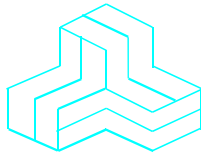


# ENGINEERING TEST REPORT



**Signal Booster**  
**Model No.: 61-38-05**  
**FCC ID: EZZ5PI613805**

*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 I)**

**UltraTech's File No.: TXRX-011FCC90**

This Test report is Issued under the Authority of  
Tri M. Luu, Professional Engineer,  
Vice President of Engineering  
UltraTech Group of Labs

Date: June 29, 2005



Report Prepared by: Anca Dobre

Tested by: Hung Trinh, EMI/RFI Technician

Issued Date: June 29, 2005

Test Dates: June 20-26, 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.

## UltraTech

3000 Bristol Circle, Oakville, Ontario, Canada, L6H 6G4

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SL2-IN-E-1119R



00-034



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File #: TXRX-011FCC90  
June 29, 2005

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

## EXHIBIT 1. SUBMITTAL CHECK LIST

| Annex No. | Exhibit Type            | Description of Contents                                                                                                                                                                                                                                                                                                                                                                     | Quality Check (OK) |
|-----------|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| --        | Test Report             | <ul style="list-style-type: none"><li>Exhibit 1: Submittal check lists</li><li>Exhibit 2: Introduction</li><li>Exhibit 3: Performance Assessment</li><li>Exhibit 4: EUT Operation and Configuration during Tests</li><li>Exhibit 5: Summary of test Results</li><li>Exhibit 6: Measurement Data</li><li>Exhibit 7: Measurement Uncertainty</li><li>Exhibit 8: Measurement Methods</li></ul> | 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           | <ul style="list-style-type: none"><li>Letter from Ultratech for Certification Request</li><li>Letter from the Applicant to appoint Ultratech to act as an agent</li><li>Letter from the Applicant to request for Confidentiality Filing</li></ul>                                                                                                                                           | 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 Diagram                                                                                                                                                                                                                                                                                                                                                                               | 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            | Users Manual                                                                                                                                                                                                                                                                                                                                                                                | OK                 |

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## EXHIBIT 2. INTRODUCTION

### 2.1. SCOPE

|                                      |                                                                                                                                                                                                                                                                                                              |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Reference:</b>                    | FCC Parts 2 and 90                                                                                                                                                                                                                                                                                           |
| <b>Title:</b>                        | Code of Federal Regulations (CFR) Title 47 - Telecommunication, Parts 2 and 90 (Subpart I).                                                                                                                                                                                                                  |
| <b>Purpose of Test:</b>              | To gain FCC Certification Authorization for Radio operating in the frequency band 138-174 MHz.                                                                                                                                                                                                               |
| <b>Test Procedures:</b>              | 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. |
| <b>Environmental Classification:</b> | 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                           | 2004                             | 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 22<br>CISPR 22 +A1<br>EN 55022 | 2003-04-10<br>2004-10-14<br>2003 | Information Technology Equipment - Radio Disturbance Characteristics – Limits and Methods of Measurement                                                            |
| CISPR 16-1-1                         | 2003                             | Specification for radio disturbance and immunity measuring apparatus and methods.<br>Part 1-1: Measuring Apparatus                                                  |
| CISPR 16-2-1                         | 2004                             | Specification for radio disturbance and immunity measuring apparatus and methods.<br>Part 2-1: Conducted disturbance measurement                                    |

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File #: TXRX-011FCC90  
June 29, 2005

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## EXHIBIT 3. PERFORMANCE ASSESSMENT

### 3.1. CLIENT INFORMATION

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

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

|                                             |                                                                                                                                                                                       |
|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Brand Name:</b>                          | TX RX Systems, Inc.                                                                                                                                                                   |
| <b>Product Name:</b>                        | Signal Booster                                                                                                                                                                        |
| <b>Model Name or Number:</b>                | 61-38-05                                                                                                                                                                              |
| <b>Type of Equipment:</b>                   | Non-broadcast Radio Communication Equipment                                                                                                                                           |
| <b>External Power Supply:</b>               | 100-240 Vac; 50/60 Hz or 24-29 Vdc                                                                                                                                                    |
| <b>Primary User functions of EUT:</b>       | Signal Booster 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. |
| <b>Transmitting/Receiving Antenna Type:</b> | 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 24-29 Vdc                                                                                                                                                                                         |
| RF Input Power Rating:          | - 20 dBm for single channel input                                                                                                                                                                                          |
| RF Output Power Rating:         | 0.63 Watts                                                                                                                                                                                                                 |
| Operating Frequency Range:      | 138 – 174 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:           | <ul style="list-style-type: none"><li>• F1D</li><li>• F3E</li></ul>                                                                                                                                                        |
| Antenna Connector Type:         | N Female                                                                                                                                                                                                                   |
| Antenna Description:            | <ul style="list-style-type: none"><li>• Outdoor/Top-Roof Antenna: The Antenna Gain Limit is 10 dB</li><li>• In-building antenna: radiating coaxial cable or a network ¼ wave whip antenna (gain not exceed 0 dB)</li></ul> |

| 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 24-29 Vdc             |
| RF Input Power Rating:          | - 20 dBm for single channel input              |
| Operating Frequency Range:      | 138 – 174 MHz                                  |

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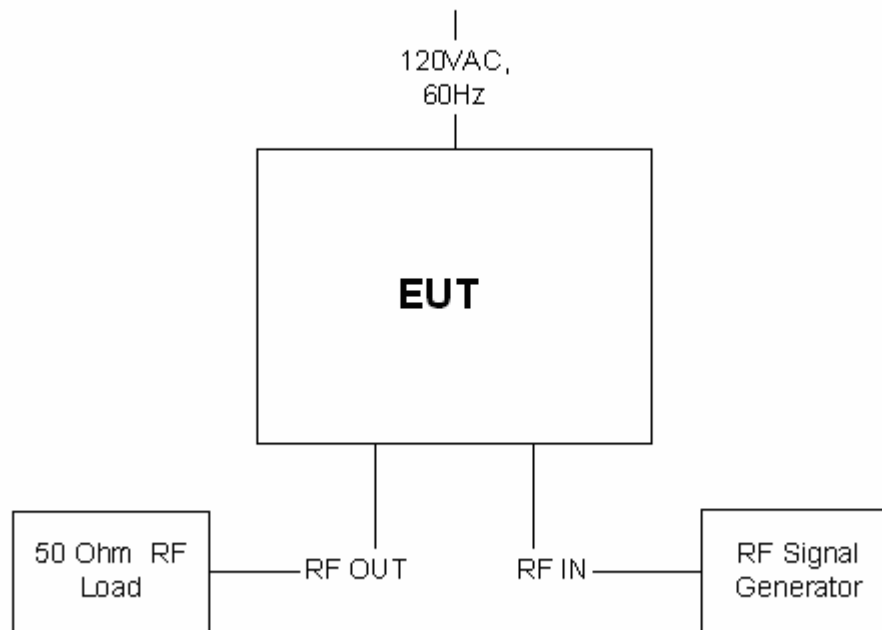
### 3.4. LIST OF EUT'S PORTS

| Port Number | EUT's Port Description    | Number of Identical Ports | Connector Type | Cable Type (Shielded/Non-shielded) |
|-------------|---------------------------|---------------------------|----------------|------------------------------------|
| 1           | RF In/Output              | 2                         | N female       | Shielded                           |
| 2           | Battery Backup Input      | 1                         | 3-pin MS style | Non-shielded                       |
| 3           | AC line conduit entry box | 1                         |                |                                    |

### 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 24-29 Vdc |

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

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

| Transmitter Test Signals                                                                                                      |                           |
|-------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| <b>Frequency Band(s):</b>                                                                                                     | 138 – 174 MHz             |
| <b>Frequency(ies) Tested:</b><br>(Near lowest, near middle and near highest frequencies in the frequency range of operation.) | 138, 159.8 MHz, 173.5 MHz |
| <b>RF Power Output (measured maximum output power):</b>                                                                       | 0.63 Watts                |
| <b>Normal Test Modulation:</b>                                                                                                | Unmodulated, F1D & F3E    |
| <b>Modulating signal source:</b>                                                                                              | 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)                      |
|---------------------------------|----------------------------------------------------------|---------------------------------------------|
| 2.1046 & 90.205                 | RF Power Output & Intermodulation                        | Yes                                         |
| 1.1307, 1.1310, 2.1091 & 2.1093 | RF Exposure Limit                                        | Yes                                         |
| 2.1055 & 90.213                 | Frequency Stability                                      | <sup>(1)</sup> Not applicable for amplifier |
| 2.1047(a) & 90.242(b)(8)        | Audio Frequency Response                                 | <sup>(2)</sup> Not applicable for amplifier |
| 2.1047(b) & 90.210              | Modulation Limiting                                      | <sup>(2)</sup> Not applicable for amplifier |
| 2.1049 & 90.210                 | Emission Limitation & Emission Mask                      | Yes                                         |
| 2.1051, 2.1057 & 90.210         | Emission Limits - Spurious Emissions at Antenna Terminal | Yes                                         |
| 2.1053, 2.1057 & 90.210         | Emission Limits - Field Strength of Spurious Emissions   | Yes                                         |

**Signal Booster 2, Model No.: 61-38-05**, 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

None.

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File #: TXRX-011FCC90  
June 29, 2005

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## **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 Exhibit 8 of this report, 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**

The essential function of the EUT is to receive an RF signal, raises its power, and couples it to an antenna so that it can be re-radiated.

## 6.5. RF POWER OUTPUT & INTERMODULATION [§§ 2.1046 & 90.205]

### 6.5.1. Limits

Please refer to FCC 47 CFR 90.205 for specification details.

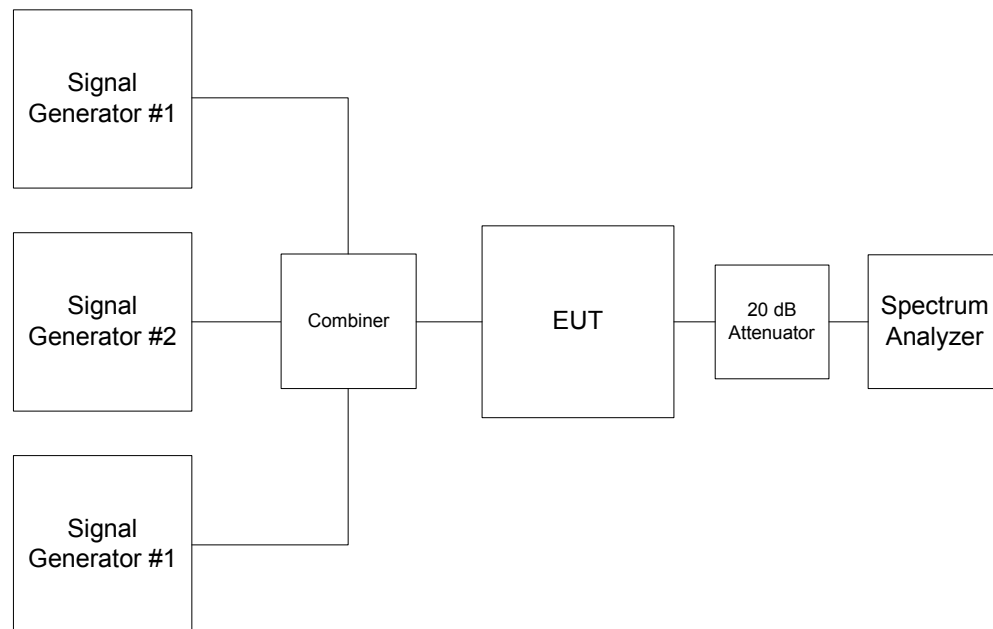
### 6.5.2. Method of Measurements

Refer to ULTRATECH Test Procedures, File # ULTR P001-2004, ANSI C63.4 and Exhibit 8 of this report for measurement details.

