 8 Intermodulation with 2 RF signal inputs/outputs
## Fc: 944 MHz & Fc – 25.0 kHz
## RF Input: (1) –5.6 dBm, (2) –6.1 dBm




*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No. 1: | 943.9439 MHz | -13.00 dBm | A |
| No. 2: | 943.9713 MHz | 26.00 dBm | A |
| No. 3: | 943.9987 MHz | 26.13 dBm | A |
| No. 4: | 944.0257 MHz | -15.00 dBm | A |
| No. 5: | | | |
| No. 6: | | | |
| No. 7: | | | |
| No. 8: | | | |
| : | | | |

## PLOT #: 9 Intermodulation with 3 RF signal inputs/outputs
## Fc: 944 MHz, Fc - 25.0 kHz & Fc – 50.0 kHz
## RF Input: (1) –7.8 dBm, (2) –8.3 dBm, (3) –8.5 dBm




*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No. 1: | 943.9186 MHz | -13.03 dBm | A |
| No. 2: | 943.9456 MHz | 23.44 dBm | A |
| No. 3: | 943.9709 MHz | 23.41 dBm | A |
| No. 4: | 943.9987 MHz | 23.53 dBm | A |
| No. 5: | 944.0240 MHz | -14.56 dBm | A |
| No. 6: | | | |
| No. 7: | | | |
| No. 8: | | | |
| : | | | |

# 5.6. RF EXPOSURE REQUIREMENTS @ 1.1310 & 2.1091

## 5.6.1. 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).

**LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)**

| Frequency Range (MHz) | Electric Field Strength (V/m) | Magnetic Field Strength (A/m) | Power Density ($mW/cm^2$) | Average Time (minutes) |
|---|---|---|---|---|
| **(A) Limits for Occupational/Control Exposures** | | | | |
| 300-1500 | ... | ... | F/300 | 6 |
| **(B) Limits for General Population/Uncontrolled Exposure** | | | | |
| 300-1500 | ... | ... | F/1500 | 6 |

F = Frequency in MHz

## 5.6.2. 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

FCC radio frequency exposure limits may be exceeded at distances closer than r cm from the antenna of this device

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

FCC radio frequency exposure limits may not be exceeded at distances closer than r cm from the antenna of this device

- 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., an 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)

## 5.6.3. Test Data

### *5.6.3.1. Indoor Antenna - For all Frequency Bands*

**Antenna Gain Limit specified by Manufactuer: 0 dBi (In-building Antenna)**

| Minimum Frequency (MHz) | Maximum EIRP (Watts) | Calculated RF Safety Distance r (cm) | Manufacturer' Specified Separation Distance (cm) | Compliance |
|---|---|---|---|---|
| 746 - 944 | 2.0 | 17.84 | 20.00 | Complies |

**Note:** **RF EXPOSURE DISTANCE LIMITS: $r = (PG/4\Pi S)^{1/2} = (EIRP/4\Pi S)^{1/2}$**
**$S = F/1500 = \text{lowest-f}/1500 = 746/1500\ mW/cm^2 = 0.5\ mW/cm^2$**

### *5.6.3.2. Outdoor Antenna - Cellular Mobile Band (824-849 MHz)*

**Antenna Gain Limit specified by Manufactuer: 10 dBi (Roof Top Antenna)**

| Minimum Frequency (MHz) | Measured RF Conducted (Watts) | Maximum Declared EIRP (Watts) | Calculated RF Safety Distance r (cm) | Manufacturer' Specified Separation Distance (cm) | Compliance |
|---|---|---|---|---|---|
| 824 | -- | 7.0 | 31.8 | 1000 | Complies |

**Note:** **RF EXPOSURE DISTANCE LIMITS: $r = (PG/4\Pi S)^{1/2} = (EIRP/4\Pi S)^{1/2}$**
**$S = F/1500 = \text{lowest-f}/1500 = 824/1500\ mW/cm^2 = 0.55\ mW/cm^2$**

The Declared Power is as mentioned in the user manual page no. 3-1.

### *5.6.3.3. Outdoor Antenna - For all other Frequency Bands except Cellular Mobile Band (824-849 MHz)*

**Antenna Gain Limit specified by Manufactuer: 20 dBi (Roof Top Antenna)**

| Minimum Frequency (MHz) | Measured RF Conducted (Watts) | Maximum Declared EIRP (Watts) | Calculated RF Safety Distance r (cm) | Manufacturer' Specified Separation Distance (cm) | Compliance |
|---|---|---|---|---|---|
| 746 - 944 | -- | 20.0 | 56.4 | 1000 | Complies |

**Note:** **RF EXPOSURE DISTANCE LIMITS: $r = (PG/4\Pi S)^{1/2} = (EIRP/4\Pi S)^{1/2}$**
**$S = F/1500 = \text{lowest-f}/1500 = 746/1500\ mW/cm^2 = 0.5\ mW/cm^2$**

| Evaluation of RF Exposure Compliance Requirements | |
|---|---|
| **RF Exposure Requirements** | **Compliance with FCC Rules** |
| Minimum separation distance between antenna and persons, specified by the manufacturer, for<br><br>• In-Building Antenna:<br>• Top-Roof Antenna | <br><br>• 20 cm<br>• 10 Meters<br><br>Please refer to page # 3-1 of the Users/ Manual and FCC RF Exposure folder |

# 5.7. 99% OBW, 20 DB BW @ FCC 2.1049 & 90.210

## 5.7.1. Limits

**FCC 90.208 & 90.210:** Emissions shall be attenuated below the mean output power of the transmitter as follows:

| FREQUENCY RANGE (MHz) | Maximum Authorized BW (KHz) | CHANNEL SPACING (KHz) | Recommended Max. FREQ. DEVIATION (KHz) | FCC APPLICABLE MASK @ FCC 90.210 |
|---|---|---|---|---|
| 806-821/ 851-866 | 20 | 25 | 5 | MASK B (Voice) & MASK G (Data) |
| 821-824/866-869 | 20 | 12.5 | 5 | MASK B (Voice) & MASK H (Data) |
| 896-902/935-940 | 13.6 | 12.5 | 2.5 | MASK I (Voice) & MASK J (Data) |
| 902-928 | Note 1 | .. | .. | Mask K (Voice & Data) |
| 929-930 | 20 | 25 | 5 | MASK B (Voice) & MASK G (Data) |

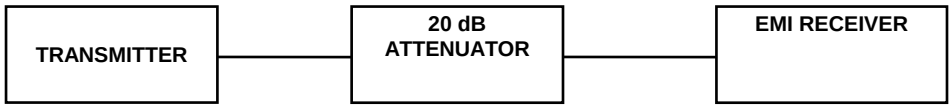
## 5.7.2. Method of Measurements

Refer to Exhibit 8, § 8.4 of this report for measurement details

## 5.7.3. Test Equipment List

| Test Instruments | Manufacturer | Model No. | Serial No. | Frequency Range |
|---|---|---|---|---|
| EMI Receiver/ EMI Receiver | Hewlett Packard | HP 8593EM | 3412A00103 | 9 kHz – 26.5 GHz |
| Attenuator(s) | Bird | .. | … | DC – 22 GHz |
| Audio Oscillator | Hewlett Packard | HP 204C | 0989A08798 | DC to 1.2 MHz |

## 5.7.4. Test Arrangement

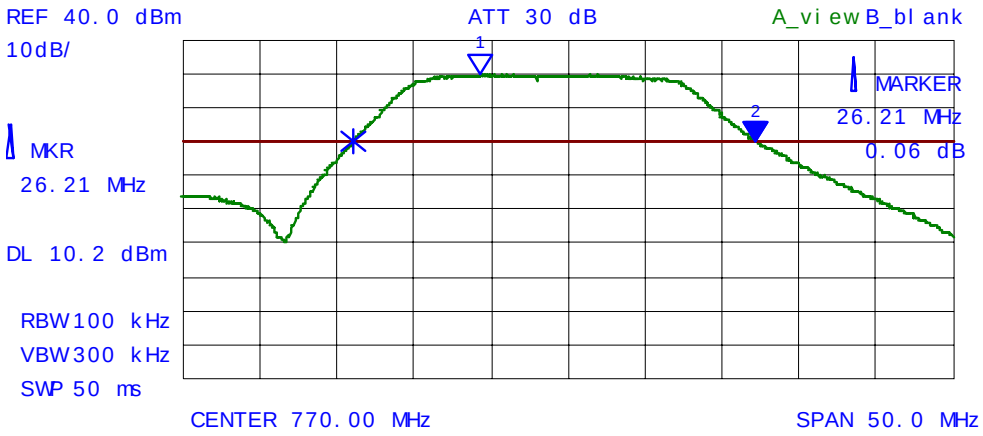


## 5.7.5. Test Data

### *5.7.5.1. 20 dB Bandwidth and Gain of the Amplifier*

- Refer to Plots # 10 to 15 for detailed measurement of 20 dB and maximum/minimum gain of the Amplifier for frequency range 770 - 938.

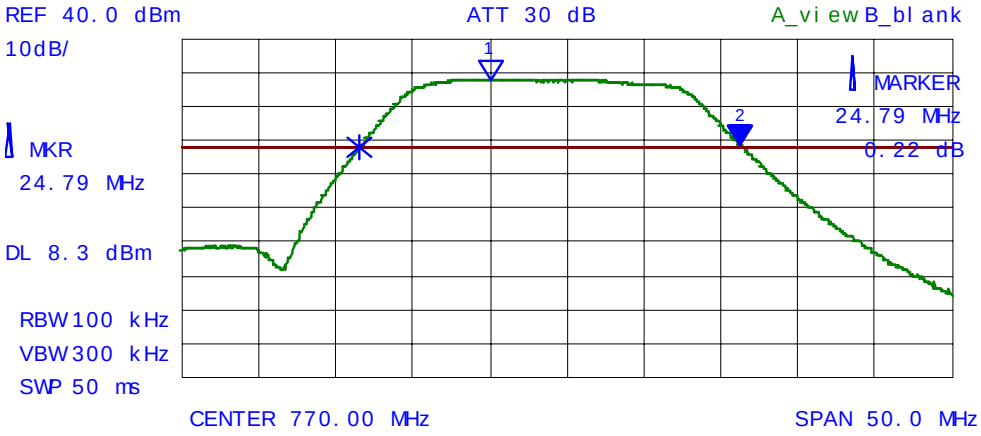
## PLOT # 10 20 dB Bandwidth and Gain of the Amplifier @ 770 MHz
## RF Input: -1.0dBm, Gain Setting: 34.0 dB




*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No. 1: | 8.36 MHz | 20.16 dB | A |
| No. 2: | 26.21 MHz | 0.06 dB | A |
| No. 3: | | | |
| No. 4: | | | |
| No. 5: | | | |
| No. 6: | | | |
| No. 7: | | | |
| No. 8: | | | |
| : | 756.00 MHz | 10.06 dBm | A |

## PLOT # 11 20 dB Bandwidth and Gain of the Amplifier @ 770 MHz
## RF Input: -51.0dBm, Gain Setting: 84.0 dB



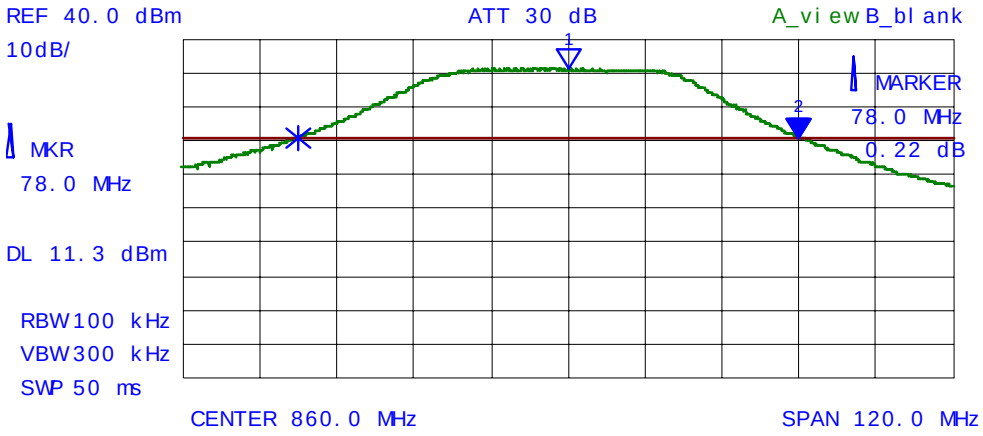

*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No. 1: | 8.50 MHz | 20.03 dB | A |
| No. 2: | 24.79 MHz | 0.22 dB | A |
| No. 3: | | | |
| No. 4: | | | |
| No. 5: | | | |
| No. 6: | | | |
| No. 7: | | | |
| No. 8: | | | |
| 1: | 756.50 MHz | 8.31 dBm | A |



- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

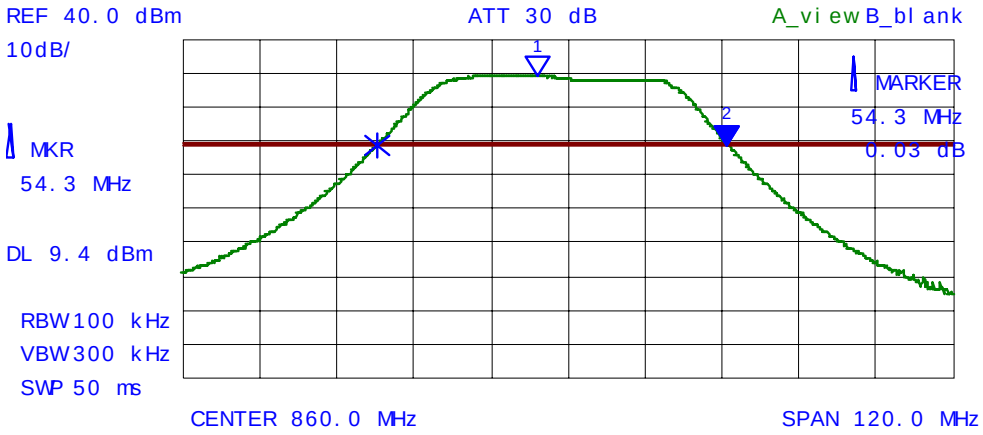
## PLOT # 12 20 dB Bandwidth and Gain of the Amplifier @ 860 MHz
## RF Input: -1.0dBm, Gain Setting: 34.0 dB




*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No. 1: | 42.2 MHz | 20.00 dB | A |
| No. 2: | 78.0 MHz | 0.22 dB | A |
| No. 3: | | | |
| No. 4: | | | |
| No. 5: | | | |
| No. 6: | | | |
| No. 7: | | | |
| No. 8: | | | |
| : | 818.0 MHz | 11.25 dBm | A |

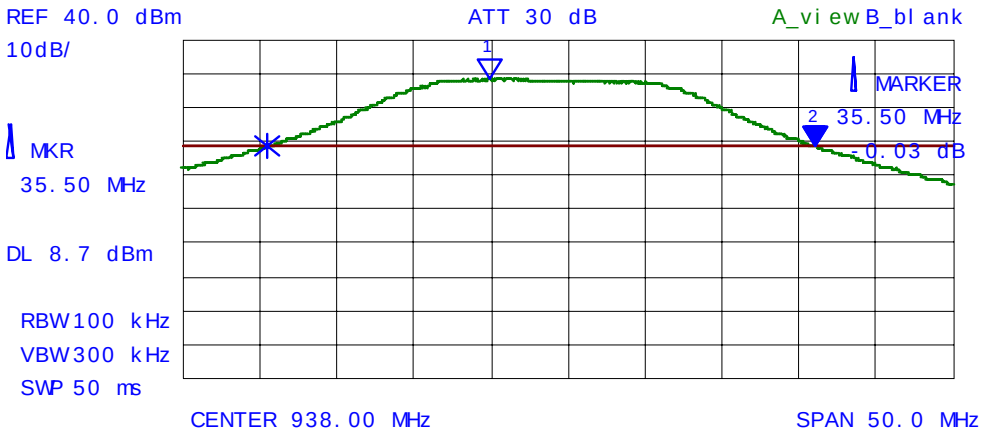
## PLOT # 13 20 dB Bandwidth and Gain of the Amplifier @ 770 MHz
## RF Input: -51.0dBm, Gain Setting: 84.0 dB