### 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 | Rohde & Schwarz | FSEK20/B4/B21 | 834157/005 | 9 kHz – 40 GHz    |

### 6.5.4. Test Arrangement



## 6.5.5. Test Data

### 6.5.5.1. RF POWER OUTPUT with MODULATION, SINGLE CHANNEL, MAXIMUM RF IN = - 20 dBm

#### 6.5.5.1.1. 120 Vac 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) |
|----------------------|------------|---------------------------------------------|-----------------------------------|-------------------|-----------------------------------------------|
| 138.0                | F1D/F3E    | 28.00                                       | 10                                | 38.00             | 28                                            |
| 159.8                | F1D/F3E    | 28.22                                       | 10                                | 38.22             | 28                                            |
| 173.5                | F1D/F3E    | 28.50                                       | 10                                | 38.50             | 28                                            |

#### 6.5.5.1.2. 29 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) |
|----------------------|------------|---------------------------------------------|-----------------------------------|-------------------|-----------------------------------------------|
| 138.0                | F1D/F3E    | 28.01                                       | 10                                | 38.01             | 28                                            |
| 159.8                | F1D/F3E    | 28.20                                       | 10                                | 38.20             | 28                                            |
| 173.5                | F1D/F3E    | 28.50                                       | 10                                | 38.50             | 28                                            |

### 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) | Manufacturer's Maximum RF Output Rating (conducted) (dBm) |
|-------------------------------------|---------------------------|-------------|------------------------------------|-------------------------------------|-----------------------------------|----------------------------|-----------------------------------------------------------|
| 138.0                               | 1                         | unmodulated | - 20.0                             | 27.4                                | 10                                | 37.4                       | 28.0                                                      |
| 138.00080<br>138.02580              | 2                         | unmodulated | -59.4                              | 24.4                                | 10                                | 34.4                       | 28.0                                                      |
| 138.00080<br>138.02580<br>138.05080 | 3                         | unmodulated | -62.4                              | 21.5                                | 10                                | 31.5                       | 28.0                                                      |
| 159.8                               | 1                         | unmodulated | -20.0                              | 27.8                                | 10                                | 37.8                       | 28.0                                                      |
| 159.80060<br>159.82560              | 2                         | unmodulated | -62.6                              | 23.01                               | 10                                | 33.01                      | 28.0                                                      |
| 159.80060<br>159.82560<br>159.85060 | 3                         | unmodulated | -65.9                              | 20.02                               | 10                                | 30.02                      | 28.0                                                      |
| 173.5                               | 1                         | unmodulated | -20.0                              | 28.03                               | 10                                | 38.03                      | 28.0                                                      |
| 173.50060<br>173.52560              | 2                         | unmodulated | -59.7                              | 24.1                                | 10                                | 34.1                       | 28.0                                                      |
| 173.50060<br>173.52560<br>173.55060 | 3                         | unmodulated | -62.9                              | 21.01                               | 10                                | 31.01                      | 28.0                                                      |

See the following plots (# 1-9) for Intermodulation in the 138-174 MHz band.

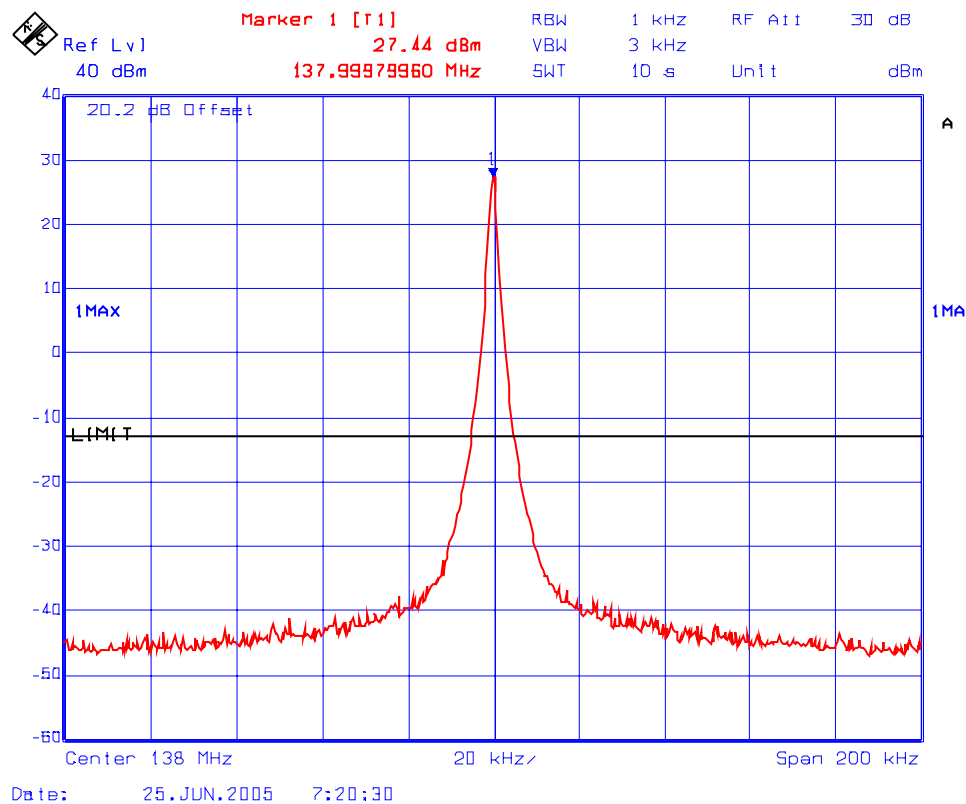
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**PLOT # 1**      **Intermodulation with 1 RF signal input in 138 – 174 MHz Frequency Band**  
**Fc: 138 MHz**  
**RF Input: - 20 dBm**



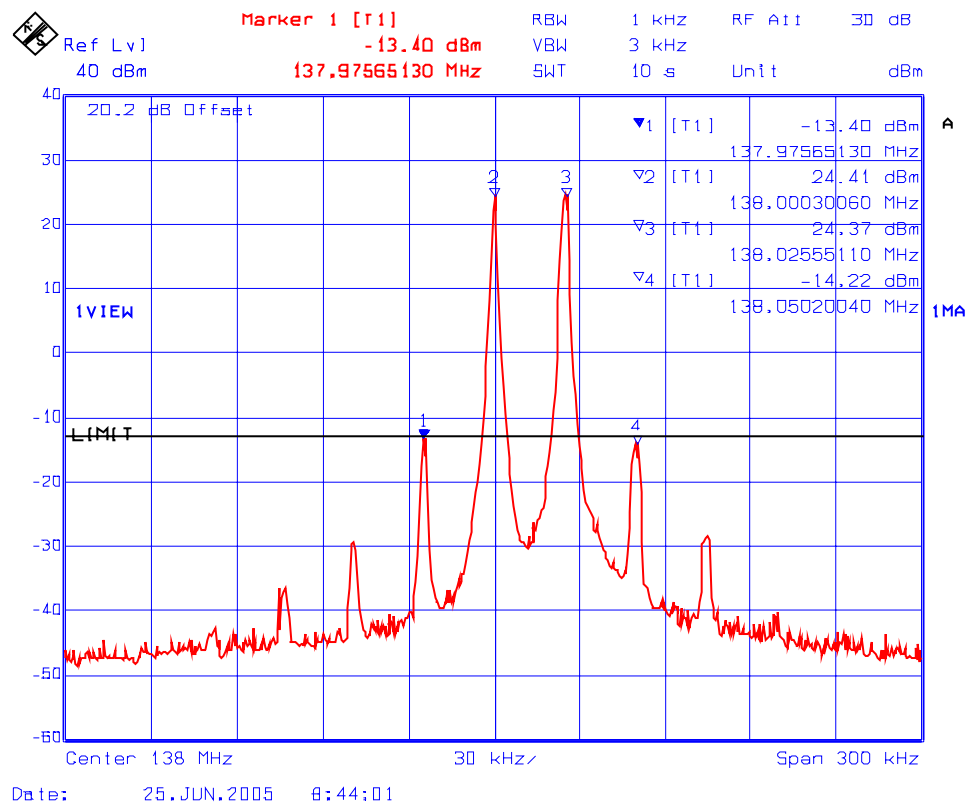
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**PLOT # 2**      **Intermodulation with 2 RF signal inputs/outputs in 138 – 174 Frequency Band**  
**Fc: 138 MHz & Fc + 25 kHz**  
**RF Input: (1) -59.38 dBm, (2) -59.31 dBm**



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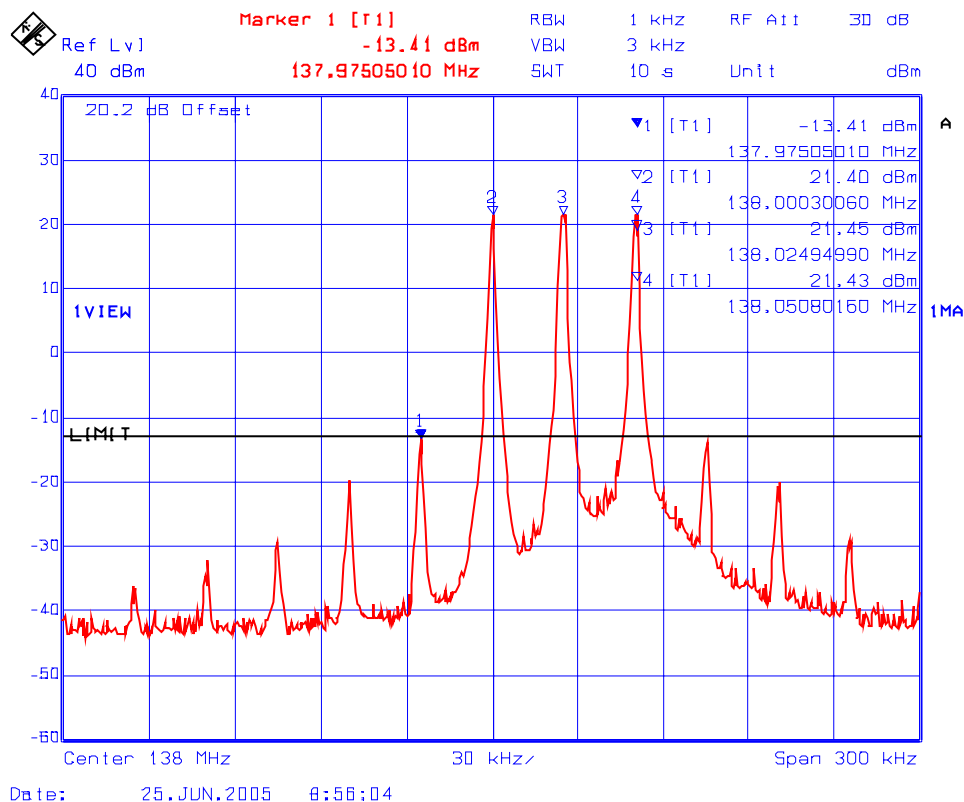
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**PLOT # 3**      **Intermodulation with 3 RF signal inputs/outputs in 138 – 174 MHz Frequency Band**  
**Fc: 138 MHz, Fc + 25 kHz & Fc + 50 kHz,**  
**RF Input: (1) -62.34 dBm, (2) -62.38 dBm, (3) -62.43 dBm**



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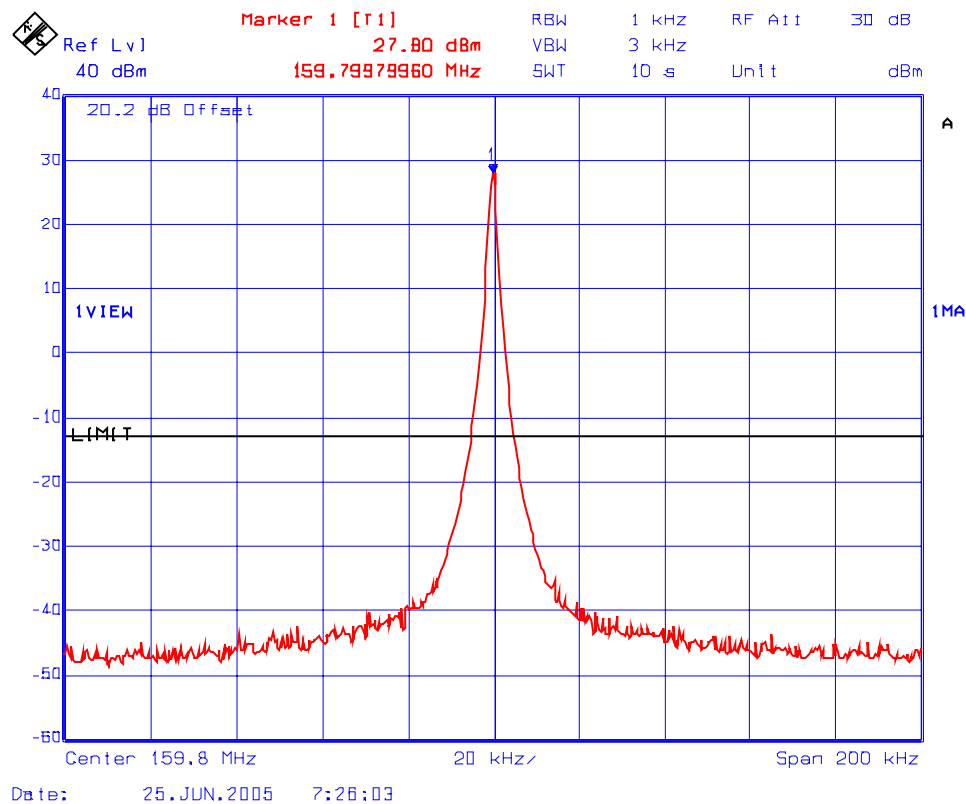
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**PLOT # 4**      **Intermodulation with 1 RF signal input in 138 – 174 MHz Frequency Band**  
**Fc: 159.8 MHz**  
**RF Input: - 20 dBm**



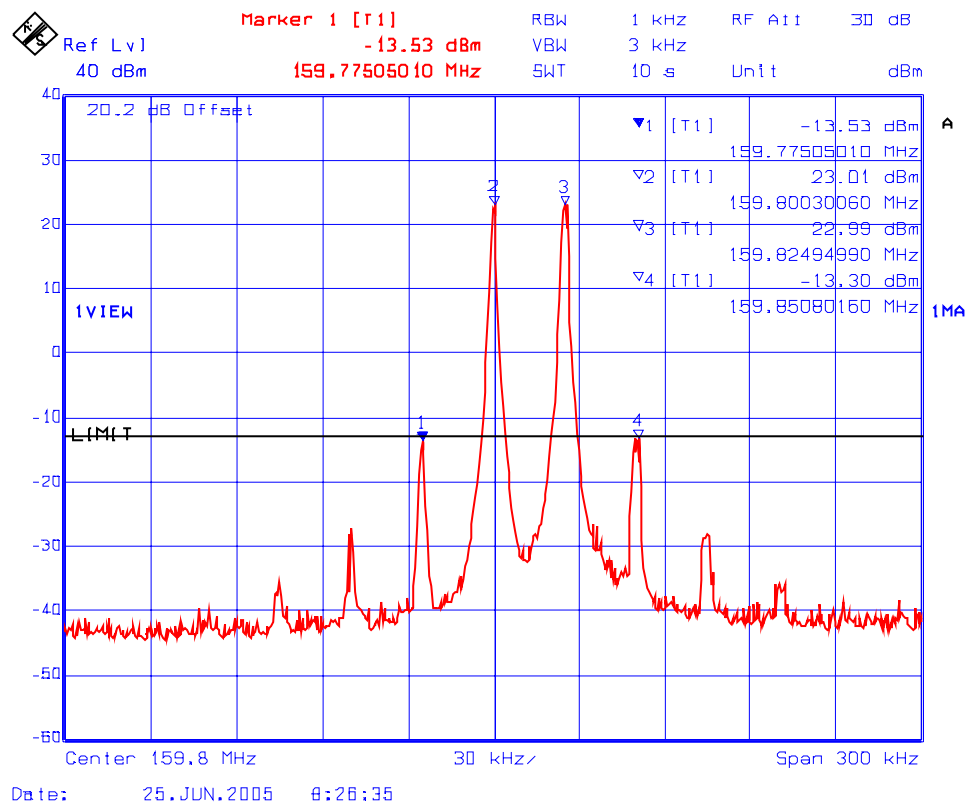
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**PLOT # 5**      **Intermodulation with 2 RF signal inputs/outputs in 138 – 174 MHz Frequency Band**  
**Fc: 159.8 MHz & Fc + 25 kHz**  
**RF Input: (1) -62.43 dBm, (2) -62.63 dBm**



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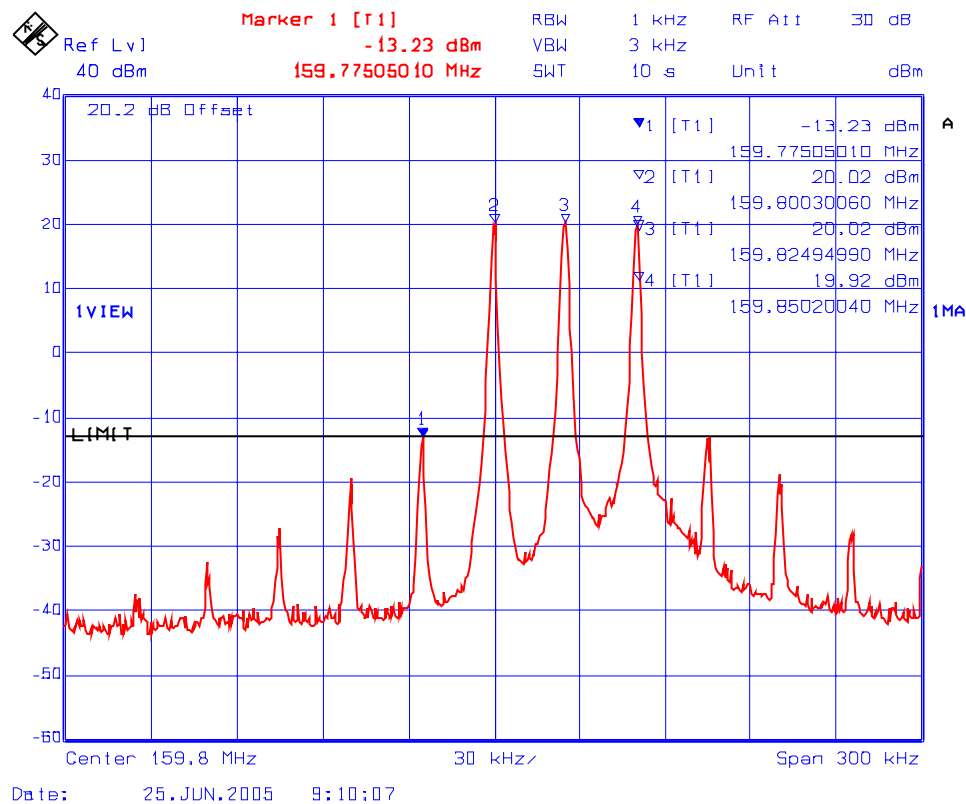
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**PLOT # 6**      **Intermodulation with 3 RF signal inputs/outputs in 138 - 174 MHz Frequency Band**  
**Fc: 159.8 MHz, Fc + 25 kHz & Fc + 50 kHz**  
**RF Input: (1) -65.46 dBm, (2) -65.70 dBm, (3) -65.90 dBm**



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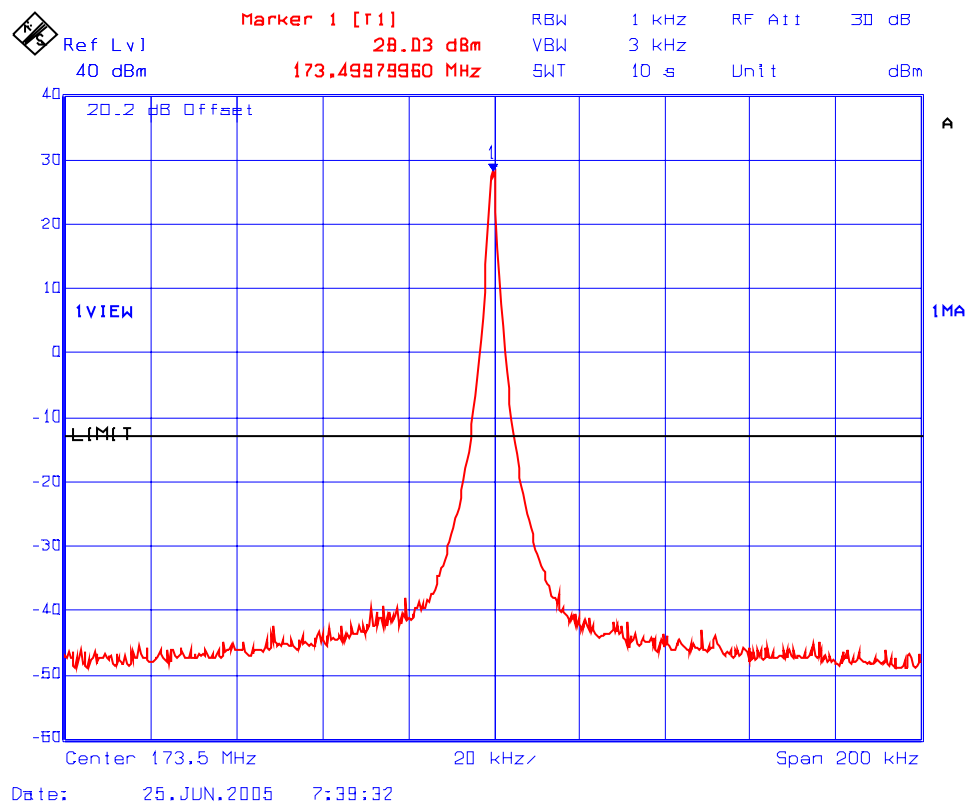
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**PLOT # 7**      **Intermodulation with 1 RF signal input in 138-174 MHz Band**  
**Fc: 173.5 MHz**  
**RF Input: - 20 dBm**



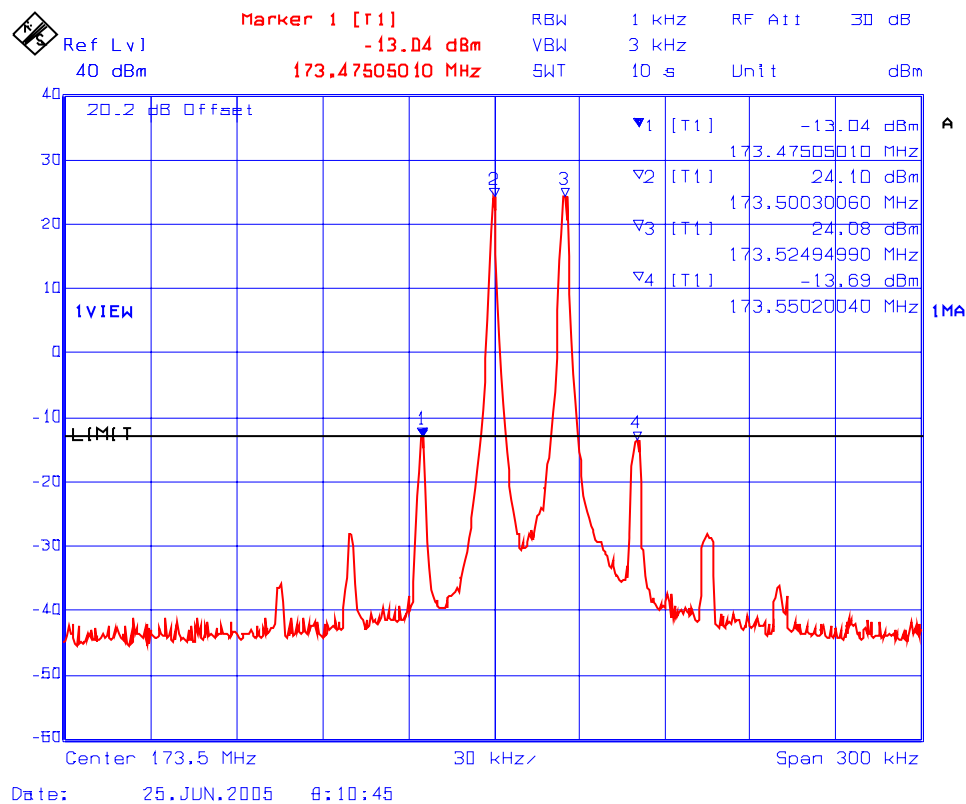
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**PLOT # 8**      **Intermodulation with 2 RF signal inputs/outputs in 138 - 174 MHz Frequency Band**  
**Fc: 173.5 MHz & Fc + 25 kHz**  
**RF Input: (1) -59.65 dBm, (2) -59.74 dBm**



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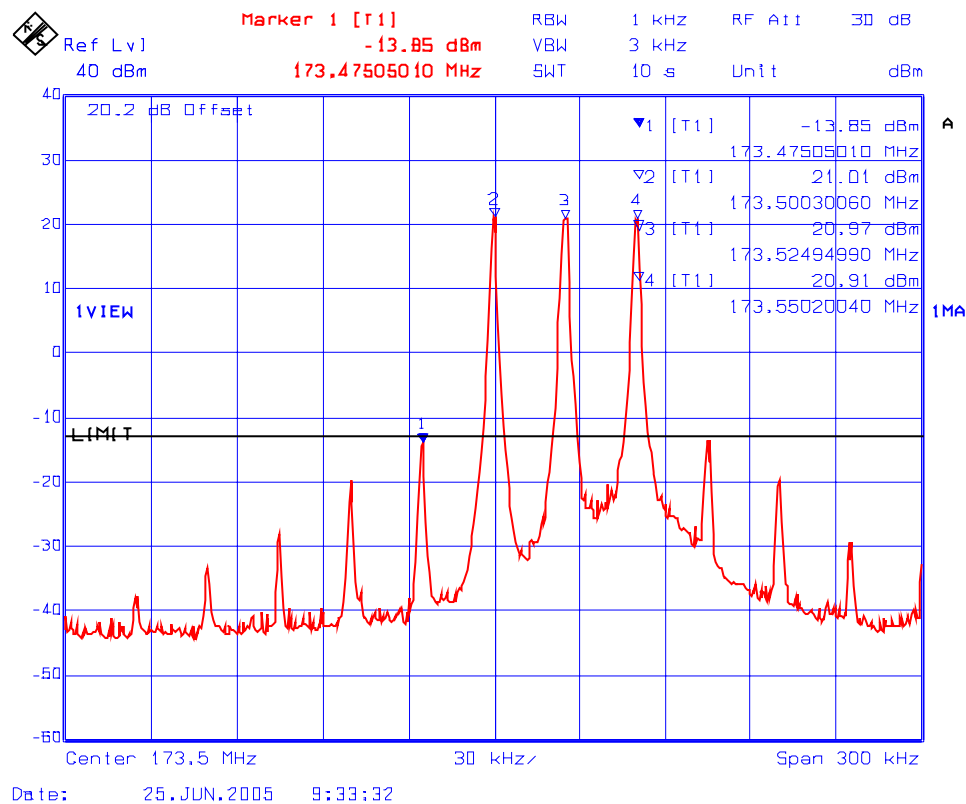
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**PLOT # 9**      **Intermodulation with 3 RF signal inputs/outputs in 138 - 174 MHz Frequency Band**  
**Fc: 173.5 z, Fc + 25 kHz & Fc + 50 kHz**  
**RF Input: (1) -62.87 dBm, (2) -62.91 dBm, (3) -62.94 dBm**