*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No. 1: | 25.0 MHz | 20.00 dB | A |
| No. 2: | 54.3 MHz | 0.03 dB | A |
| No. 3: | | | |
| No. 4: | | | |
| No. 5: | | | |
| No. 6: | | | |
| No. 7: | | | |
| No. 8: | | | |
| Δ: | 830.3 MHz | 9.38 dBm | A |

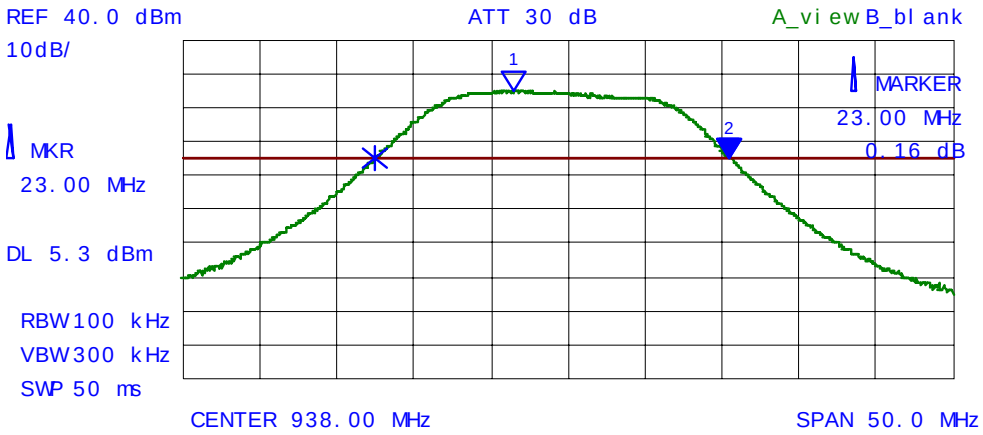
## PLOT # 14 20 dB Bandwidth and Gain of the Amplifier @ 938 MHz
## RF Input: -1.0dBm, Gain Setting: 34.0 dB




*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No. 1: | 14.36 MHz | 19.91 dB | A |
| No. 2: | 35.50 MHz | -0.03 dB | A |
| No. 3: | | | |
| No. 4: | | | |
| No. 5: | | | |
| No. 6: | | | |
| No. 7: | | | |
| No. 8: | | | |
| Δ: | 918.50 MHz | 8.81 dBm | A |

## PLOT # 15 20 dB Bandwidth and Gain of the Amplifier @ 938 MHz
## RF Input: -51.0dBm, Gain Setting: 84.0 dB




*** Multi Marker List ***

| | | | |
|---|---|---|---|
| No. 1: | 9.00 MHz | 20.09 dB | A |
| No. 2: | 23.00 MHz | 0.16 dB | A |
| No. 3: | | | |
| No. 4: | | | |
| No. 5: | | | |
| No. 6: | | | |
| No. 7: | | | |
| No. 8: | | | |
| Δ: | 925.50 MHz | 5.22 dBm | A |

### *5.7.5.2. 99% Occupied Bandwidth Measurements*

**Remark**: 98% OBW of the RF input and RF output signals were measured for comparison

#### *5.7.5.2.1. Frequency: 746 MHz*

| EUT's Subband (MHz) | Channel Spacing (kHz) | Modulation | RF IN Measured 99% OBW (kHz) | RF OUT Measured 99% OBW (kHz) |
|---|---|---|---|---|
| 746 | 12.5 | FM with 2.5 kHz Sine wave signal | 10.1 | 10.1 |
| 746 | 25.0 | FM with 2.5 kHz Sine wave signal | 15.0 | 15.0 |
| 746 | 12.5 | FM with an External 9600 b/s random data source | 10.2 | 10.2 |
| 746 | 25.0 | FM with an External 9600 b/s random data source | 16.0 | 16.1 |

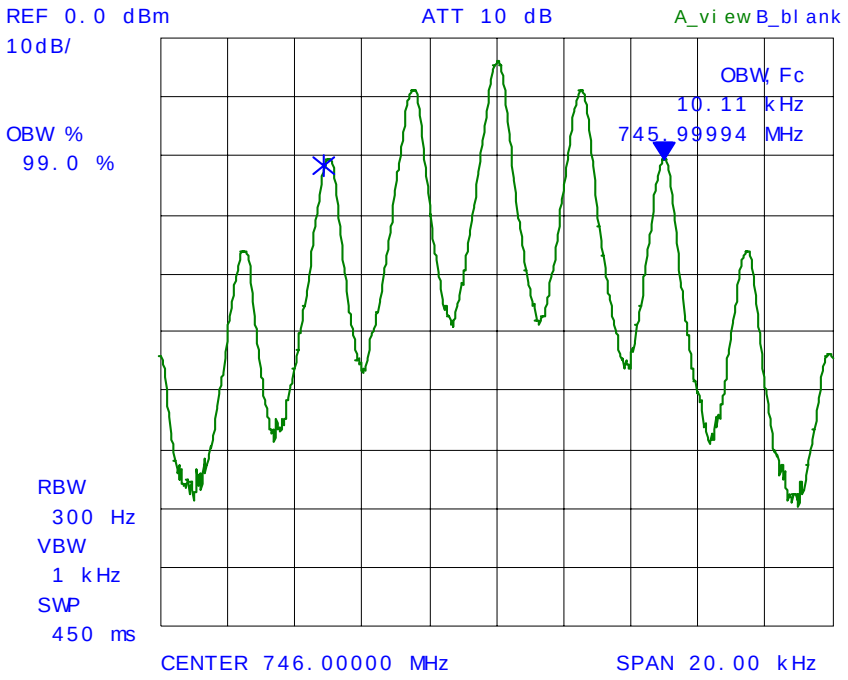
#### *5.7.5.2.2. Frequency: 845 MHz*

| EUT's Subband (MHz) | Channel Spacing (kHz) | Modulation | RF IN Measured 99% OBW (kHz) | RF OUT Measured 99% OBW (kHz) |
|---|---|---|---|---|
| 845 | 12.5 | FM with 2.5 kHz Sine wave signal | 10.1 | 10.0 |
| 845 | 25.0 | FM with 2.5 kHz Sine wave signal | 15.3 | 15.3 |
| 845 | 12.5 | FM with an External 9600 b/s random data source | 10.0 | 10.1 |
| 845 | 25.0 | FM with an External 9600 b/s random data source | 16.2 | 16.2 |

#### *5.7.5.2.3. Frequency: 944 MHz*

| EUT's Subband (MHz) | Channel Spacing (kHz) | Modulation | RF IN Measured 99% OBW (kHz) | RF OUT Measured 99% OBW (kHz) |
|---|---|---|---|---|
| 944 | 12.5 | FM with 2.5 kHz Sine wave signal | 10.1 | 10.1 |
| 944 | 25.0 | FM with 2.5 kHz Sine wave signal | 15.0 | 15.0 |
| 944 | 12.5 | FM with an External 9600 b/s random data source | 10.1 | 10.1 |
| 44 | 25.0 | FM with an External 9600 b/s random data source | 16.0 | 16.0 |

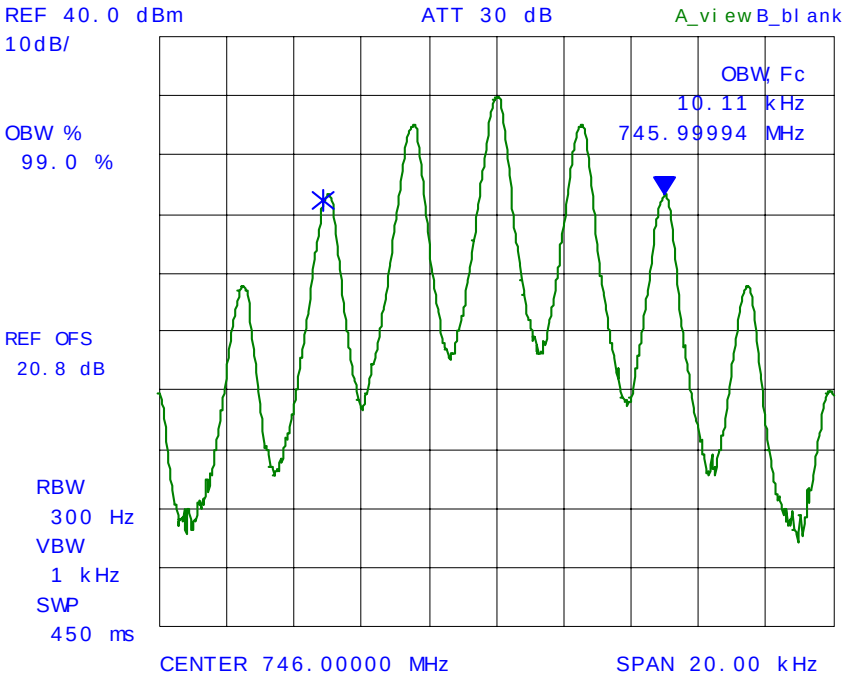
## PLOT # 16 99% Occupied Bandwidth – RF Input Signal
## Frequency: 746.0 MHz, 12.5 kHz Channel Spacing
## Modulation: FM modulation with 2.5 kHz Sine wave signal






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

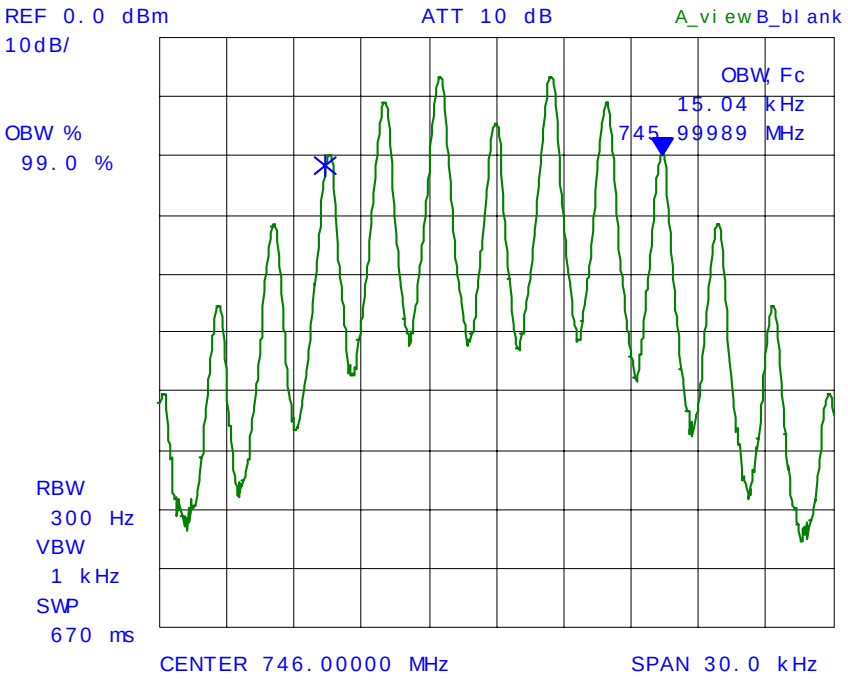
## PLOT # 17 99% Occupied Bandwidth – RF Output Signal
## Frequency: 746.0 MHz, 12.5 kHz Channel Spacing
## Modulation: FM modulation with 2.5 kHz Sine wave signal






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

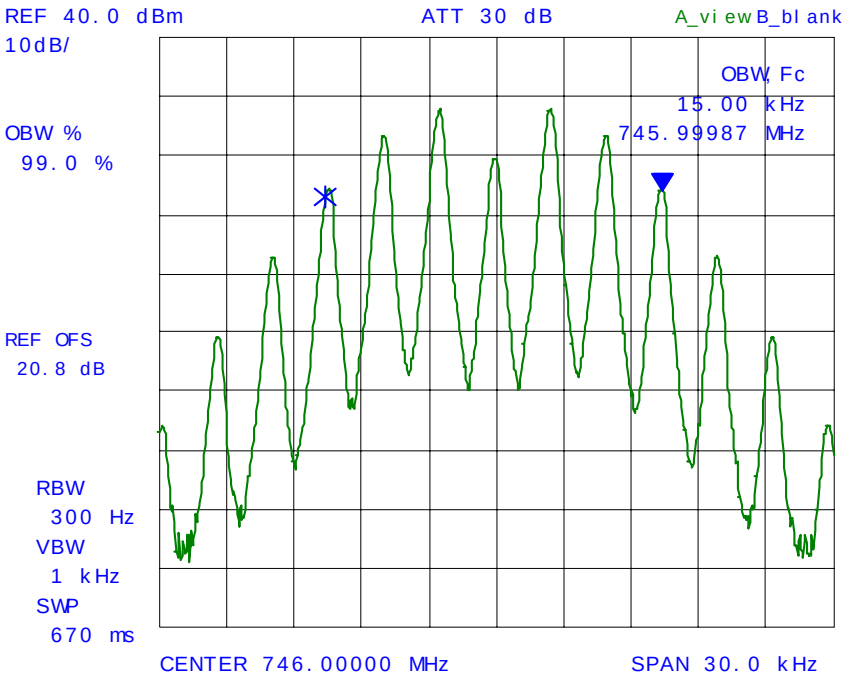
## PLOT # 18 99% Occupied Bandwidth – RF Input Signal
## Frequency: 746.0 MHz, 25 kHz Channel Spacing
## Modulation: FM modulation with 5 kHz Sine wave signal






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

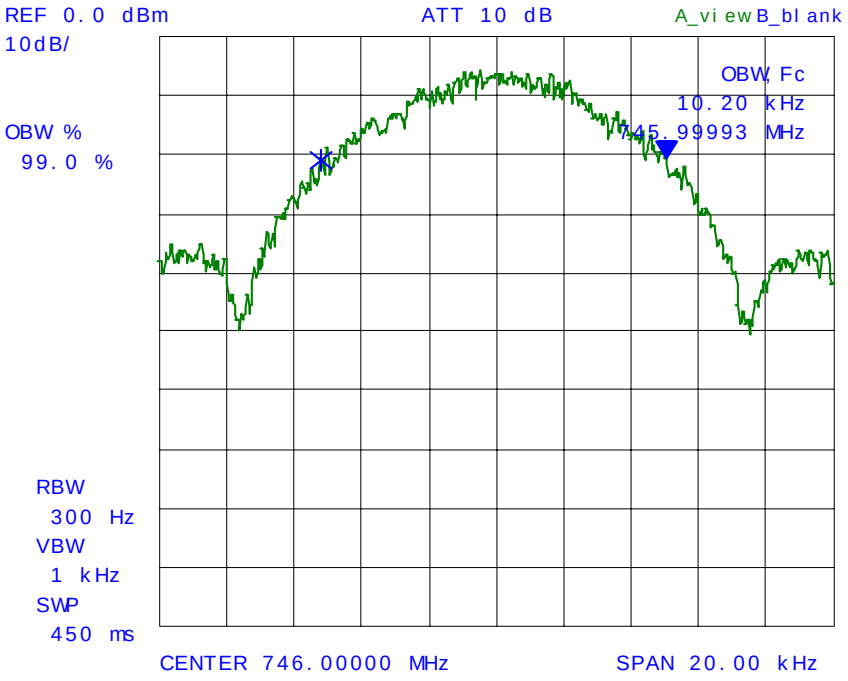
## PLOT # 19 99% Occupied Bandwidth – RF Output Signal
## Frequency: 746.0 MHz, 25 kHz Channel Spacing
## Modulation: FM modulation with 5 kHz Sine wave signal