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## 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<br>(MHz)                                       | Electric field<br>strength<br>(V/m) | Magnetic field<br>strength<br>(A/m) | Power density<br>(mW/cm <sup>2</sup> ) | Averaging time<br>(minutes) |
|----------------------------------------------------------------|-------------------------------------|-------------------------------------|----------------------------------------|-----------------------------|
| <b>(A) Limits for Occupational/Controlled Exposures</b>        |                                     |                                     |                                        |                             |
| 0.3–3.0 .....                                                  | 614                                 | 1.63                                | *(100)                                 | 6                           |
| 3.0–30 .....                                                   | 1842/f                              | 4.89/f                              | *(900/f <sup>2</sup> )                 | 6                           |
| 30–300 .....                                                   | 61.4                                | 0.163                               | 1.0                                    | 6                           |
| 300–1500 .....                                                 | .....                               | .....                               | f/300                                  | 6                           |
| 1500–100,000 .....                                             | .....                               | .....                               | 5                                      | 6                           |
| <b>(B) Limits for General Population/Uncontrolled Exposure</b> |                                     |                                     |                                        |                             |
| 0.3–1.34 .....                                                 | 614                                 | 1.63                                | *(100)                                 | 30                          |
| 1.34–30 .....                                                  | 824/f                               | 2.19/f                              | *(180/f <sup>2</sup> )                 | 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<sup>2</sup>  
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) | Calculated Minimum RF Safety Distance r (cm)* | Manufacturer' Specified Separation Distance (cm) |
|----------------------------|-----------------------------------|-----------------------|-----------------------------------------------|--------------------------------------------------|
| 138                        | 28.5                              | 30.65                 | 21.5                                          | 21.5                                             |

- (1) The calculation is based on the lowest frequency (138 MHz) and the highest conducted power (28.5 dBm) for the worst case.

\* The minimum separation distance between the antenna and bodies of users are calculated using the following formula:

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

$$\text{General Population/ Uncontrolled Exposure: } S = 0.2 \text{ mW/cm}^2$$

$$r = EIRP/4\pi S)^{1/2} = (1161.45/4\pi(0.2))^{1/2} = 21.5 \text{ cm}$$

#### 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) |
|----------------------------|-----------------------------------|-----------------------|-----------------------------------------------|--------------------------------------------------|
| 138                        | 28.5                              | 40.65                 | 70                                            | 70                                               |

- (1) The calculation is based on the lowest frequency (138 MHz) and the highest conducted power (28.5 dBm) for the worst case.

\* The minimum separation distance between the antenna and bodies of users are calculated using the following formula:

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

$$\text{General Population/ Uncontrolled Exposure: } S = 0.2 \text{ mW/cm}^2$$

$$r = EIRP/4\pi S)^{1/2} = (11614.5/4\pi(0.2))^{1/2} = 70 \text{ cm}$$

| 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: 21.5 cm<br>*Outdoor Antenna: 70 cm                                                    | Manufacturer' instruction for separation distance between antenna and persons required:<br><br>Indoor Antenna: 21.5 cm<br>Outdoor Antenna: 70 cm |
| Antenna installation and device operating instructions for installers (professional/unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirement | Please refer to User's Manual for details.                                                                                                       |
| Caution statements and/or warning labels that are necessary in order to comply with the exposure limits                                                                                    | Please refer to User's Manual for RF Exposure Information.                                                                                       |
| Any other RF exposure related issues that may affect MPE compliance                                                                                                                        | None.                                                                                                                                            |

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## 6.7. OCCUPIED BANDWIDTH AND EMISSION MASK [§§ 2.1049, 90.209 & 90.210]

### 6.7.1. Limits

Emissions shall be attenuated below the mean output power of the transmitter as follows:

| Frequency Band (MHz) | Maximum Authorized BW (kHz) | Channel Spacing (kHz) | FCC Applicable Mask @ FCC 90.210 |
|----------------------|-----------------------------|-----------------------|----------------------------------|
| 150-174              | 20                          | 25                    | Mask B (voice) & Mask C (data)   |
| 150-174              | 11.25                       | 12.5                  | Mask D (voice & data)            |

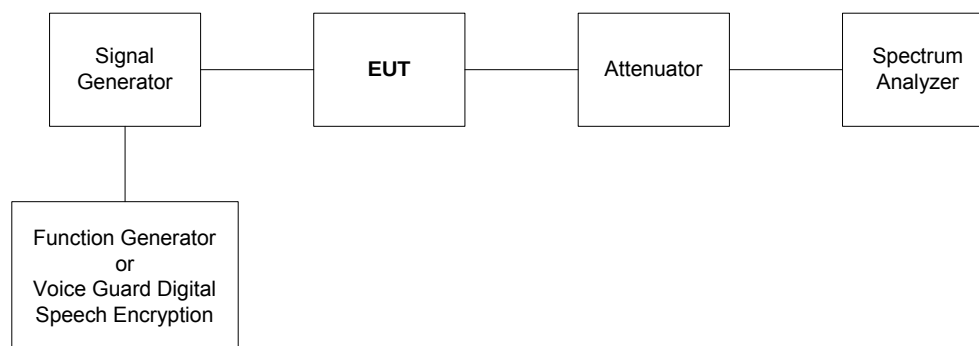
### 6.7.2. Method of Measurements

Refer to ULTRATECH Test Procedures, File # ULTR P001-2004 and Exhibit 8 of this report for measurement details.

### 6.7.3. 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  |
| 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     |

### 6.7.4. Test Arrangement



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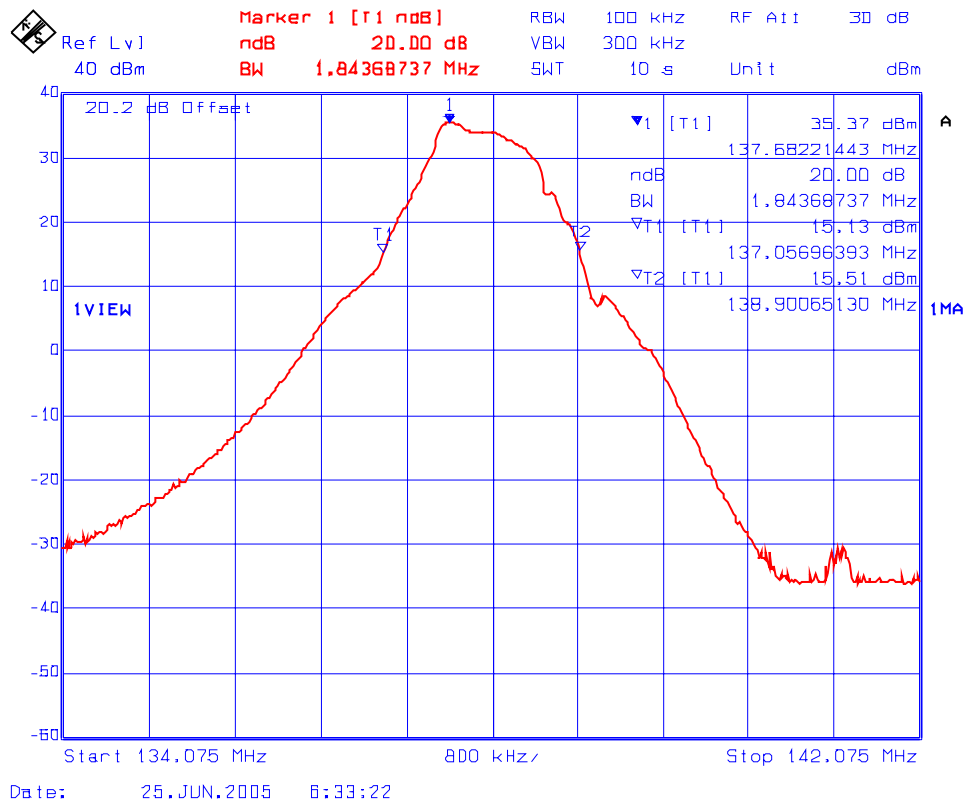
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## 6.7.5. Test Data

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

See the following plots for 20 dB passband gains of 138-174 MHz frequency band (Plot # 10 to 12).

**PLOT # 10**      **20 dB BW of the 138.00-138.15 MHz Passband Gain**  
**RF Input: -20 dBm. Tracking from 134.075-142.075 MHz**  
**Max Gain: 55.37 dB**



Note:

Manufacturer Specifications for Amplifier Bandwidth in 138-144 MHz band is 150 kHz. Please refer to User Manual for further details.

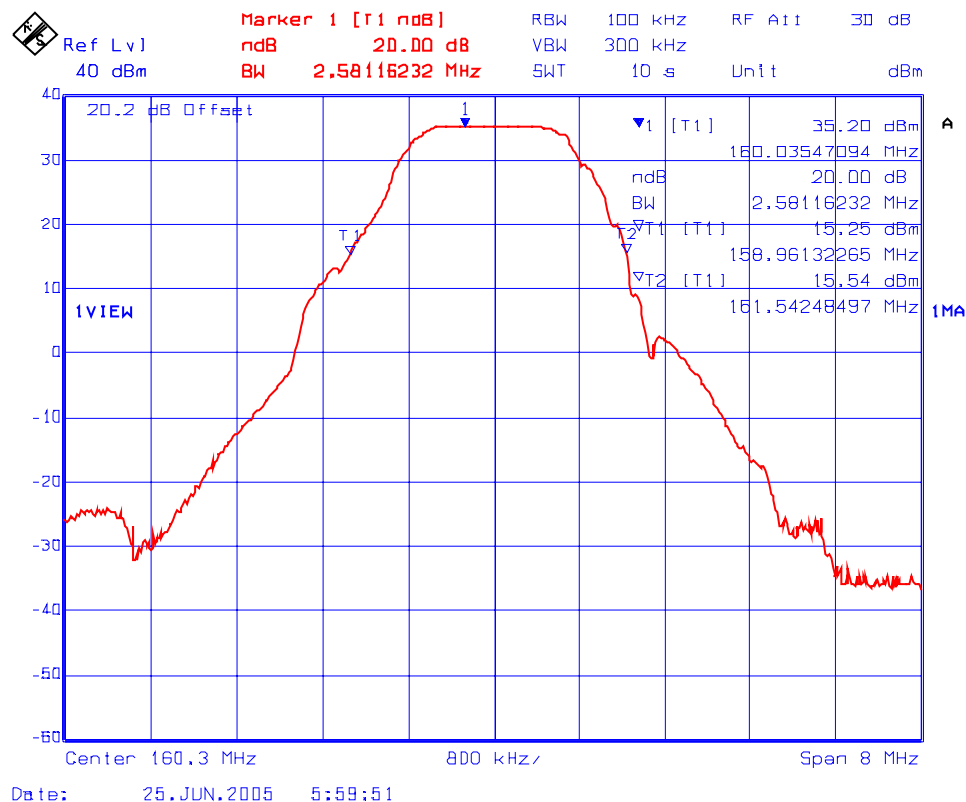
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**PLOT # 11**      **20 dB BW of the 159.8-160.8 MHz Passband Gain**  
**RF Input: -20 dBm. Tracking from 150-170 MHz**  
**Max Gain: 55.20 dB**



Note:

Manufacturer' Specifications for Amplifier Bandwidth in 148-174 MHz band is 1 MHz. Please refer to User Manual for further details.