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

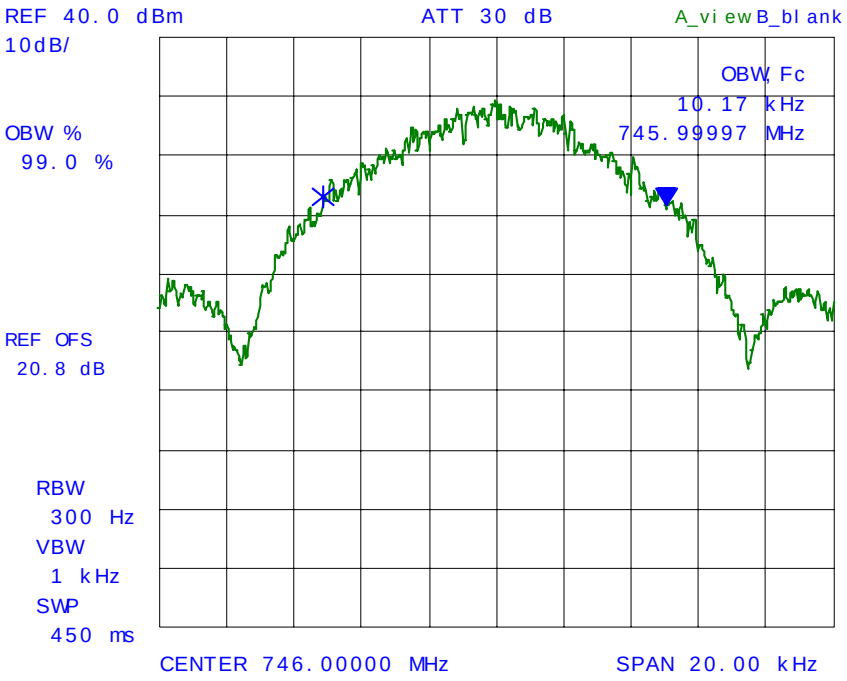
## PLOT # 20 99% Occupied Bandwidth – RF Input Signal
## Frequency: 746.0 MHz, 12.5 kHz Channel Spacing
## Modulation: FM Modulation with an external 9600 b/s random data source






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

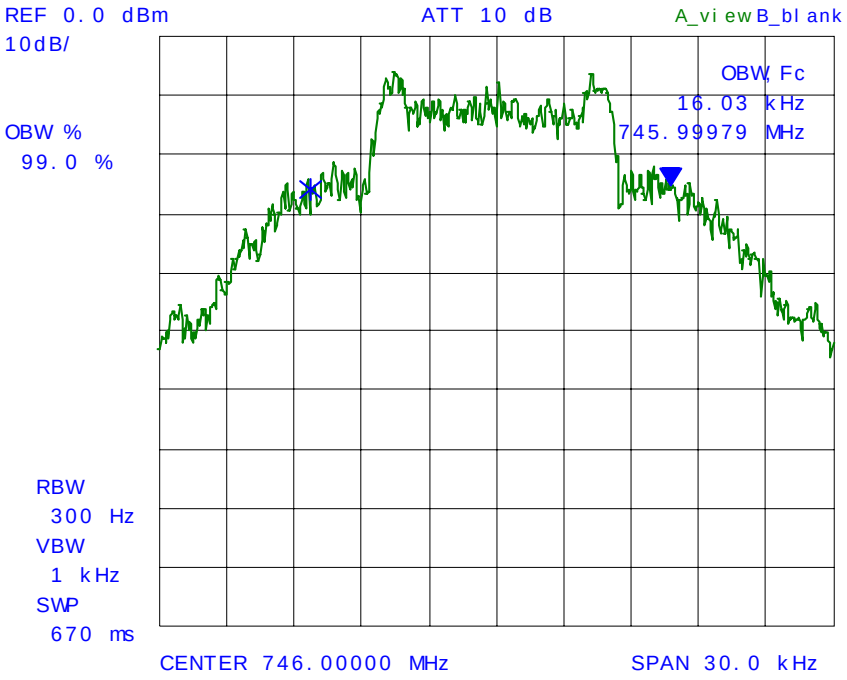
## PLOT # 21 99% Occupied Bandwidth – RF Output Signal
## Frequency: 746.0 MHz, 12.5 kHz Channel Spacing
## Modulation: FM Modulation with an external 9600 b/s random data source






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

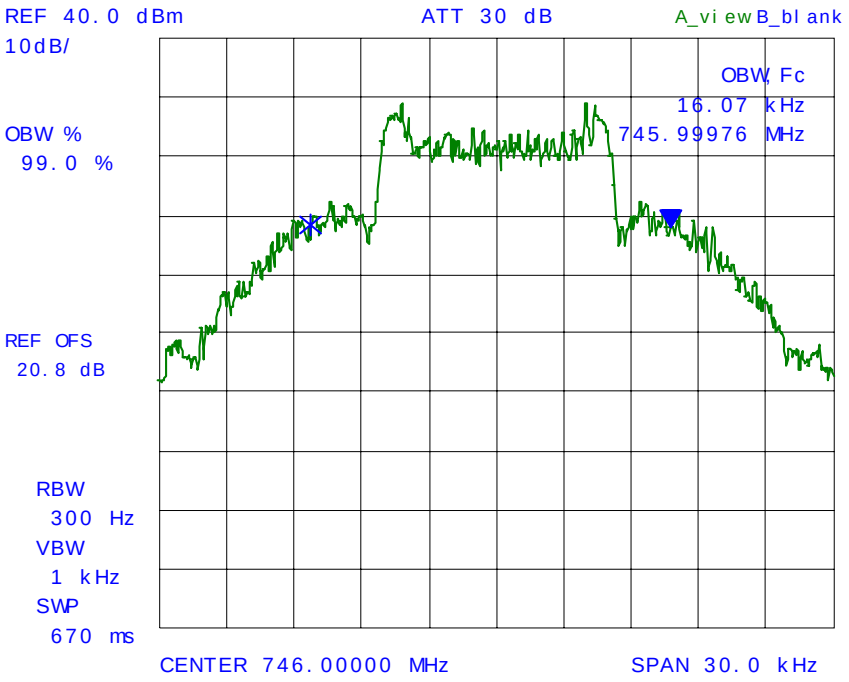
## PLOT # 22 99% Occupied Bandwidth – RF Input Signal
## Frequency: 746.0 MHz, 25 kHz Channel Spacing
## Modulation: FM Modulation with an external 9600 b/s random data source






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

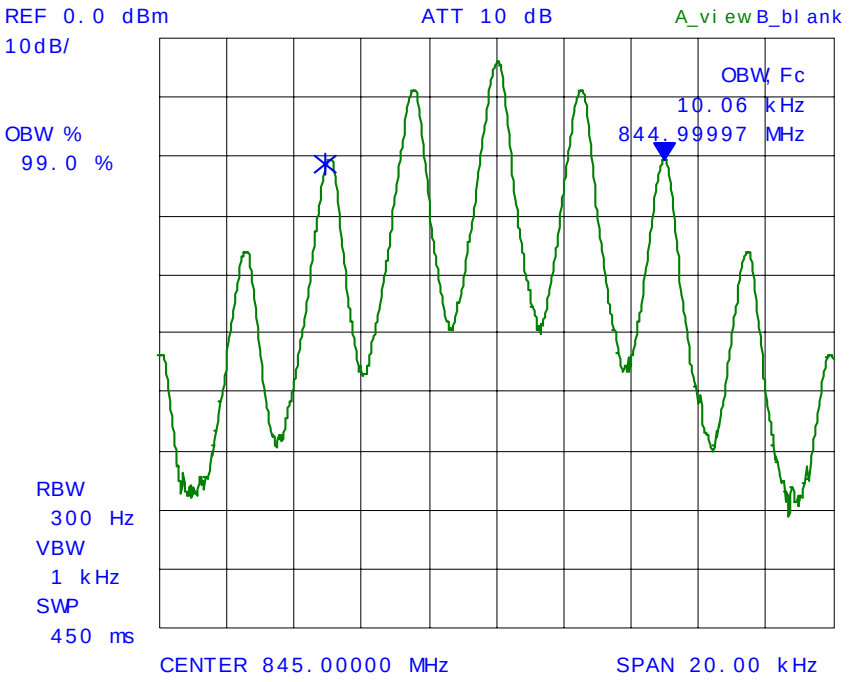
## PLOT # 23 99% Occupied Bandwidth – RF Output Signal
## Frequency: 746.0 MHz, 25 kHz Channel Spacing
## Modulation: FM Modulation with an external 9600 b/s random data source






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

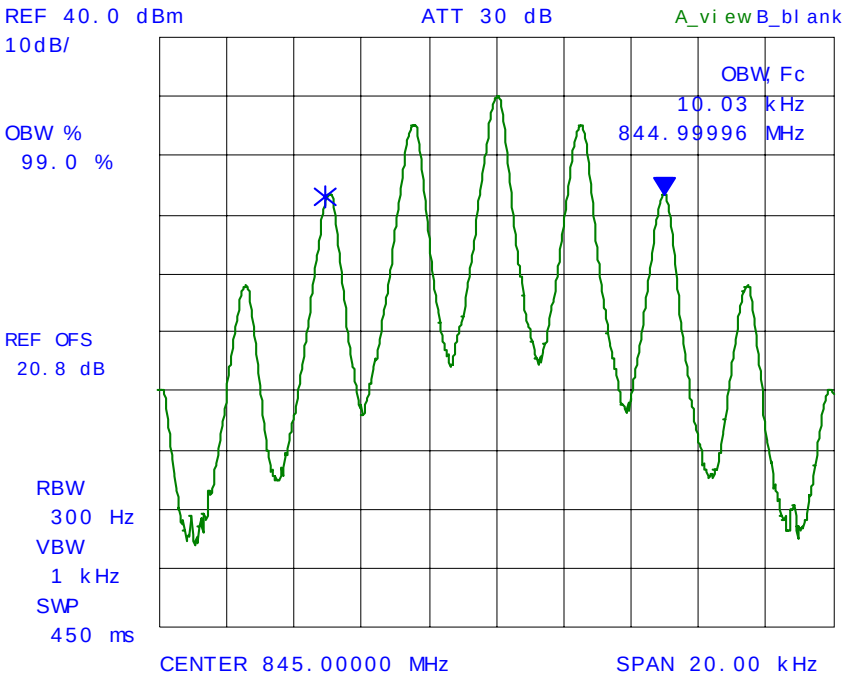
## PLOT # 24 99% Occupied Bandwidth – RF Input Signal
## Frequency: 845.0 MHz, 12.5 kHz Channel Spacing
## Modulation: FM modulation with 2.5 kHz Sine wave signal






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

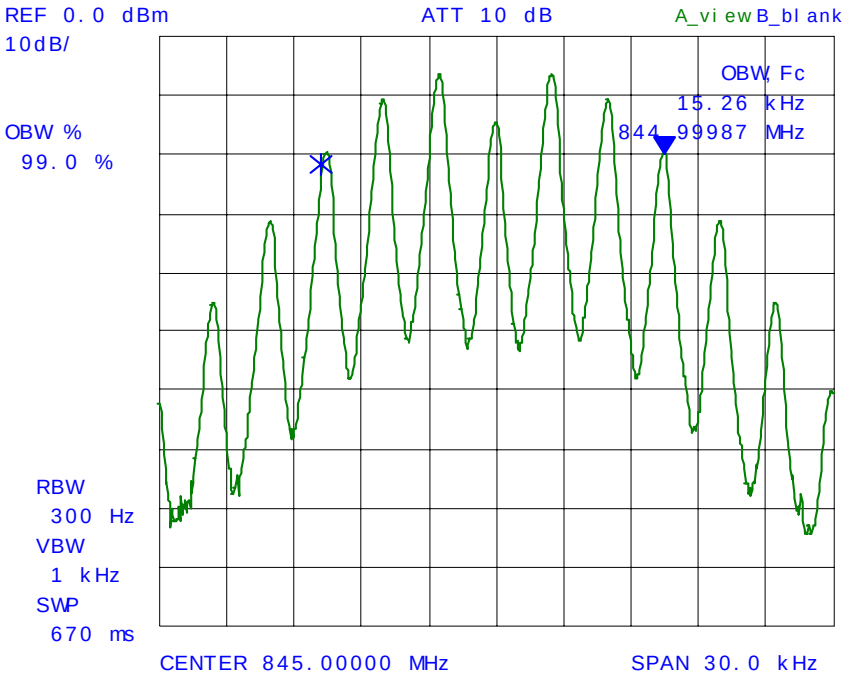
## PLOT # 25 99% Occupied Bandwidth – RF Output Signal
## Frequency: 845.0 MHz, 12.5 kHz Channel Spacing
## Modulation: FM modulation with 2.5 kHz Sine wave signal






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

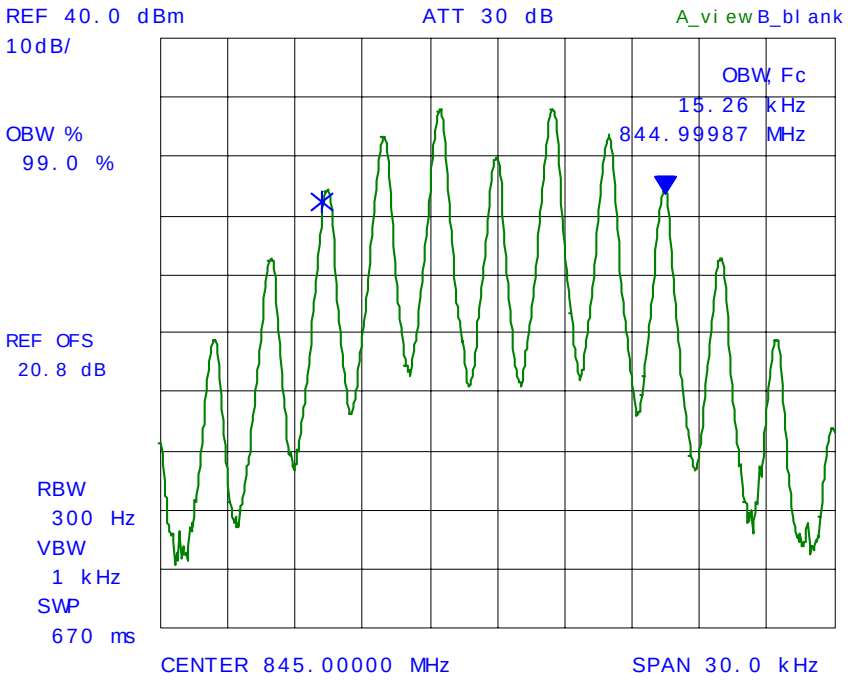
## PLOT # 26 99% Occupied Bandwidth – RF Input Signal
## Frequency: 845.0 MHz, 25 kHz Channel Spacing
## Modulation: FM modulation with 5 kHz Sine wave signal






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

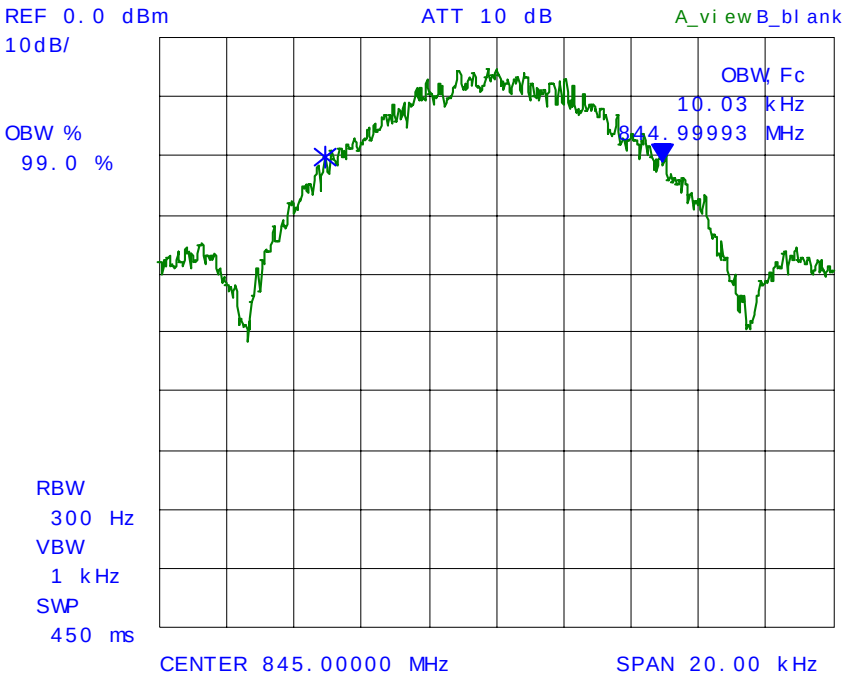
## PLOT # 27 99% Occupied Bandwidth – RF Output Signal
## Frequency: 845.0 MHz, 25 kHz Channel Spacing
## Modulation: FM modulation with 5 kHz Sine wave signal






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

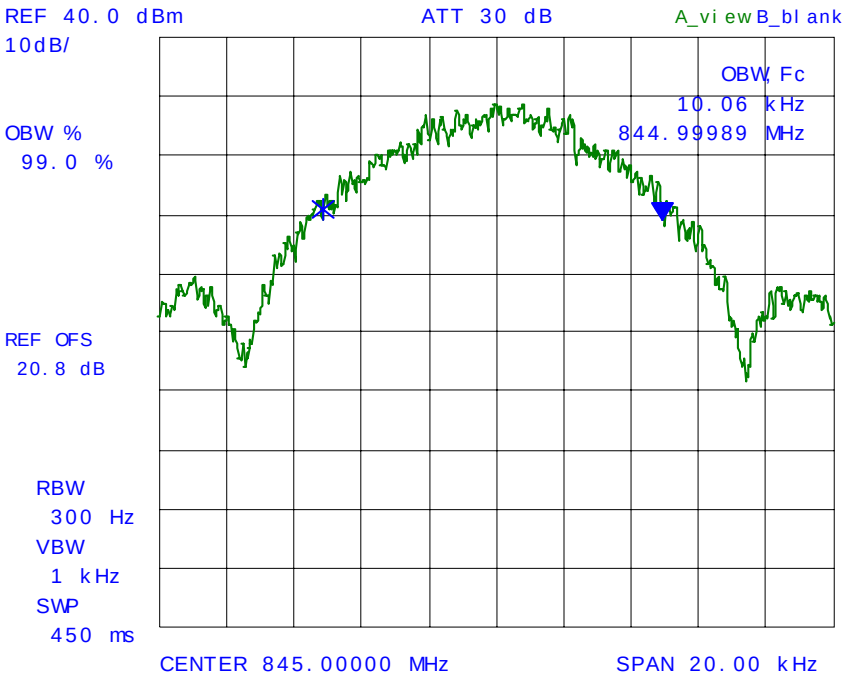
## PLOT # 28 99% Occupied Bandwidth – RF Input Signal
## Frequency: 845.0 MHz, 12.5 kHz Channel Spacing
## Modulation: FM Modulation with an external 9600 b/s random data source






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

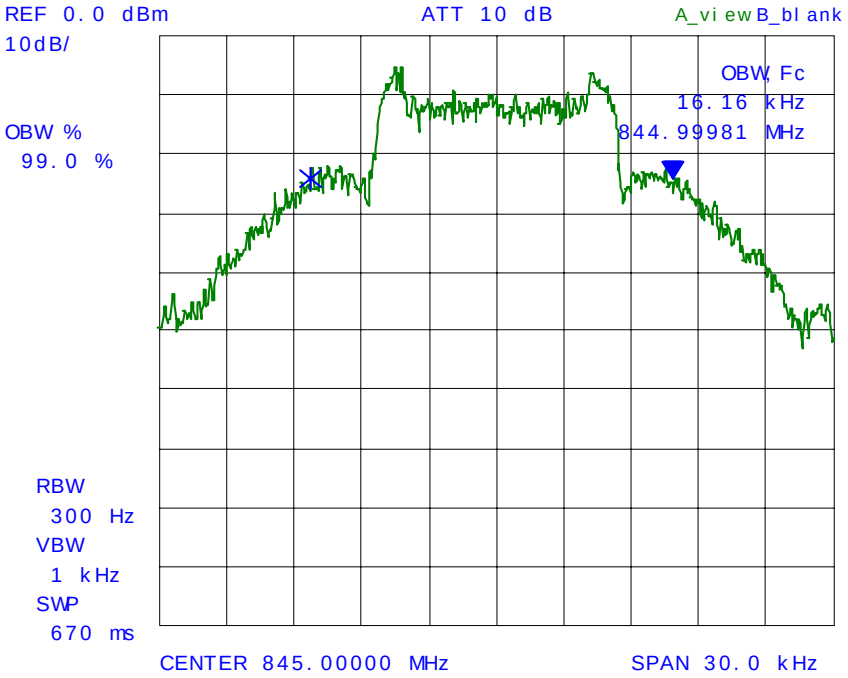
## PLOT # 29 99% Occupied Bandwidth – RF Output Signal
## Frequency: 845.0 MHz, 12.5 kHz Channel Spacing
## Modulation: FM Modulation with an external 9600 b/s random data source






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

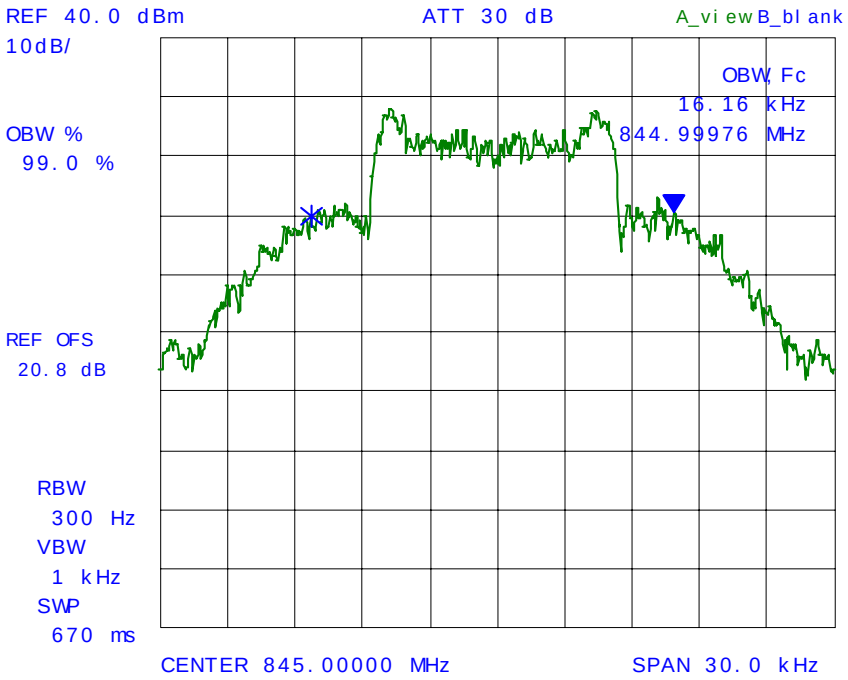
## PLOT # 30 99% Occupied Bandwidth – RF Input Signal
## Frequency: 845.0 MHz, 25 kHz Channel Spacing
## Modulation: FM Modulation with an external 9600 b/s random data source






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

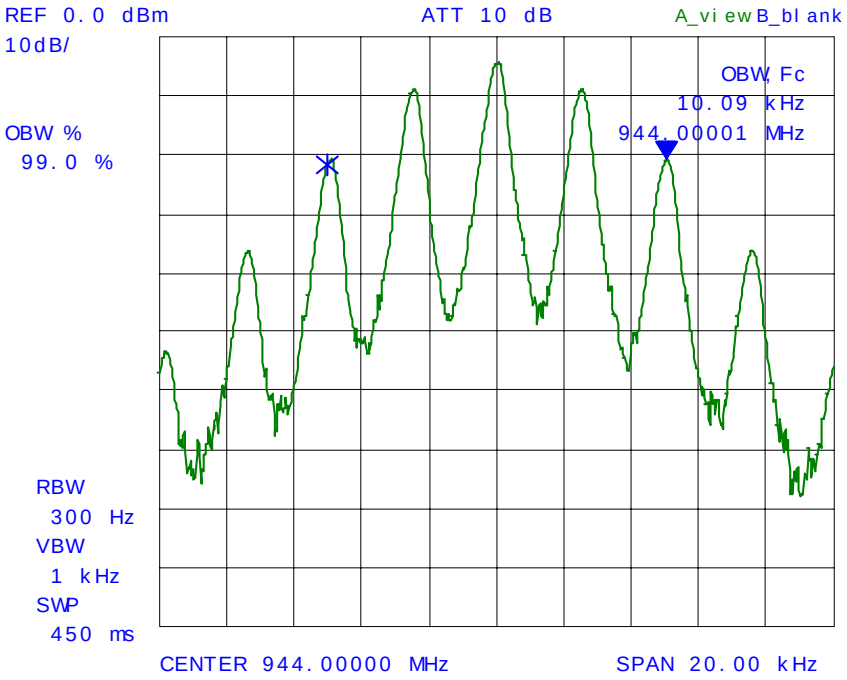
## PLOT # 31 99% Occupied Bandwidth – RF Output Signal
## Frequency: 845.0 MHz, 25 kHz Channel Spacing
## Modulation: FM Modulation with an external 9600 b/s random data source






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

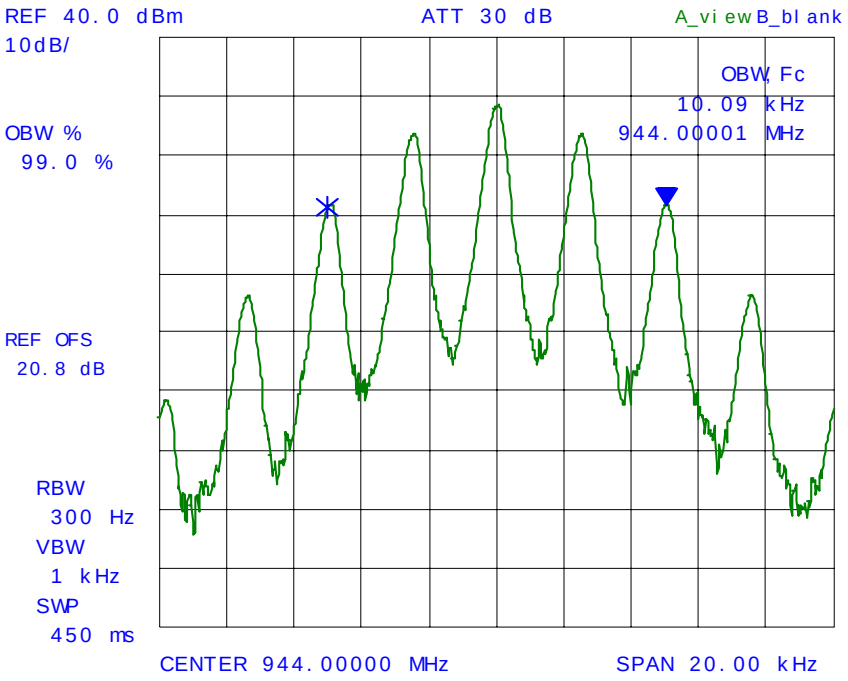
## PLOT # 32 99% Occupied Bandwidth – RF Input Signal
## Frequency: 944.0 MHz, 12.5 kHz Channel Spacing
## Modulation: FM modulation with 2.5 kHz Sine wave signal






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

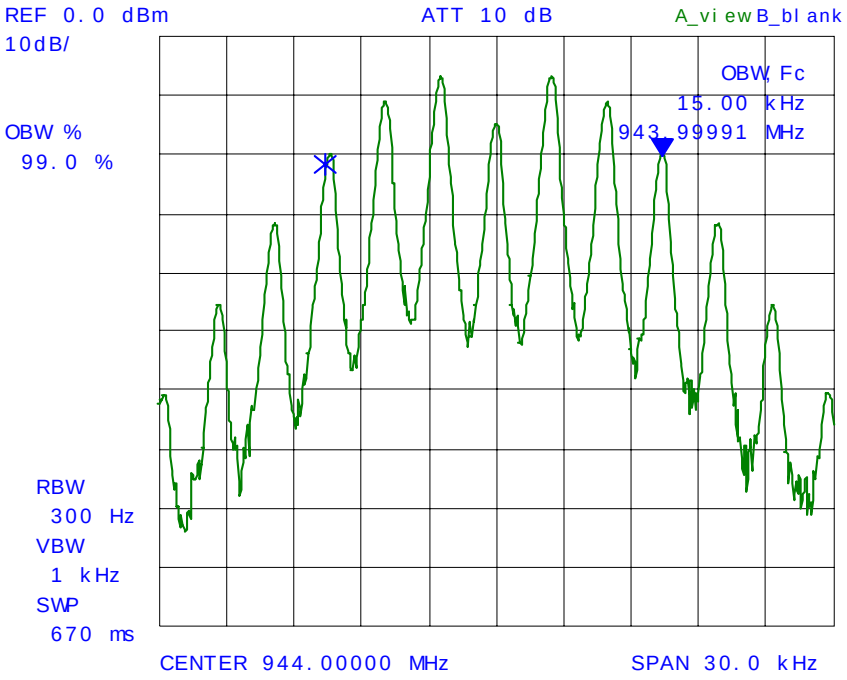
## PLOT # 33 99% Occupied Bandwidth – RF Output Signal
## Frequency: 944.0 MHz, 12.5 kHz Channel Spacing
## Modulation: FM modulation with 2.5 kHz Sine wave signal






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

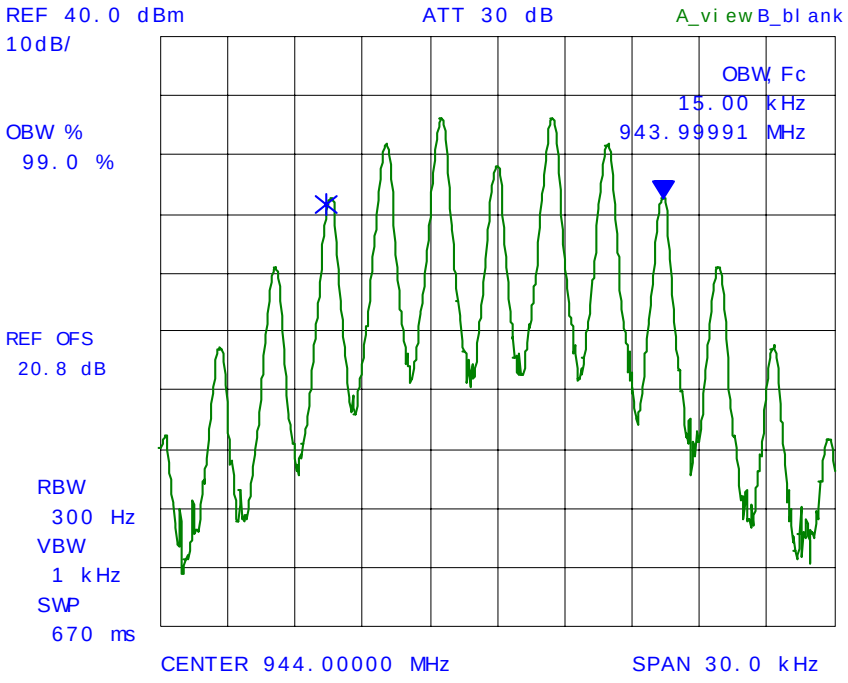
## PLOT # 34 99% Occupied Bandwidth – RF Input Signal
## Frequency: 944.0 MHz, 25 kHz Channel Spacing
## Modulation: FM modulation with 5 kHz Sine wave signal