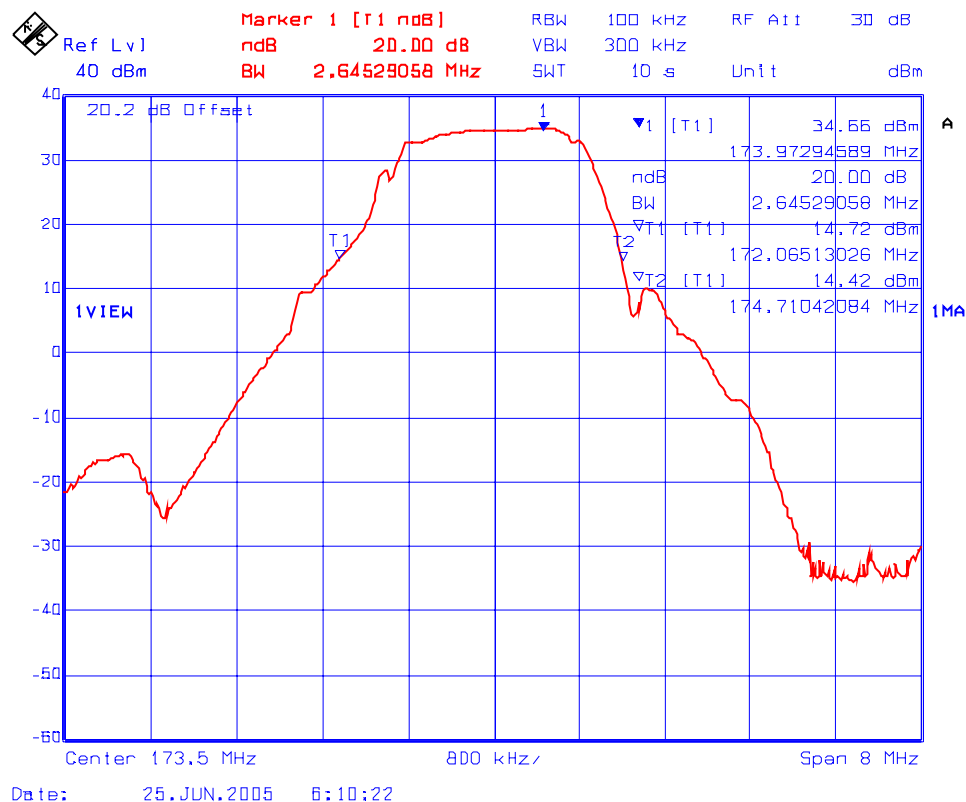
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**PLOT # 12      20 dB BW of the 173-174 MHz Passband Gain**  
**RF Input: -20 dBm. Tracking from 169.5-177.5 MHz**  
**Max Gain: 54.66 dB**



Note:  
Manufacturer' Specifications for Amplifier Bandwidth in 148-174 MHz band is 1 MHz. Please refer to User Manual for further details.

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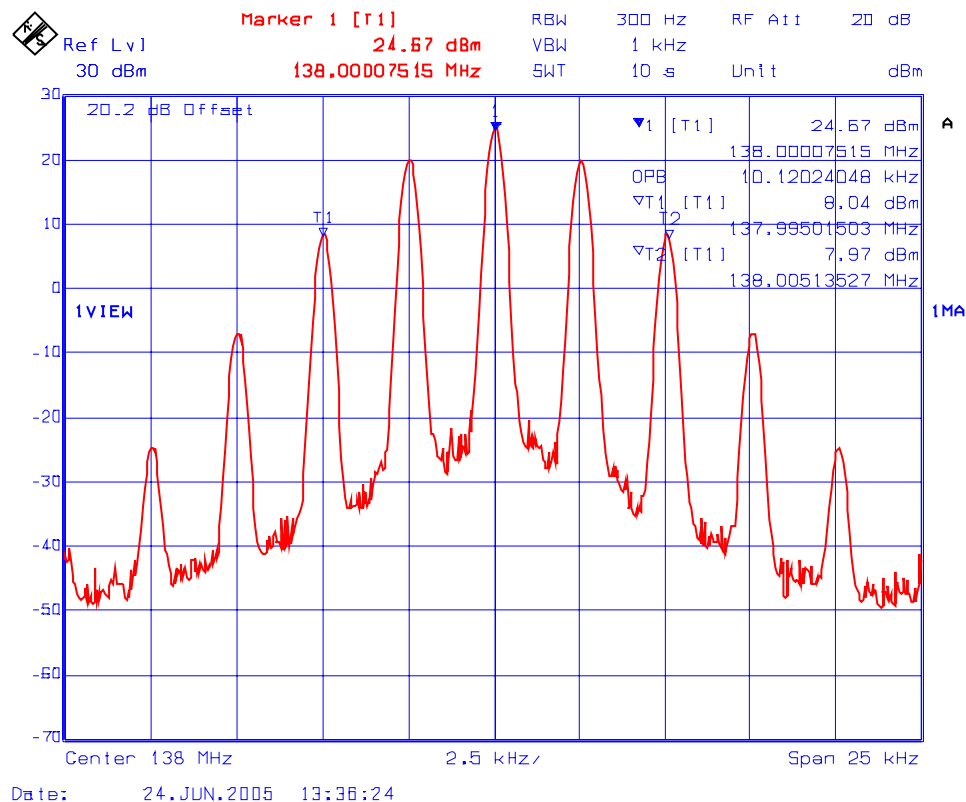
#### 6.7.5.2. 99% Occupied Bandwidth Measurements

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

| Frequency (MHz)                                                                               | Channel Spacing (kHz) | RF IN Measured 99% OBW (kHz) | RF OUT Measured 99% OBW (kHz) |
|-----------------------------------------------------------------------------------------------|-----------------------|------------------------------|-------------------------------|
| <b>Channel Spacing: 12.5, Modulation: FM with 2.5 kHz sine wave signal</b>                    |                       |                              |                               |
| 138                                                                                           | 12.5                  | --                           | 10.1                          |
| 159.8                                                                                         | 12.5                  | 10.1                         | 10.1                          |
| 173.5                                                                                         | 12.5                  | --                           | 10.1                          |
| <b>Channel Spacing: 25 kHz, Modulation: FM with 2.5 kHz sine wave signal</b>                  |                       |                              |                               |
| 138                                                                                           | 25.0                  | --                           | 15.2                          |
| 159.8                                                                                         | 25.0                  | 15.3                         | 15.2                          |
| 173.5                                                                                         | 25.0                  | --                           | 15.3                          |
| <b>Channel Spacing: 12.5 kHz, Modulation: FM with an external 9600 b/s random data source</b> |                       |                              |                               |
| 138                                                                                           | 12.5                  | --                           | 11.1                          |
| 159.8                                                                                         | 12.5                  | 11.3                         | 11.1                          |
| 173.5                                                                                         | 12.5                  | --                           | 11.2                          |
| <b>Channel Spacing: 25 kHz, Modulation: FM with an external 9600 b/s random data source</b>   |                       |                              |                               |
| 138                                                                                           | 25.0                  | --                           | 18.3                          |
| 159.8                                                                                         | 25.0                  | 18.0                         | 18.0                          |
| 173.5                                                                                         | 25.0                  | --                           | 17.8                          |

See the following plots (# 13-28) for 99% occupied bandwidth measurements.

**PLOT # 13**      **99% Occupied Bandwidth – RF Output Signal**  
**Frequency: 138 MHz, 12.5 kHz Channel Spacing**  
**Modulation: FM modulation with 2.5 kHz sine wave signal**



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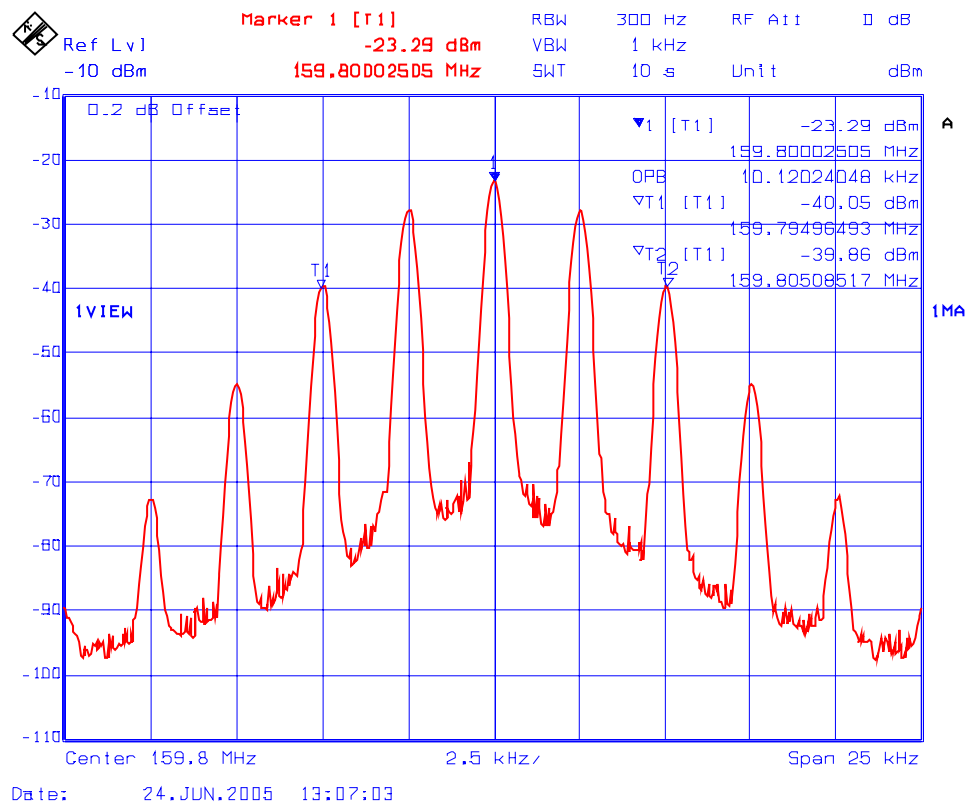
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**PLOT # 14**      **99% Occupied Bandwidth – RF Input Signal**  
**Frequency: 159.8 MHz, 12.5 kHz Channel Spacing**  
**Modulation: FM modulation with 2.5 kHz Sine wave signal**



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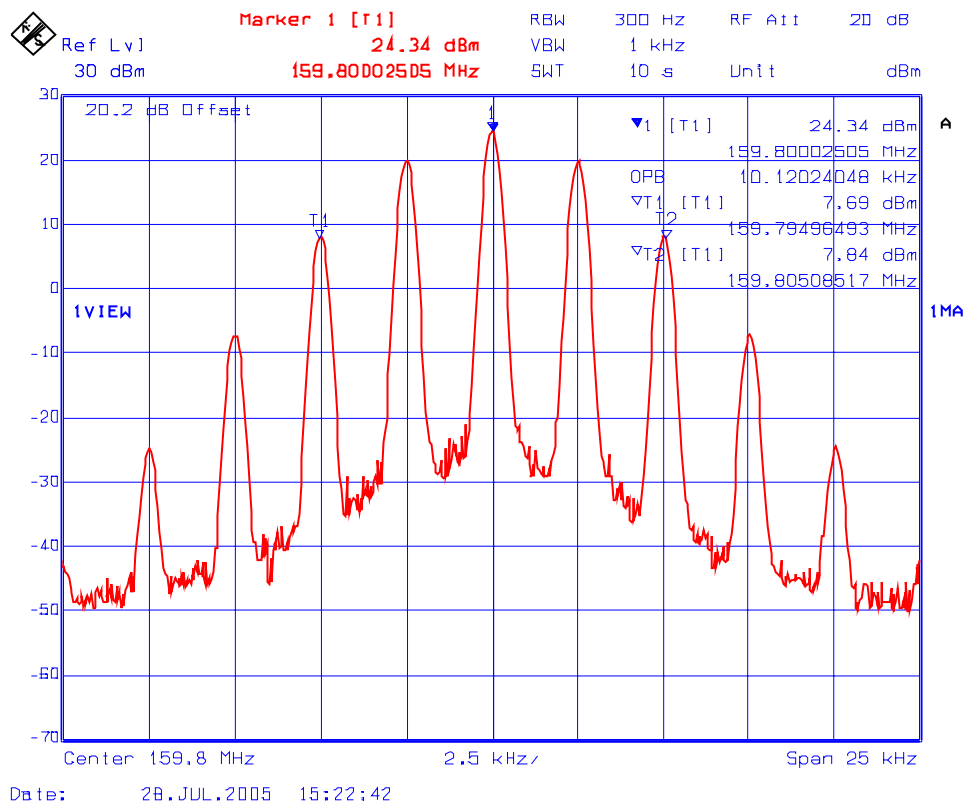
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**PLOT # 15**      **99% Occupied Bandwidth – RF Output signal**  
**Frequency: 159.8 MHz, 12.5 kHz Channel Spacing**  
**Modulation: FM modulation with 2.5 kHz sine wave signal**