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

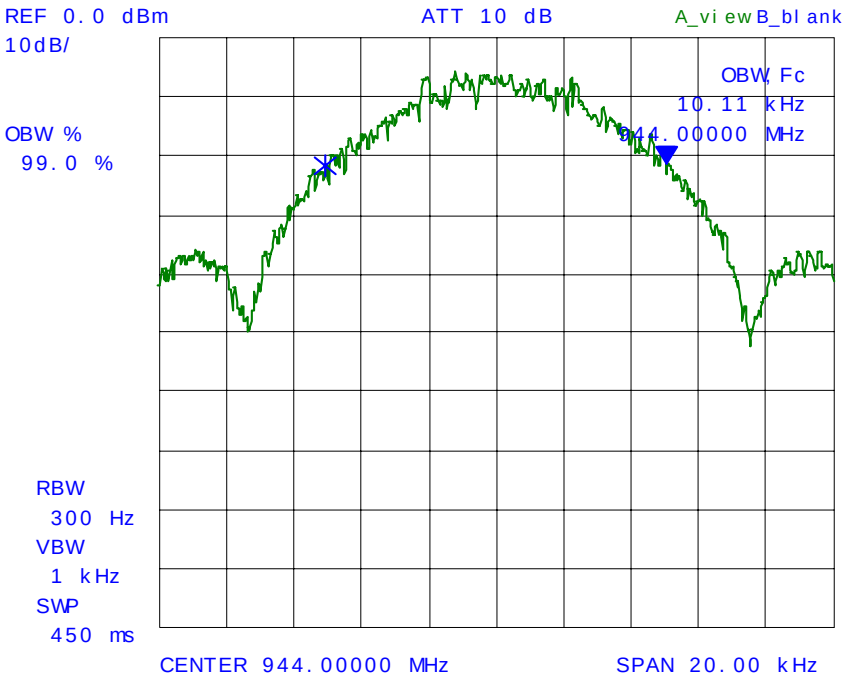
## PLOT # 35 99% Occupied Bandwidth – RF Output Signal
## Frequency: 944.0 MHz, 25 kHz Channel Spacing
## Modulation: FM modulation with 5 kHz Sine wave signal






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

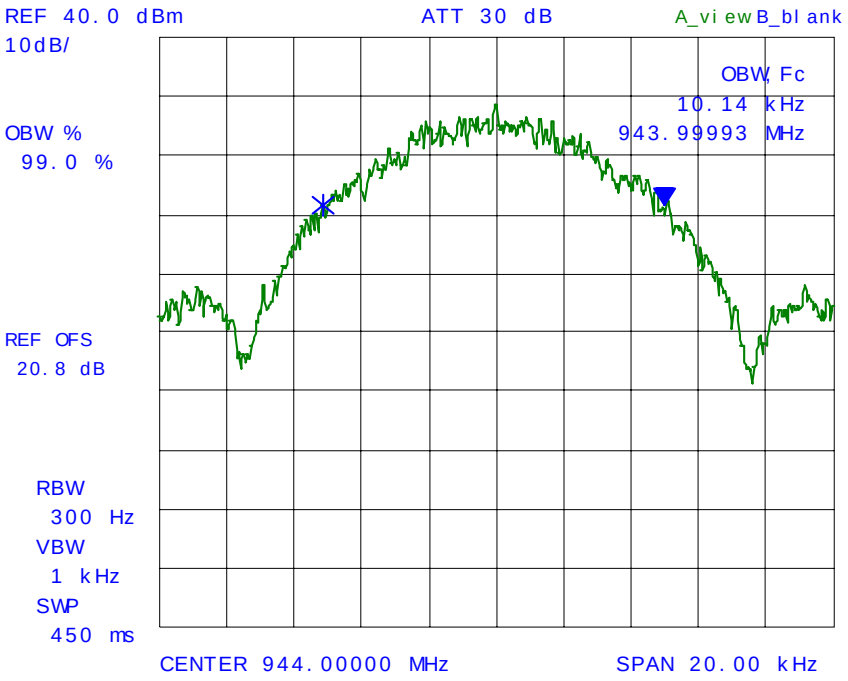
## PLOT # 36 99% Occupied Bandwidth – RF Input Signal
## Frequency: 944.0 MHz, 12.5 kHz Channel Spacing
## Modulation: FM Modulation with an external 9600 b/s random data source






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

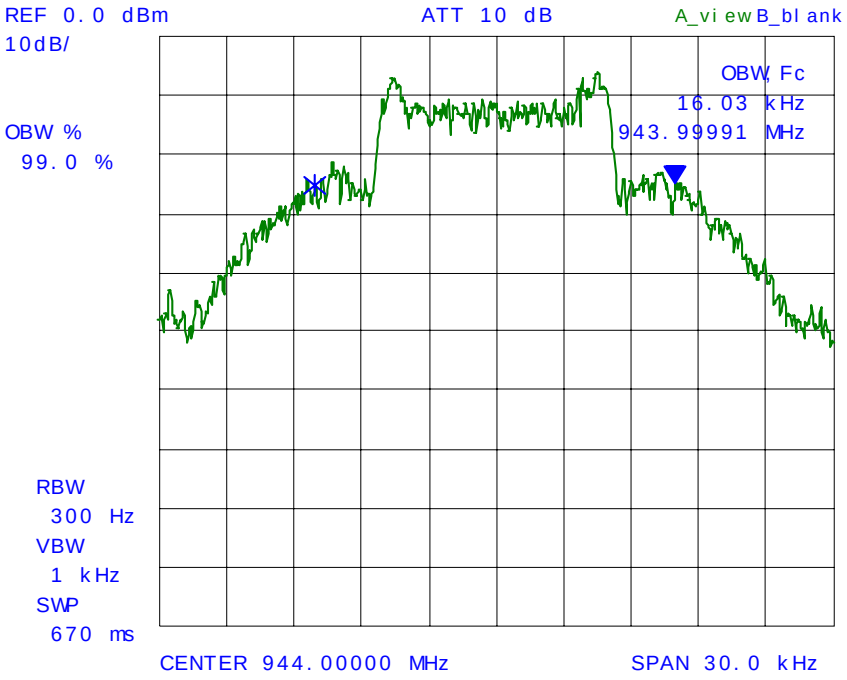
## PLOT # 37 99% Occupied Bandwidth – RF Output Signal
## Frequency: 944.0 MHz, 12.5 kHz Channel Spacing
## Modulation: FM Modulation with an external 9600 b/s random data source






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

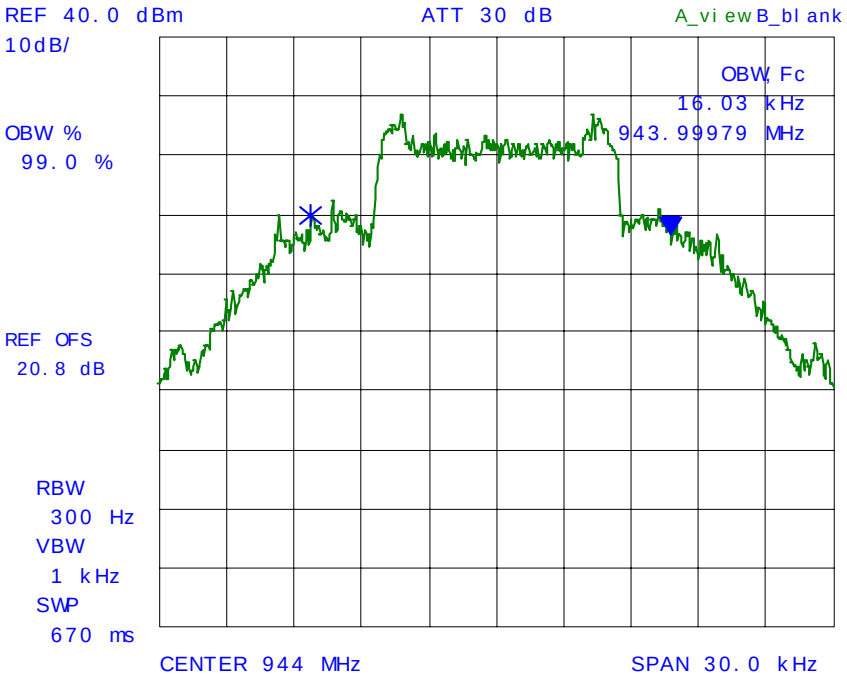
## PLOT # 38 99% Occupied Bandwidth – RF Input Signal
## Frequency: 944.0 MHz, 25 kHz Channel Spacing
## Modulation: FM Modulation with an external 9600 b/s random data source






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

## PLOT # 39 99% Occupied Bandwidth – RF Output Signal
## Frequency: 944.0 MHz, 25 kHz Channel Spacing
## Modulation: FM Modulation with an external 9600 b/s random data source






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

# 5.8. TRANSMITTER ANTENNA POWER SPURIOUS/HARMONIC CONDUCTED EMISSIONS @ 27.53(C)&(D), 90.210, 90.543(C), 2.1057 & 2.1051

## 5.8.1. Limits

The most stringent limit of 43+10*log(P in Watts) dBc is applied for worst case.

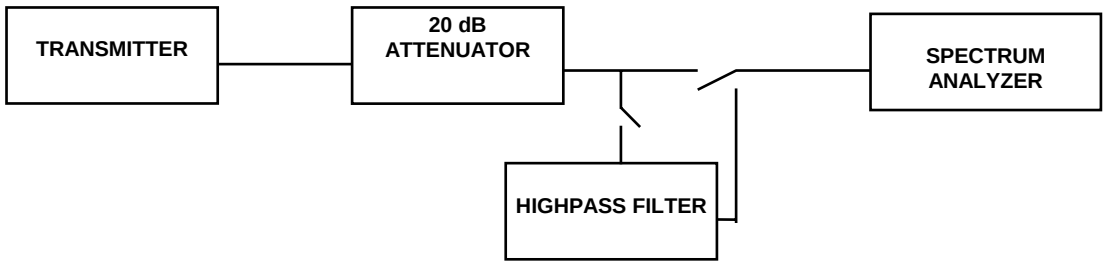
## 5.8.2. Method of Measurements

Refer to Exhibit 8 § 8.5 of this report for measurement details

## 5.8.3. Test Equipment List

| Test Instruments | Manufacturer | Model No. | Serial No. | Frequency Range |
|---|---|---|---|---|
| Spectrum Analyzer/ EMI Receiver | Hewlett Packard | HP 8593EM | 3412A00103 | 9 kHz – 26.5 GHz |
| Attenuator(s) | Bird | .. | … | DC – 22 GHz |
| Audio Oscillator | Hewlett Packard | HP 204C | 0989A08798 | DC to 1.2 MHz |
| Highpass Filter, Microphase | Microphase | CR220HID | IITI11000AC | Cut-off Frequency at 600 MHz, 1.3 GHz or 4 GHz |

## 5.8.4. Test Arrangement



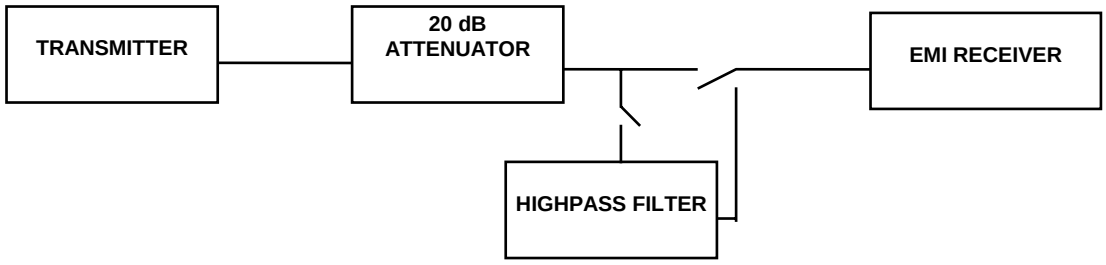
## 5.8.5. Method of Measurements

Refer to Exhibit 8 § 8.5 of this report for measurement details

## 5.8.6. Test Equipment List

| Test Instruments | Manufacturer | Model No. | Serial No. | Frequency Range |
|---|---|---|---|---|
| EMI Receiver/ EMI Receiver | Hewlett Packard | HP 8593EM | 3412A00103 | 9 kHz – 26.5 GHz |
| Attenuator(s) | Bird | .. | … | DC – 22 GHz |
| Audio Oscillator | Hewlett Packard | HP 204C | 0989A08798 | DC to 1.2 MHz |
| Highpass Filter, Microphase | Microphase | CR220HID | IITI11000AC | Cut-off Frequency at 600 MHz, 1.3 GHz or 4 GHz |

## 5.8.7. Test Arrangement




## 5.8.8. Test Data

**Notes:**

**(1)** The most stringent limit of 43+10*log(P in Watts) dBc is applied for all sub-bands for worst case.

**(2)** The rf emissions were scanned with all different modulations and there are no difference emissions were found; therefore, the final tests were only performed without modulation and it shall represent for all different modulations required.

### *5.8.8.1. Antenna Conducted RF Spurious Emissions @ Fc = 746 MHz*

Fundamental Frequency: 746 MHz, 1 RF Signal input/output
RF Output Power: 32.9 dBm (conducted)
Modulation: Unmodulated

| FREQUENCY | TRANSMITTER CONDUCTED ANTENNA EMISSIONS | | LIMIT | MARGIN | PASS/ |
|---|---|---|---|---|---|
| (MHz) | (dBm) | (dBc) | (dBc) | (dB) | FAIL |
| 1463 | -27.4 | -60.3 | -45.9 | -14.4 | PASS |

- The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded.
- Refer to Plots # 40-41 for spurious emissions measurement.

Fundamental Frequency: 746 & 746.025 MHz (2 channel inputs/outputs)
RF Output Power: 31.0 dBm (conducted)
Modulation: Unmodulatedl

| FREQUENCY | TRANSMITTER CONDUCTED ANTENNA EMISSIONS | | LIMIT | MARGIN | PASS/ |
|---|---|---|---|---|---|
| (MHz) | (dBm) | (dBc) | (dBc) | (dB) | FAIL |
| 1463 | -30.1 | -61.1 | -44.0 | -17.1 | PASS |

- The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded.
- Refer to Plots # 42-43 for spurious emissions measurement.

Fundamental Frequency: 746, 746.025, 746.050 (3 channel inputs/outputs)
RF Output Power: 31.8 dBm (conducted)
Modulation: Unmodulated

| FREQUENCY | TRANSMITTER CONDUCTED ANTENNA EMISSIONS | | LIMIT | MARGIN | PASS/ |
|---|---|---|---|---|---|
| (MHz) | (dBm) | (dBc) | (dBc) | (dB) | FAIL |
| 1463 | -29.2 | -61.0 | -44.8 | -16.2 | PASS |

- The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded.
- Refer to Plots # 44-45 for spurious emissions measurement.

### *5.8.8.2. Antenna Conducted RF Spurious Emissions @ Fc = 845 MHz*

Fundamental Frequency: 845 MHz, 1 RF Signal input/output
RF Output Power: 32.2 dBm (conducted)
Modulation: Unmodulated

| FREQUENCY | TRANSMITTER CONDUCTED ANTENNA EMISSIONS | | LIMIT | MARGIN | PASS/ |
|---|---|---|---|---|---|
| (MHz) | (dBm) | (dBc) | (dBc) | (dB) | FAIL |
| 1658 | -35.8 | -68.0 | -45.2 | -22.8 | PASS |

- The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded.
- Refer to Plots # 46-47 for spurious emissions measurement.

Fundamental Frequency: 845 & 845.025 MHz (2 channel inputs/outputs)
RF Output Power: 31.6 dBm (conducted)
Modulation: Unmodulatedl

| FREQUENCY | TRANSMITTER CONDUCTED ANTENNA EMISSIONS | | LIMIT | MARGIN | PASS/ |
|---|---|---|---|---|---|
| (MHz) | (dBm) | (dBc) | (dBc) | (dB) | FAIL |
| 1658 | -37.8 | -69.4 | -44.6 | -24.8 | PASS |

- The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded.
- Refer to Plots # 48-49 for spurious emissions measurement.

Fundamental Frequency: 845, 845.025, 845.050 (3 channel inputs/outputs)
RF Output Power: 31.7 dBm (conducted)
Modulation: Unmodulated

| FREQUENCY | TRANSMITTER CONDUCTED ANTENNA EMISSIONS | | LIMIT | MARGIN | PASS/ |
|---|---|---|---|---|---|
| (MHz) | (dBm) | (dBc) | (dBc) | (dB) | FAIL |
| 1658 | -36.4 | -68.1 | -44.7 | -23.4 | PASS |

- The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded.
- Refer to Plots # 50-51 for spurious emissions measurement.

### *5.8.8.3. Antenna Conducted RF Spurious Emissions @ Fc = 944 MHz*

Fundamental Frequency: 944 MHz, 1 RF Signal input/output
RF Output Power: 30.3 dBm (conducted)
Modulation: Unmodulated

| FREQUENCY | TRANSMITTER CONDUCTED ANTENNA EMISSIONS | | LIMIT | MARGIN | PASS/ |
|---|---|---|---|---|---|
| (MHz) | (dBm) | (dBc) | (dBc) | (dB) | FAIL |
| 1864 | -34.8 | -65.1 | -43.3 | -21.8 | PASS |

- The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded.
- Refer to Plots # 52-53 for spurious emissions measurement.

Fundamental Frequency: 944 & 944.025 MHz (2 channel inputs/outputs)
RF Output Power: 29.7 dBm (conducted)
Modulation: Unmodulatedl

| FREQUENCY | TRANSMITTER CONDUCTED ANTENNA EMISSIONS | | LIMIT | MARGIN | PASS/ |
|---|---|---|---|---|---|
| (MHz) | (dBm) | (dBc) | (dBc) | (dB) | FAIL |
| 1864 | -33.2 | -62.9 | -42.7 | -20.2 | PASS |

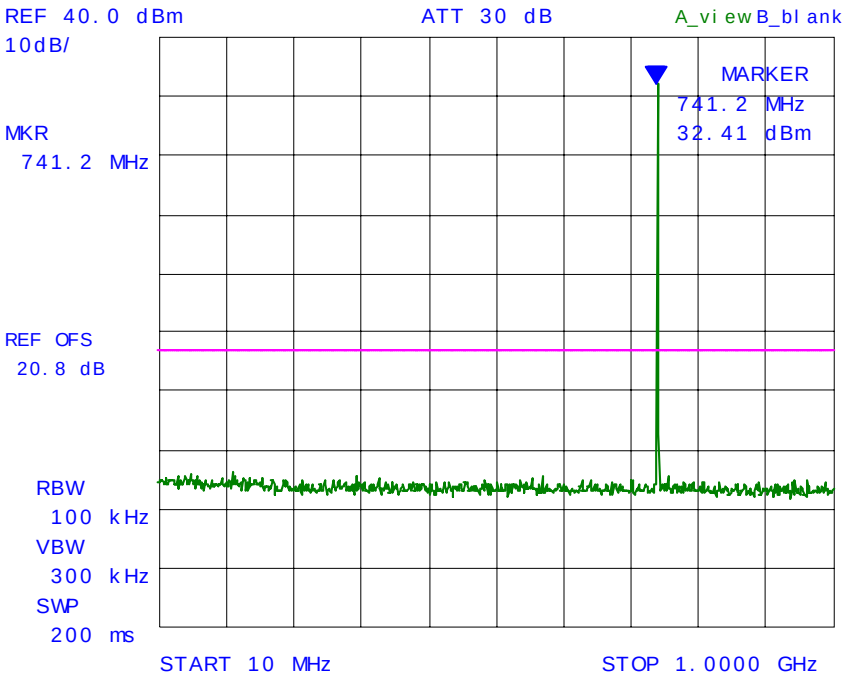
- The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded.
- Refer to Plots # 54-55 for spurious emissions measurement.

Fundamental Frequency: 944, 944.025, 944.050 (3 channel inputs/outputs)
RF Output Power: 31.3 dBm (conducted)
Modulation: Unmodulated

| FREQUENCY | TRANSMITTER CONDUCTED ANTENNA EMISSIONS | | LIMIT | MARGIN | PASS/ |
|---|---|---|---|---|---|
| (MHz) | (dBm) | (dBc) | (dBc) | (dB) | FAIL |
| 1876 | -31.5 | -62.8 | -44.3 | -18.5 | PASS |

- The emissions were scanned from 10 MHz to 10 GHz and all emissions within 20 dB below the limits were recorded.
- Refer to Plots # 56-57 for spurious emissions measurement.

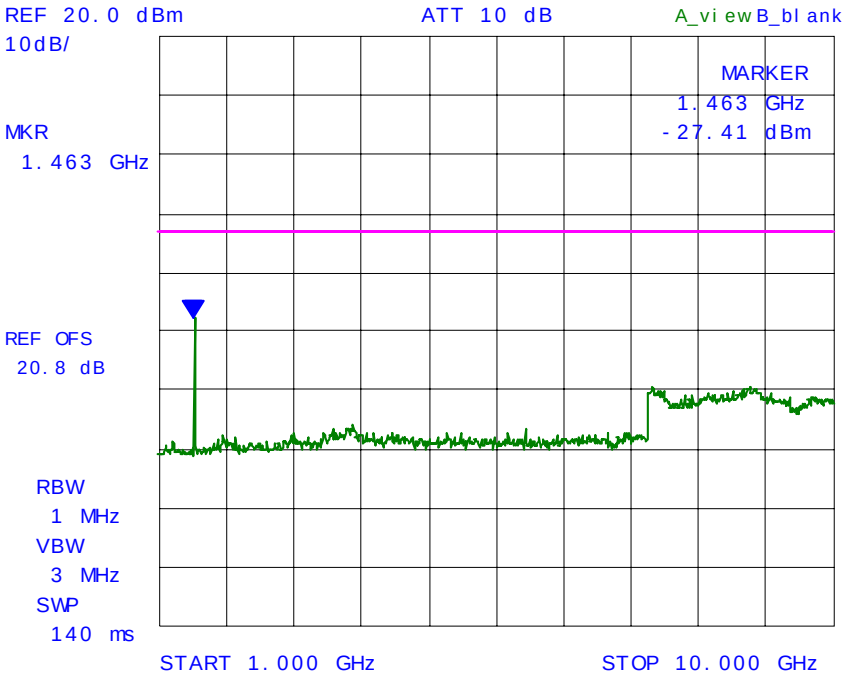
## PLOT # 40 Conducted Spurious Emissions with 1 RF signal input/output Fc: 746 MHz






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

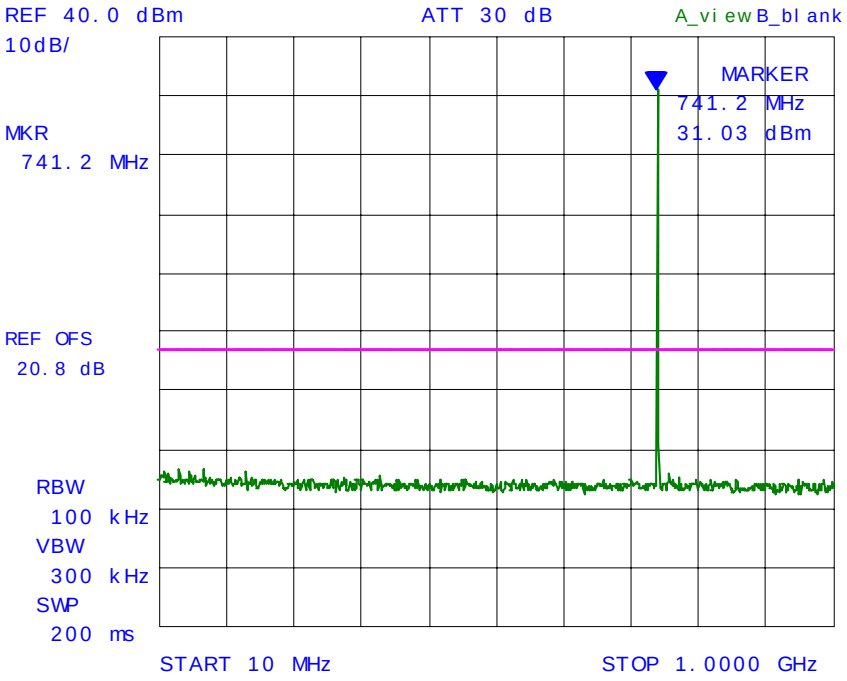
## PLOT # 41 Conducted Spurious Emissions with 1 RF signal input/output Fc: 746 MHz






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

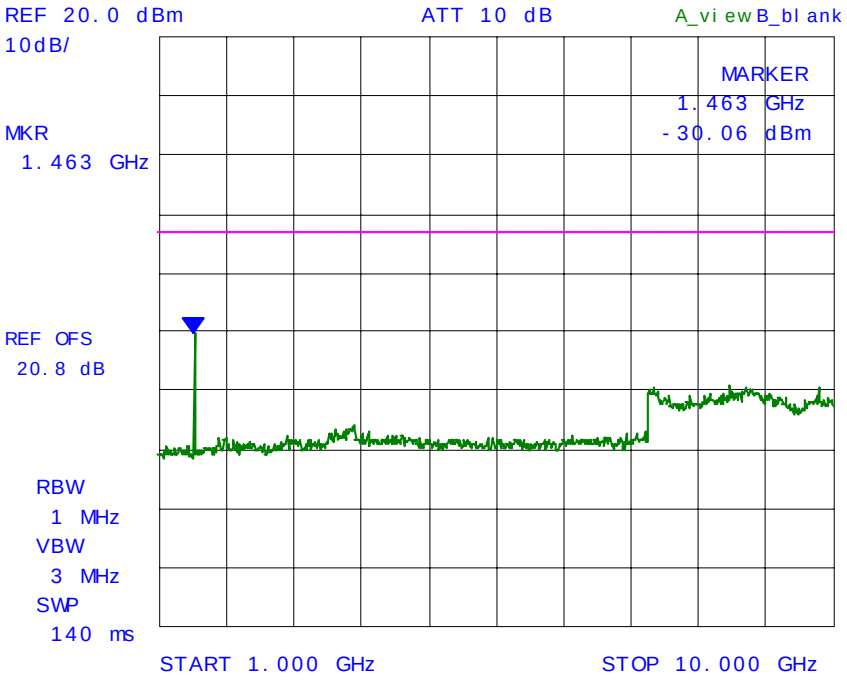
## PLOT # 42 Conducted Spurious Emissions with 2 RF signal inputs/outputs Fc: 746 MHz, Fc + 25.0 kHz



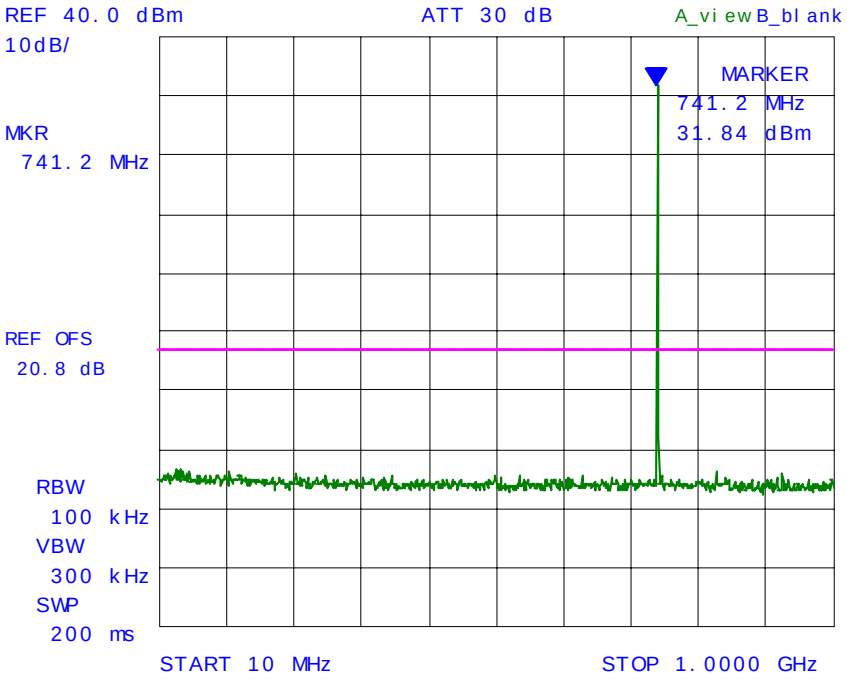



- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

## PLOT # 43 Conducted Spurious Emissions with 2 RF signal inputs/outputs Fc: 746 MHz, Fc + 25.0 kHz



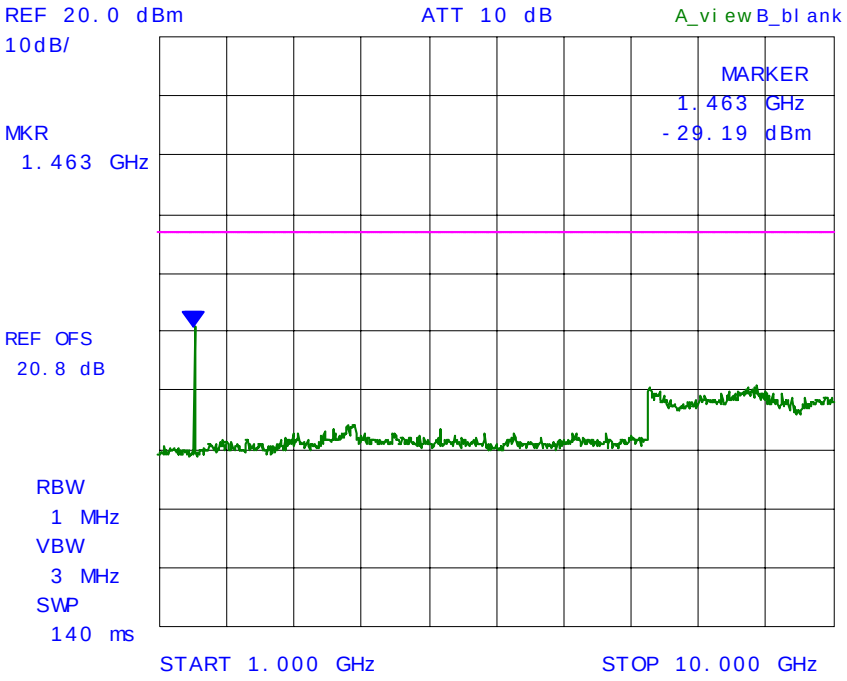
## PLOT # 44 Conducted Spurious Emissions with 3 RF signal inputs/outputs Fc: 746 MHz, Fc + 25.0 kHz & Fc + 50.0 kHz



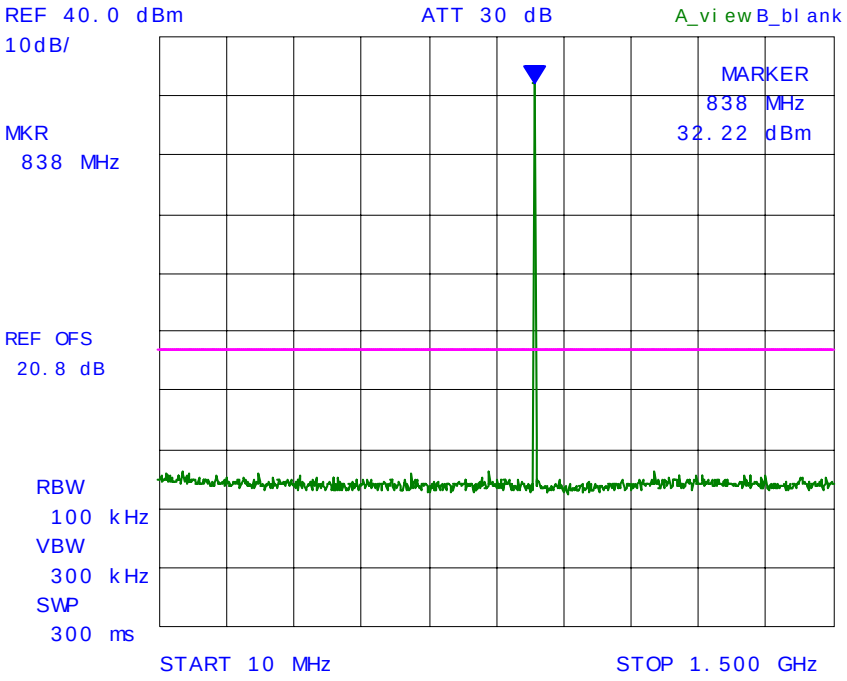



- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

## PLOT # 45 Conducted Spurious Emissions with 3 RF signal inputs/outputs Fc: 746 MHz, Fc + 25.0 kHz & Fc + 50.0 kHz



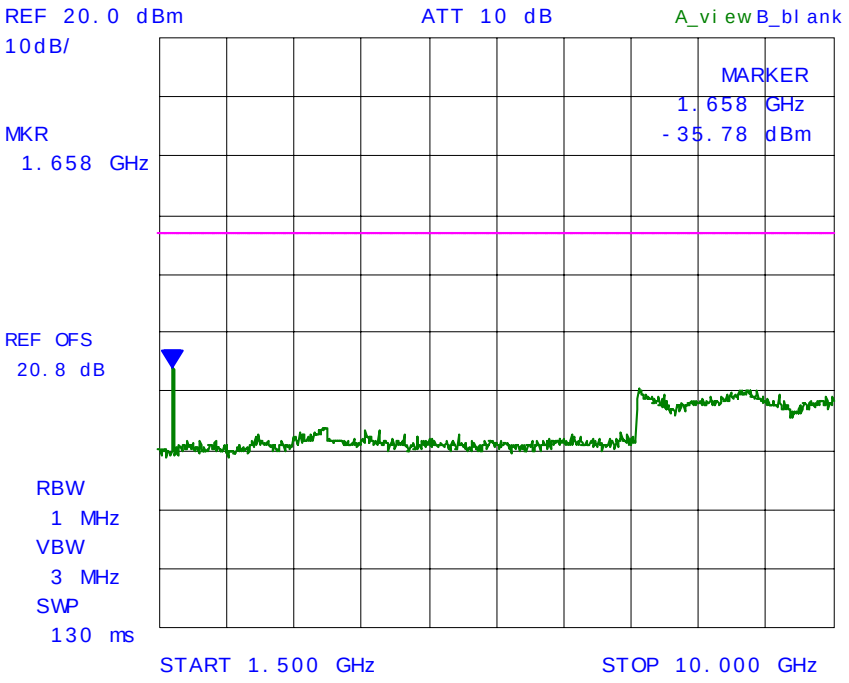
## PLOT # 46 Conducted Spurious Emissions with 1 RF signal input/output Fc: 845 MHz