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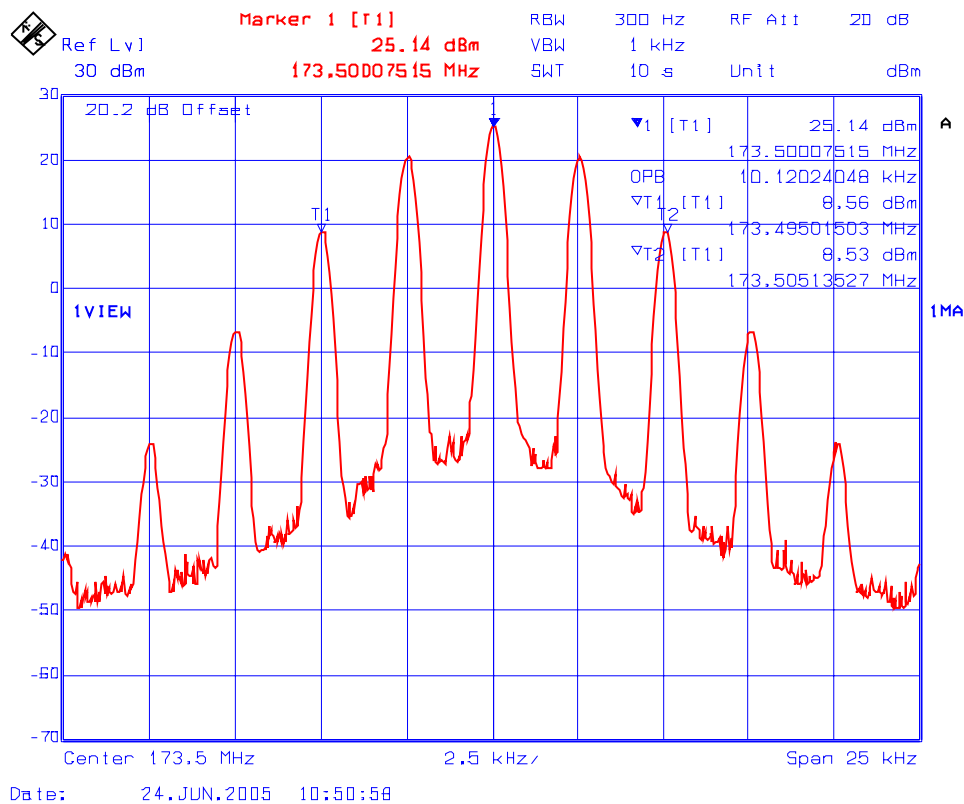
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4  
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Website: <http://www.ultratech-labs.com>

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June 29, 2005

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**PLOT # 16**      **99% Occupied Bandwidth– RF Output Signal**  
**Frequency: 173.5 MHz, 12.5 kHz Channel Spacing**  
**Modulation: FM modulation with 2.5 kHz sine wave signal**



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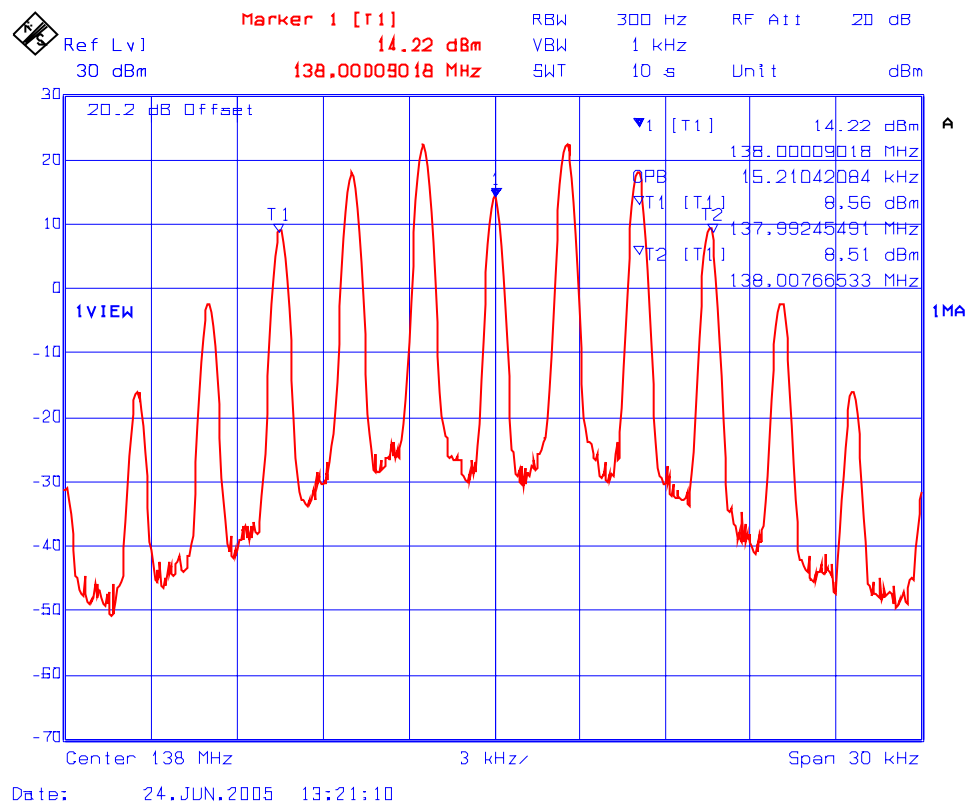
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4  
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Website: <http://www.ultratech-labs.com>

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**PLOT # 17**      **99% Occupied Bandwidth- RF Output Signal**  
**Frequency: 138 MHz, 25 kHz Channel Spacing**  
**Modulation: FM modulation with 2.5 kHz sine wave signal**



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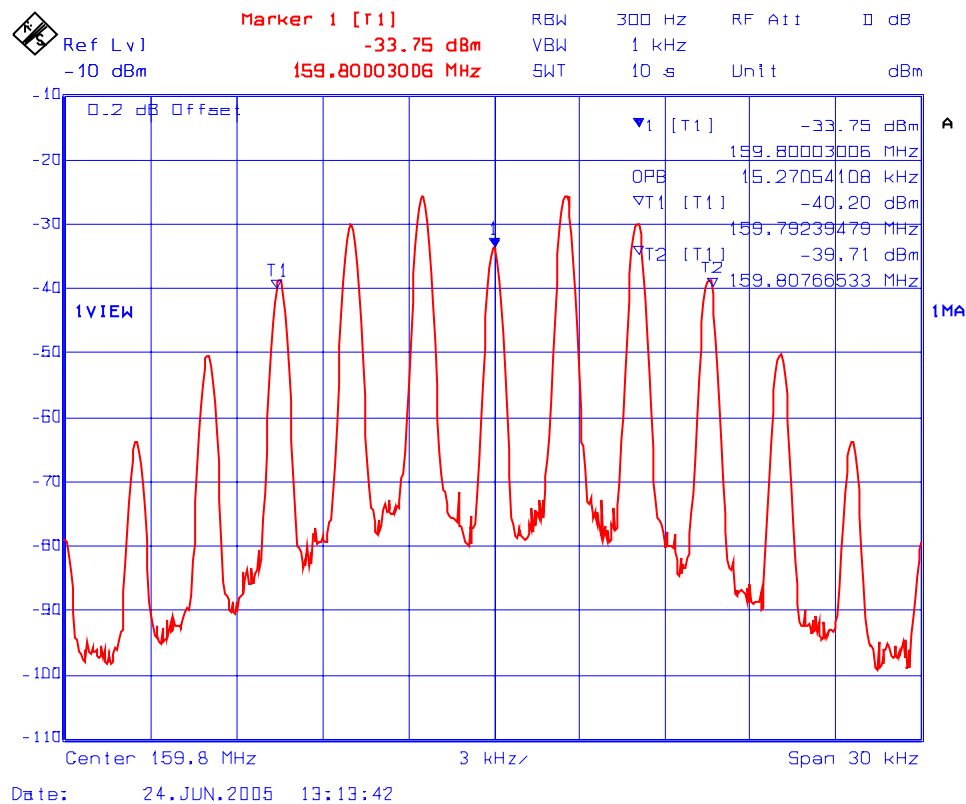
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4  
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Website: <http://www.ultratech-labs.com>

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**PLOT # 18**      **99% Occupied Bandwidth- RF Input signal**  
**Frequency: 159.8 MHz, 25 kHz Channel Spacing**  
**Modulation: FM modulation with 2.5 kHz sine wave signal**



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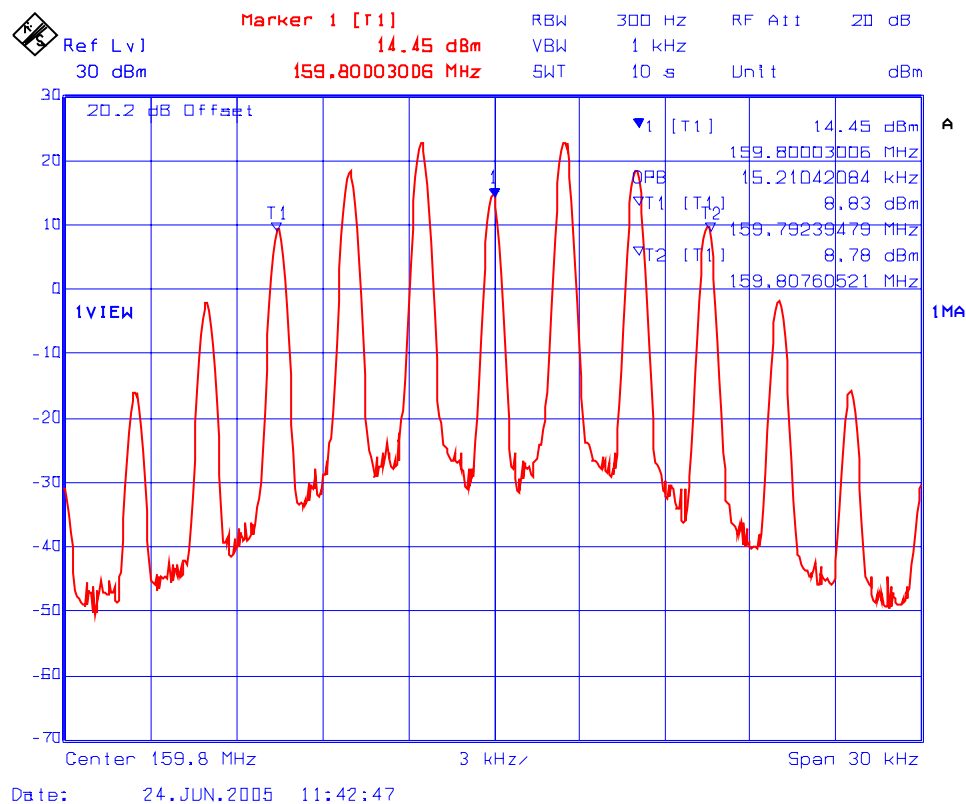
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4  
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Website: <http://www.ultratech-labs.com>

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**PLOT # 19**      **99% Occupied Bandwidth-RF Output signal**  
**Frequency: 159.8 MHz, 25 kHz Channel Spacing**  
**Modulation: FM modulation with 2.5 kHz sine wave signal**



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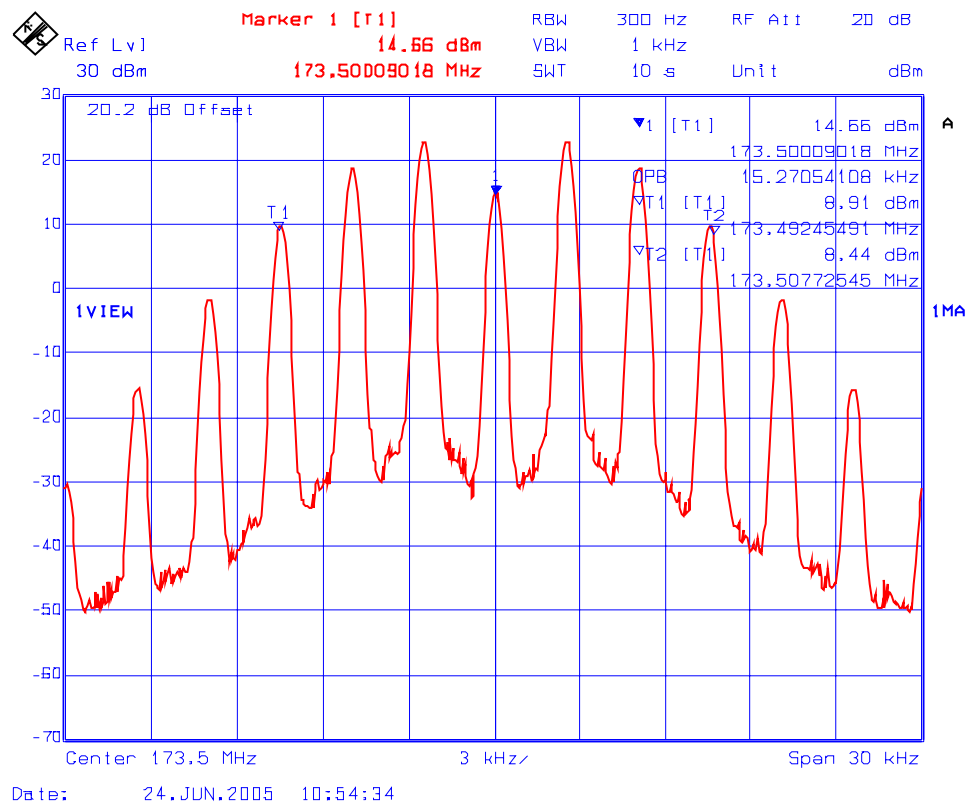
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4  
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Website: <http://www.ultratech-labs.com>