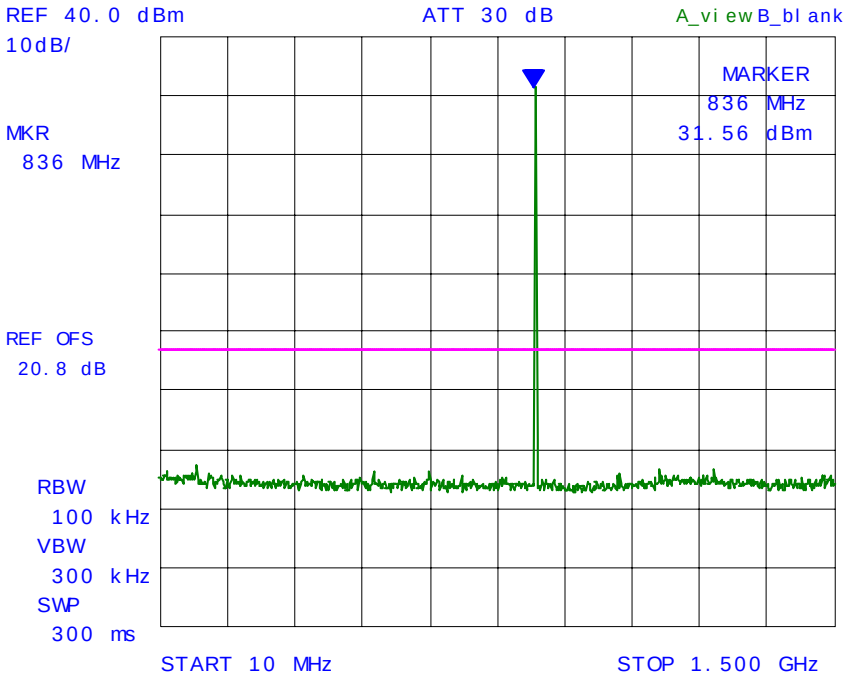



- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

## PLOT # 47 Conducted Spurious Emissions with 1 RF signal input/output Fc: 845 MHz



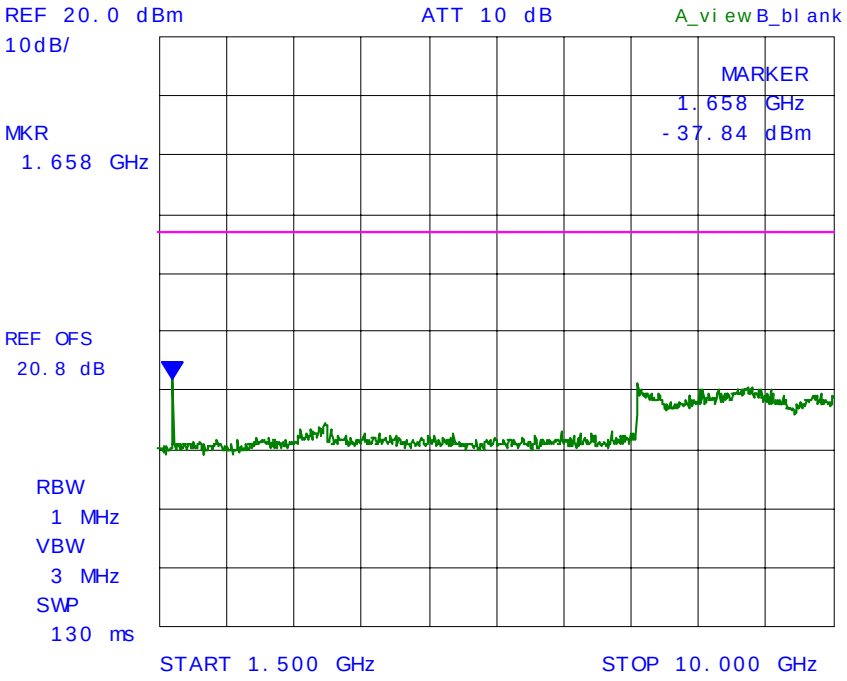
## PLOT # 48 Conducted Spurious Emissions with 2 RF signal inputs/outputs Fc: 845 MHz, Fc + 25.0 kHz



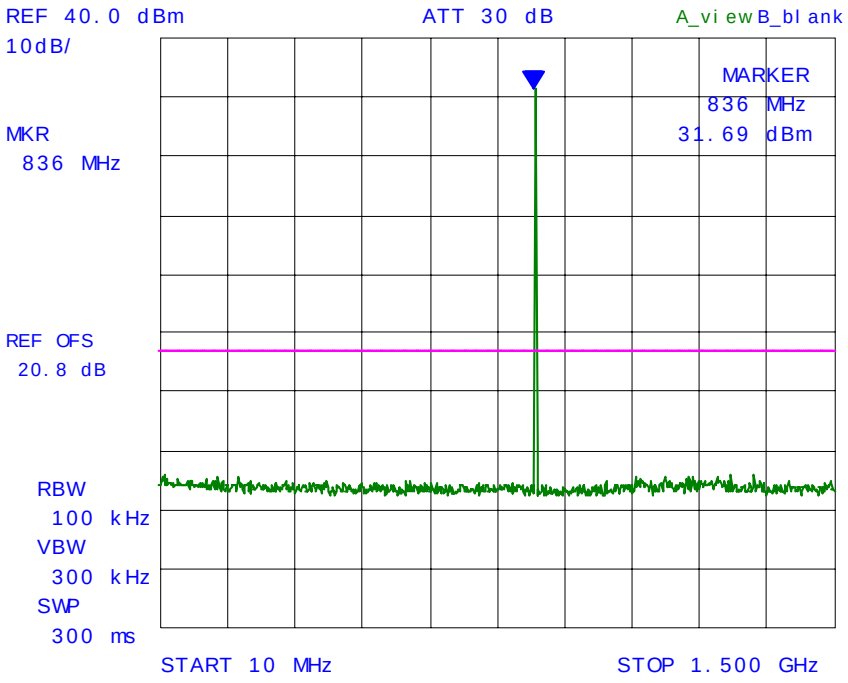



- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

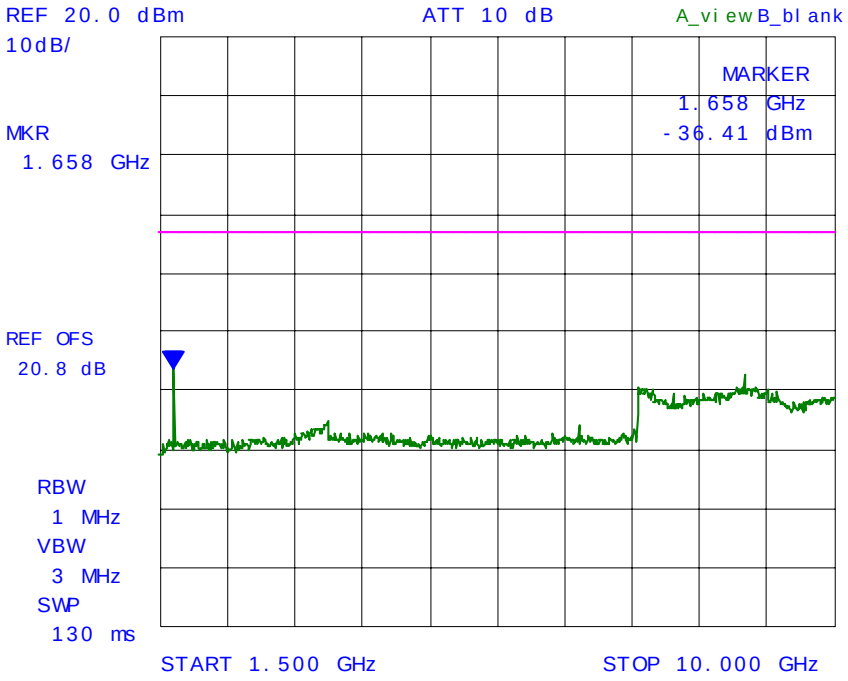
## PLOT # 49 Conducted Spurious Emissions with 2 RF signal inputs/outputs Fc: 845 MHz, Fc + 25.0 kHz



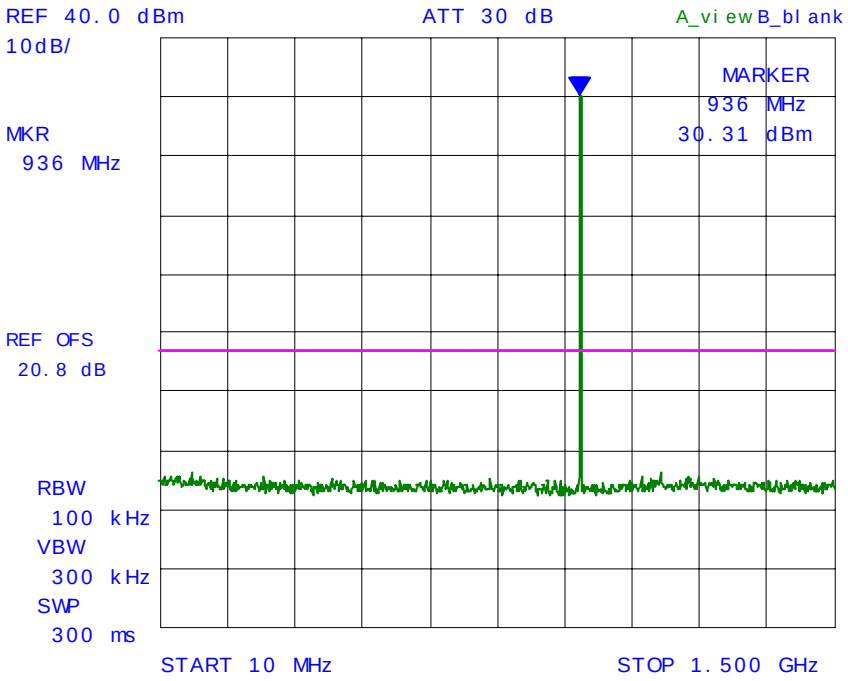
## PLOT # 50 Conducted Spurious Emissions with 3 RF signal inputs/outputs Fc: 845 MHz, Fc + 25.0 kHz & Fc + 50.0 kHz



## PLOT # 51 Conducted Spurious Emissions with 3 RF signal inputs/outputs Fc: 845 MHz, Fc + 25.0 kHz & Fc + 50.0 kHz



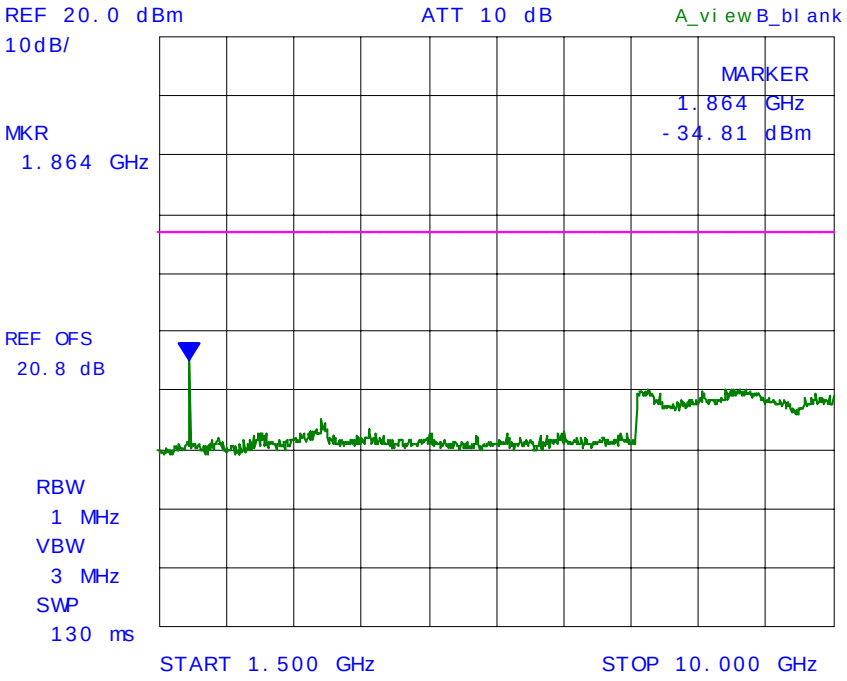
## PLOT # 52 Conducted Spurious Emissions with 1 RF signal input/output Fc: 944 MHz



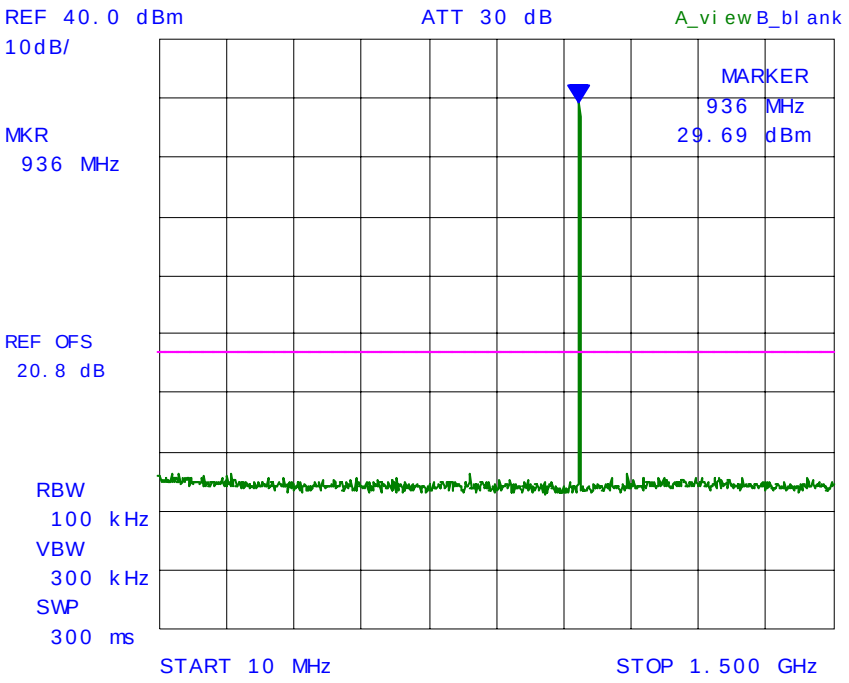



- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

## PLOT # 53 Conducted Spurious Emissions with 1 RF signal input/output Fc: 944 MHz



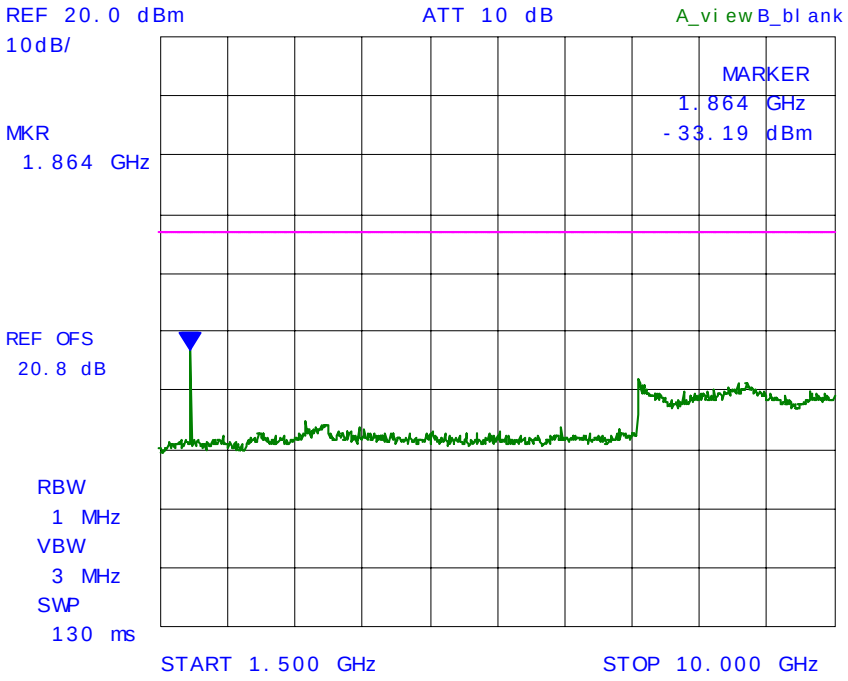
## PLOT # 54 Conducted Spurious Emissions with 2 RF signal inputs/outputs Fc: 944 MHz, Fc + 25.0 kHz