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**PLOT # 20**      **99% Occupied Bandwidth-RF Output signal**  
**Frequency: 173.5 MHz, 25 kHz Channel Spacing**  
**Modulation: FM modulation with 2.5 kHz sine wave signal**



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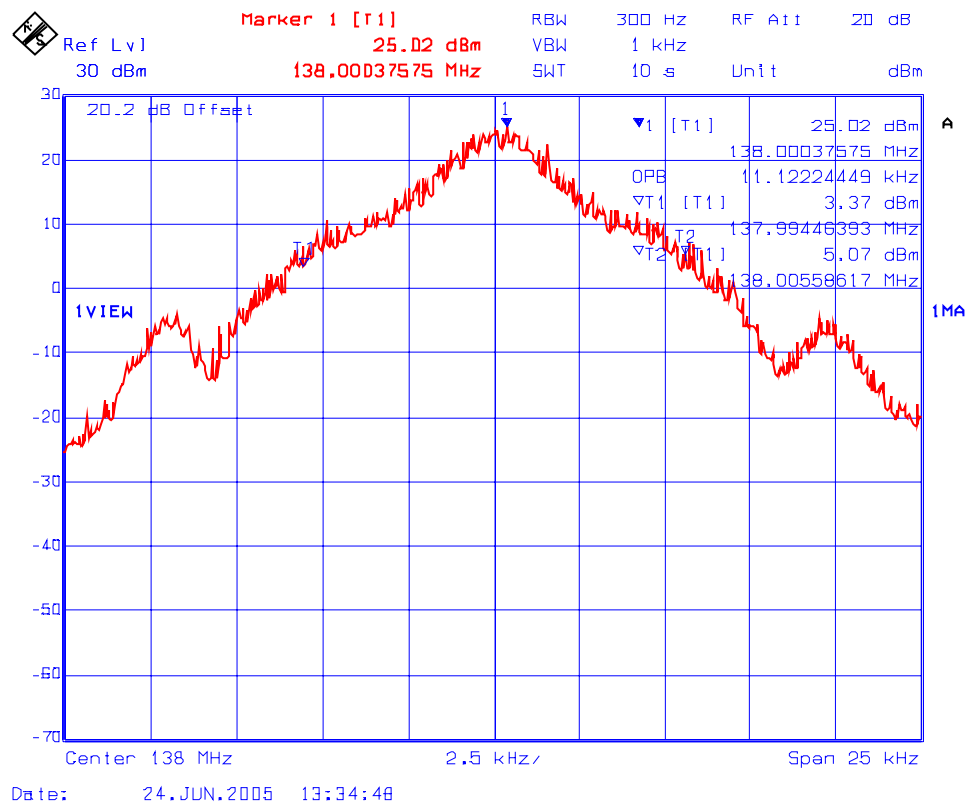
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4  
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Website: <http://www.ultratech-labs.com>

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**PLOT # 21**      **99% Occupied Bandwidth-RF Output signal**  
**Frequency: 138 MHz, 12.5 kHz Channel Spacing**  
**Modulation: FM Modulation with an external 9600 b/s random data source**



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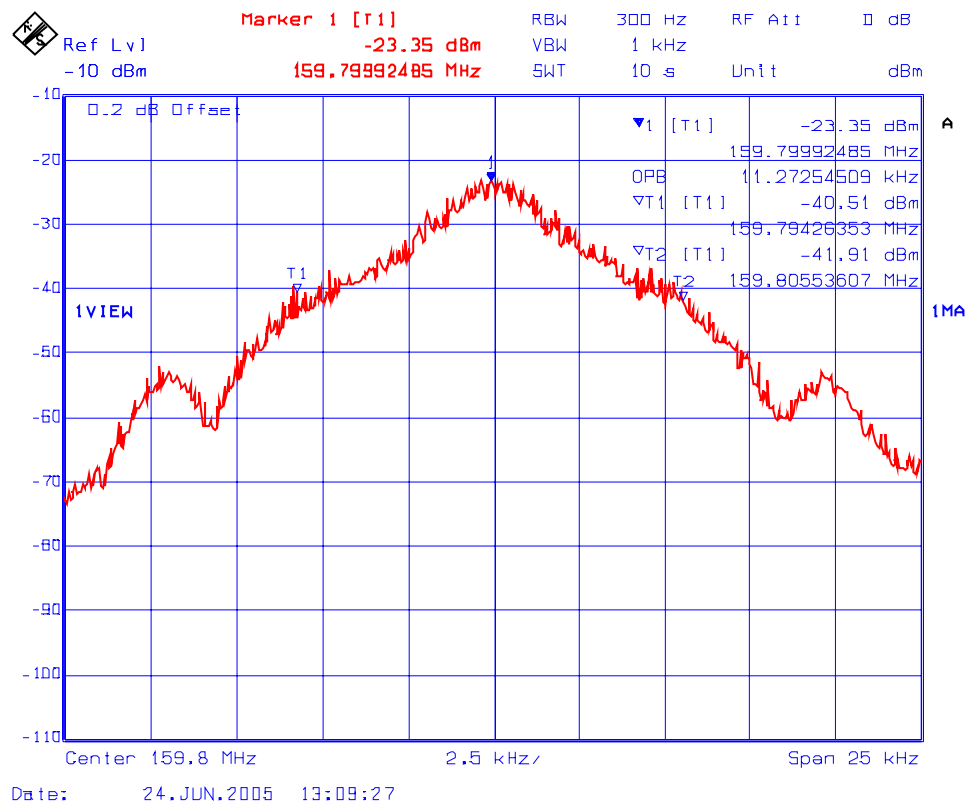
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4  
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Website: <http://www.ultratech-labs.com>

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**PLOT # 22**      **99% Occupied Bandwidth - RF Input signal**  
**Frequency: 159.8 MHz, 12.5 kHz Channel Spacing**  
**Modulation: FM modulation with an external 9600 b/s random data source**



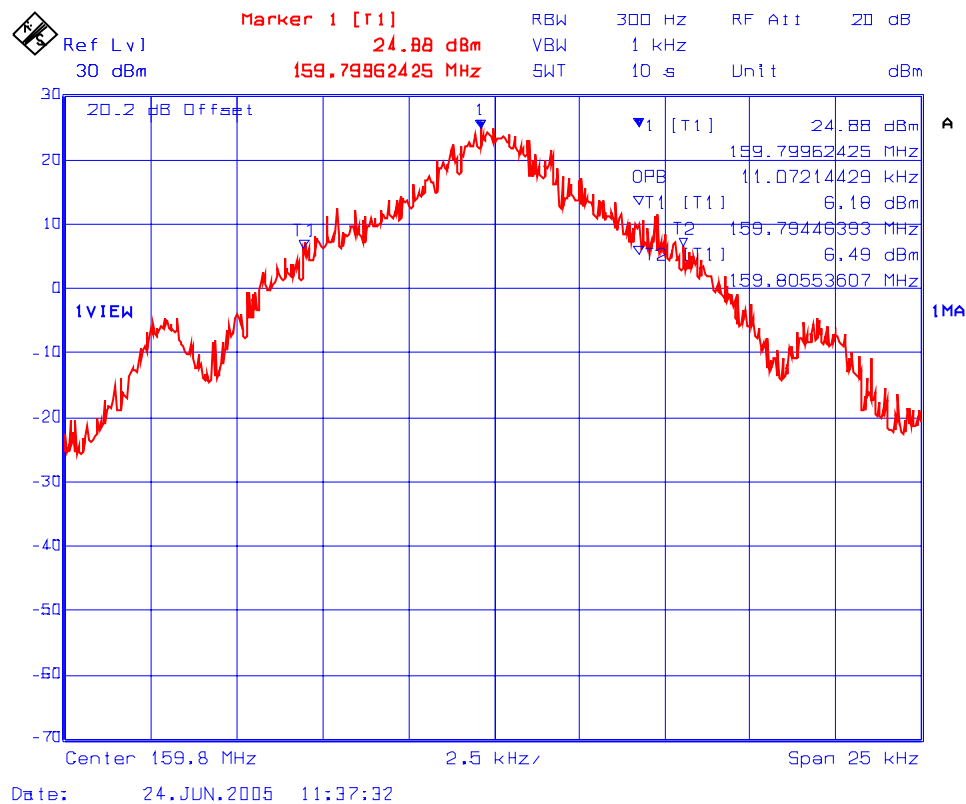
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**PLOT # 23**      **99% Occupied Bandwidth - RF Output signal**  
**Frequency: 159.8 MHz, 12.5 kHz Channel Spacing**  
**Modulation: FM modulation with an external 9600 b/s random data source**



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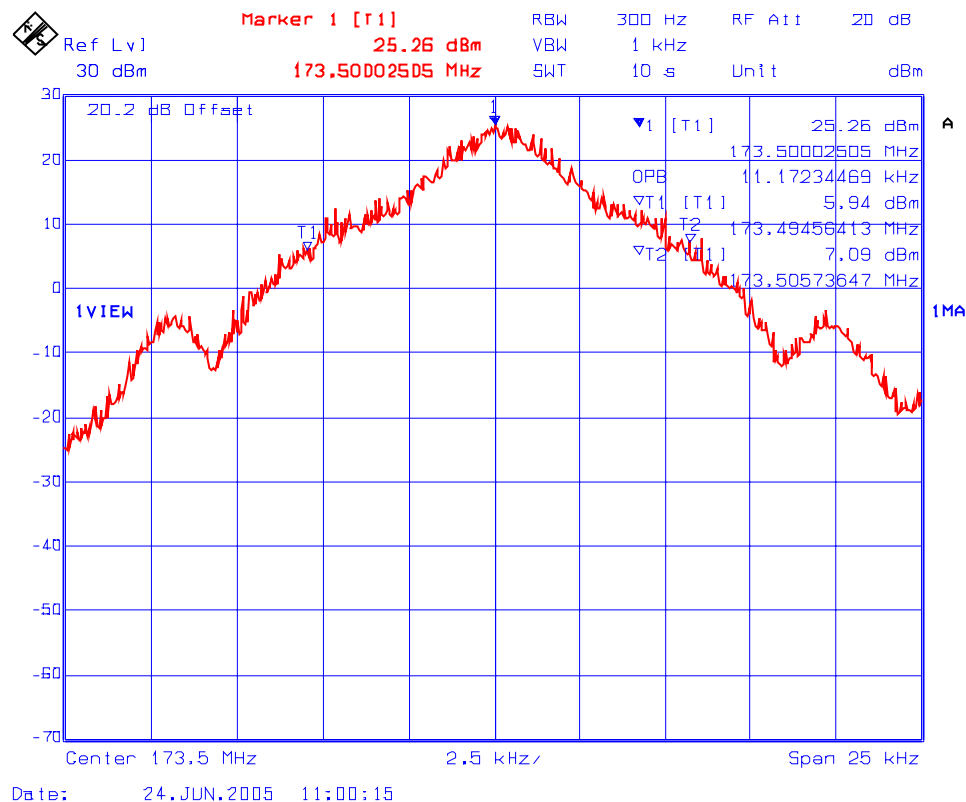
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4  
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Website: <http://www.ultratech-labs.com>

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**PLOT # 24**      **99% Occupied Bandwidth - RF Output signal**  
**Frequency: 173.5 MHz, 12.5 kHz Channel Spacing**  
**Modulation: FM modulation with an external 9600 b/s random data source**