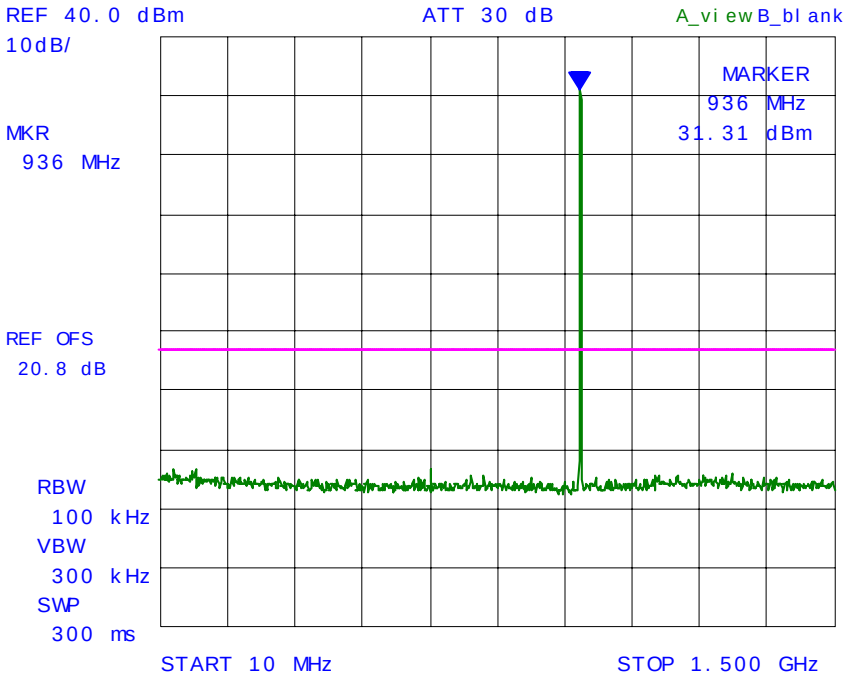



- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

## PLOT # 55 Conducted Spurious Emissions with 2 RF signal inputs/outputs Fc: 944 MHz, Fc + 25.0 kHz



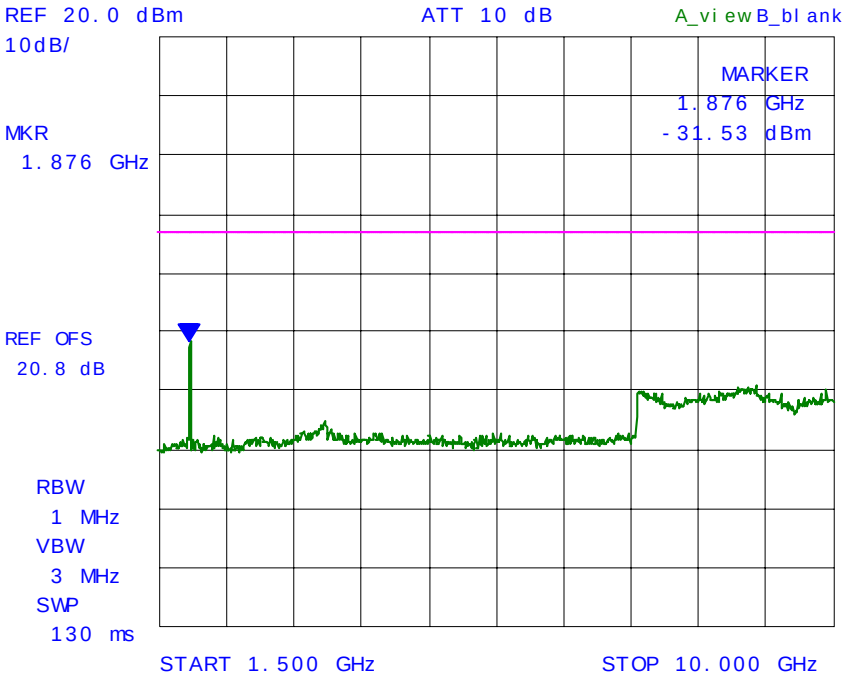
## PLOT # 56 Conducted Spurious Emissions with 3 RF signal inputs/outputs Fc: 944 MHz, Fc + 25.0 kHz & Fc + 50.0 kHz






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

## PLOT # 57 Conducted Spurious Emissions with 3 RF signal inputs/outputs Fc: 944 MHz, Fc + 25.0 kHz & Fc + 50.0 kHz






- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

# 5.9. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS @ 27.53(C)&(D), 90.210, 90.543(C), 2.1057 & 2.1053

## 5.9.1. Limits

The most stringent limit of 43+10*log(P in Watts) dBc is applied for all sub-bands for worst case.

## 5.9.2. Method of Measurements

The spurious/harmonic ERP measurements are using substitution method specified in Exhibit 8, § 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 = xxx 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)**

## 5.9.3. Test Equipment List

| Test Instruments | Manufacturer | Model No. | Serial No. | Frequency Range |
|---|---|---|---|---|
| Spectrum Analyzer/ EMI Receiver | Hewlett Packard | HP 8546A | … | 9 kHz to 5.6 GHz with built-in 30 dB Gain Pre-selector, QP, Average & Peak Detectors. |
| RF Amplifier | Com-Power | PA-102 | | 1 MHz to 1 GHz, 30 dB gain nomimal |
| 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 |

## 5.9.4. Test Setup

Please refer to Photo # 1to 2 for detailed of test setup.

## 5.9.5. Test Data

### *5.9.5.1. Lowest Frequency (746 MHz)*

| FREQUENCY (MHz) | E-FIELD Level @3m (dBuV/m) | ERP Substitution measured by Method (dBm) | (dBc) | EMI Receiver Detector (Peak/QP) | ANTENNA PLANE (H/V) | LIMIT (dBc) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|---|
| 30 – 10000 | ** | ** | ** | PEAK | V & H | -45.9 | ** | PASS |
| • The emissions were scanned from 30 MHz to 10 GHz and no significant rf spurious/harmonic emissions were found to be less than 20 dB below the FCC Limits. | | | | | | | | |

### *5.9.5.2. Middle Frequency (845 MHz)*

| FREQUENCY (MHz) | E-FIELD Level @3m (dBuV/m) | ERP Substitution measured by Method (dBm) | (dBc) | EMI Receiver Detector (Peak/QP) | ANTENNA PLANE (H/V) | LIMIT (dBc) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|---|
| 30 – 10000 | ** | ** | ** | PEAK | V & H | -45.6 | ** | PASS |
| • The emissions were scanned from 30 MHz to 10 GHz and no significant rf spurious/harmonic emissions were found to be less than 20 dB below the FCC Limits. | | | | | | | | |

### *5.9.5.3. Highest Frequency (944 MHz)*

| FREQUENCY (MHz) | E-FIELD Level @3m (dBuV/m) | ERP Substitution measured by Method (dBm) | (dBc) | EMI Receiver Detector (Peak/QP) | ANTENNA PLANE (H/V) | LIMIT (dBc) | MARGIN (dB) | PASS/ FAIL |
|---|---|---|---|---|---|---|---|---|
| 30 – 10000 | ** | ** | ** | PEAK | V & H | -44.5 | ** | PASS |
| • The emissions were scanned from 30 MHz to 10 GHz and no significant rf spurious/harmonic emissions were found to be less than 20 dB below the FCC Limits. | | | | | | | | |

# EXHIBIT 6. MEASUREMENT UNCERTAINTY

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

## 6.1. 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 Directivit | 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 $20\text{Log}(1\pm\Gamma_1\Gamma_R)$ | U-Shaped | +1.1<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



- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

# EXHIBIT 7. MEASUREMENT METHODS

## 7.1. 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.

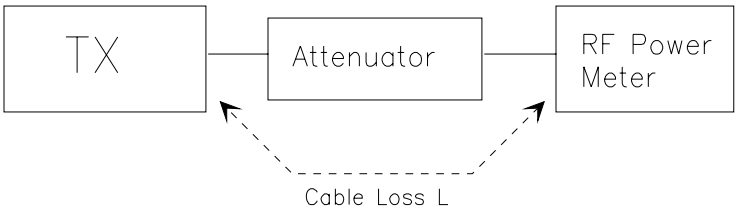
**Step 2**: Calculation of Average EIRP. See Figure 1

- 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.**



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

## 7.2.1. 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

## 7.2.2. 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° 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**

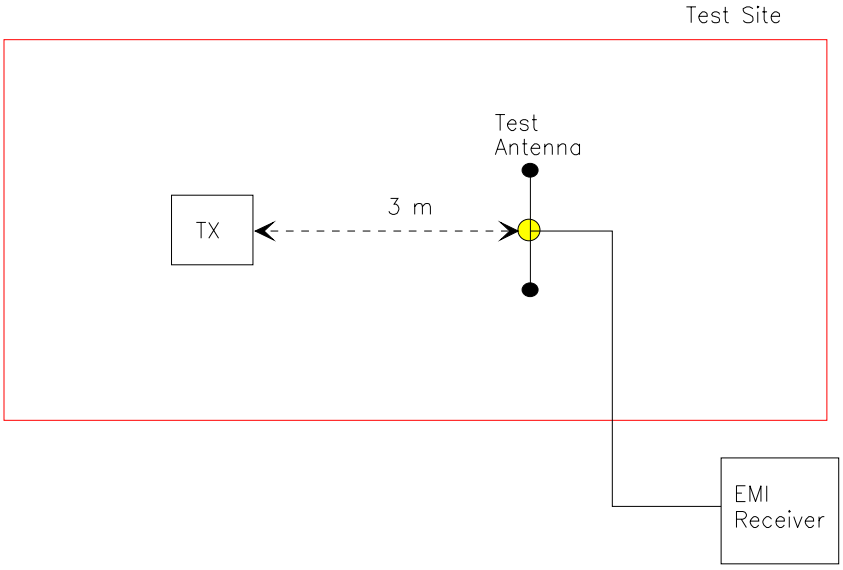
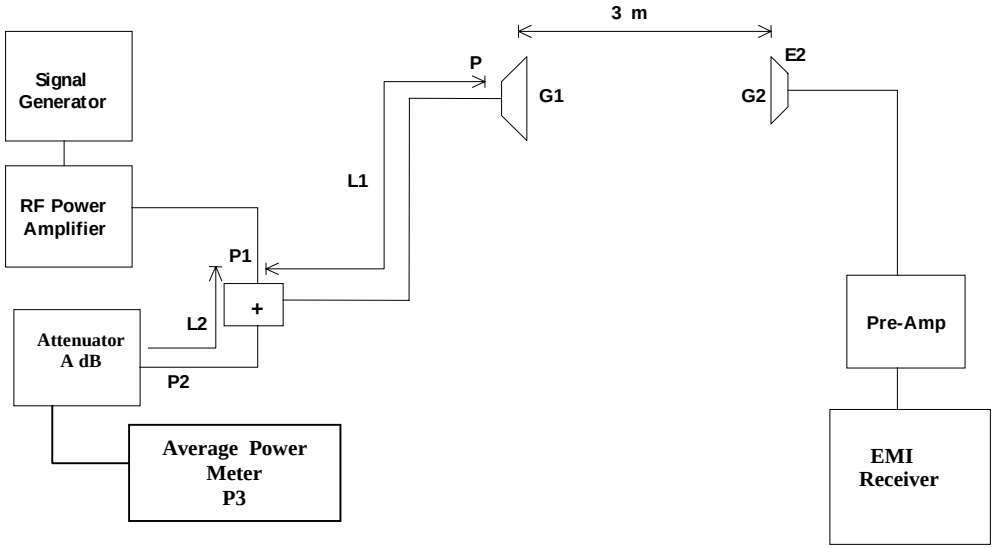



**Figure 3**



## 7.3. FREQUENCY STABILITY

Refer to FCC @ 2.1055.

(a) The frequency stability shall be measured with variation of ambient temperature as follows: From -30 to +50 centigrade except that specified in subparagraph (2) & (3) of this paragraph.

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

(d) The frequency stability supply shall be measured with variation of primary supply voltage as follows:

(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.

(2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.

(3) The supply voltage shall be measured at the input to the cable normally provide with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

(e) When deemed necessary, the Commission may require tests of frequency stability under conditions in addition to those specifically set out in paragraphs (a), (b), (c) and (d) of this section. (For example, measurements showing the effect of proximity to large metal objects, or of various types of antennas, may be required for portable equipment).

## 7.4. EMISSION MASK

**Voice or Digital Modulation Through a Voice Input Port @ 2.1049(c)(i)**:- The transmitter was modulated by a 2.5 KHz tone signal at an input level 16 dB greater than that required to produce 50% modulation (e.g.: ±2.5 KHz peak deviation at 1 KHz modulating frequency). The input level was established at the frequency of maximum response of the audio modulating circuit.

**Digital Modulation Through a Data Input Port @ 2.1049(h)**:- Transmitters employing digital modulation techniques - when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the Emission Masks shall be shown for operation with any devices used for modifying the spectrum when such devices are operational at the discretion of the user.

The following EMI Receiver bandwidth shall be used for measurement of Emission Mask/Out-of-Band Emission Measurements:

(1) For 25 kHz Channel Spacing: RBW = 300 Hz
(2) For 12.5 kHz or 6.25 kHz Channel Spacings: RBW = 100 Hz

The all cases the Video Bandwidth shall be equal or greater than the measuring bandwidth.

## 7.5. SPURIOUS EMISSIONS (CONDUCTED)

With transmitter modulation characteristics described in Out-of-Band Emissions measurements @ 2.1049, the transmitter spurious and harmonic emissions were scanned. The spurious and harmonic emissions were measured with the EMI Receiver controls set as RBW = 30 kHz minimum , VBW ≥ RBW and SWEEP TIME = AUTO). The transmitter was operated at a full rated power output, and modulated as follows:

**FCC CFR 47, Para. 2.1057 - Frequency spectrum to be investigated:-** The spectrum was investigated from the lowest radio generated in the equipment up to at least the $10^{th}$ harmonic of the carrier frequency or to the highest frequency practicable in the present state of the art of measuring techniques, whichever is lower. Particular attention should be paid to harmonics and subharmonics of the carrier frequency. Radiation at the frequencies of multiplier stages should be checked. The
amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.

**FCC CFR 47, Para. 2.1051 - Spurious Emissions at Antenna Terminal:-** The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of the harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.