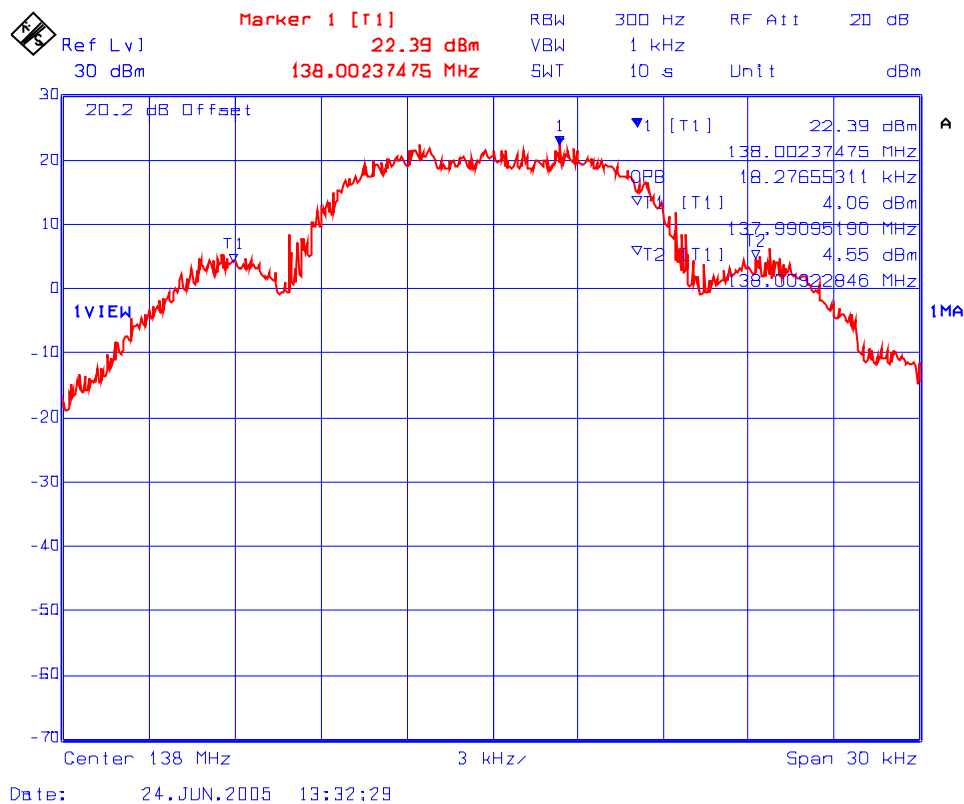
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**PLOT # 25**      **99% Occupied Bandwidth - RF Output signal**  
**Frequency: 138 MHz, 25 kHz Channel Spacing**  
**Modulation: FM modulation with an external 9600 b/s random data source**



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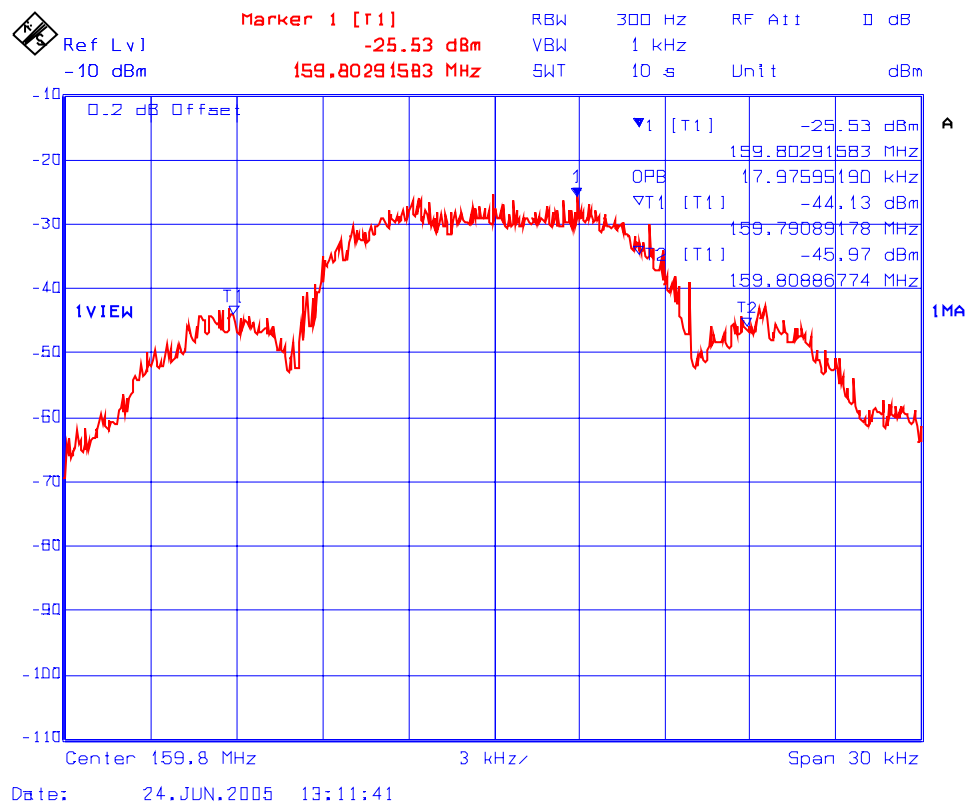
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4  
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Website: <http://www.ultratech-labs.com>

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**PLOT # 26**      **99% Occupied Bandwidth - RF Input signal**  
**Frequency: 159.8 MHz, 25 kHz Channel Spacing**  
**Modulation: FM modulation with an external 9600 b/s random data source**



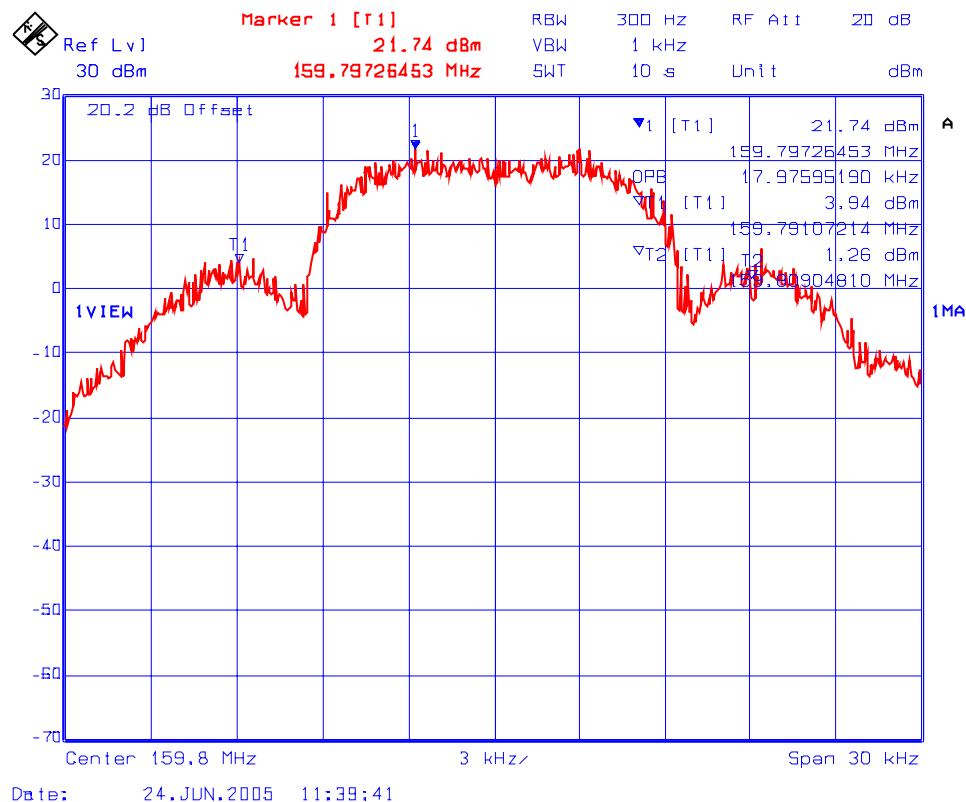
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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Website: <http://www.ultratech-labs.com>

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**PLOT # 27**      **99% Occupied Bandwidth - RF Output signal**  
**Frequency: 159.8 MHz, 25 kHz Channel Spacing**  
**Modulation: FM modulation with an external 9600 b/s random data source**



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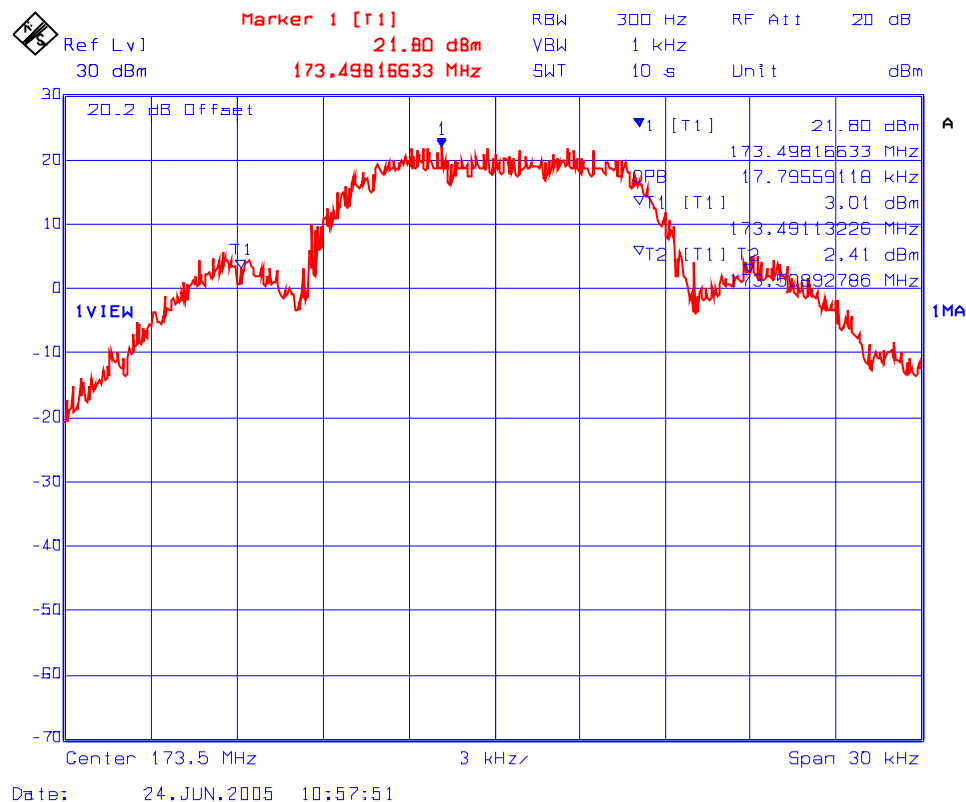
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4  
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Website: <http://www.ultratech-labs.com>

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**PLOT # 28**      **99% Occupied Bandwidth - RF Output signal**  
**Frequency: 173.5 MHz, 25 kHz Channel Spacing**  
**Modulation: FM modulation with an external 9600 b/s random data source**



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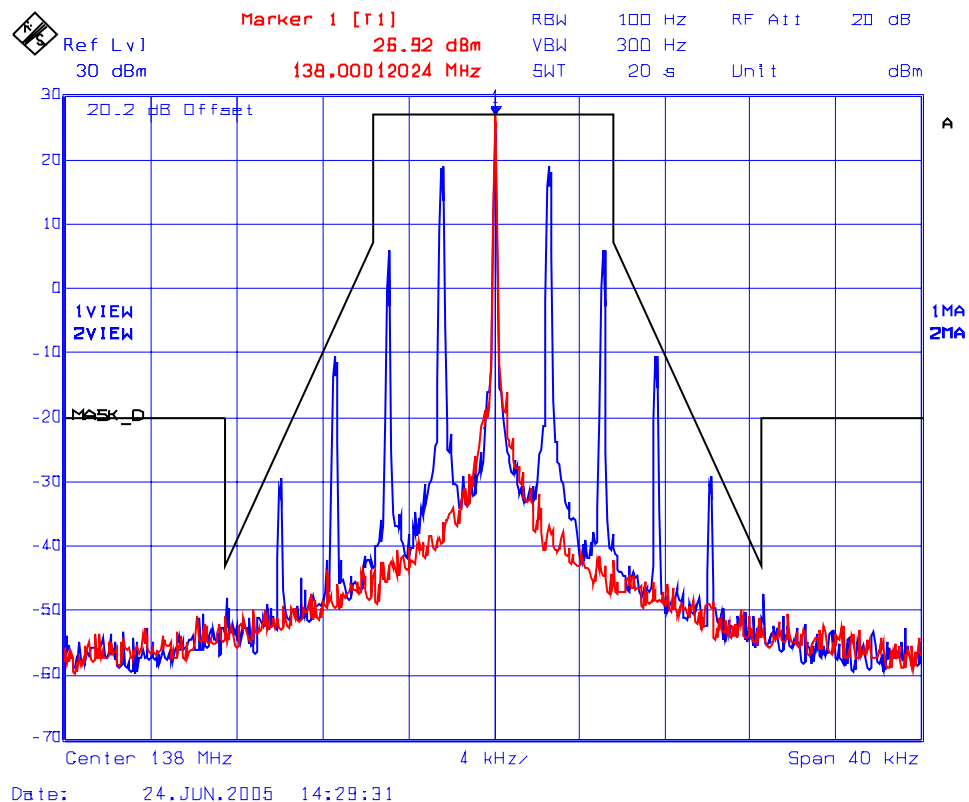
### 6.7.5.3. Emission Masks and Band-Edge Emissions

Conform.

#### 6.7.5.3.1. Emission Mask D, RF Output signal

See the following plots (29 through 34) for details.

**PLOT # 29**      **Frequency: 138 MHz, 12.5 kHz Channel Spacing**  
**Modulation: FM modulation with 2.5 kHz Sine wave signal**



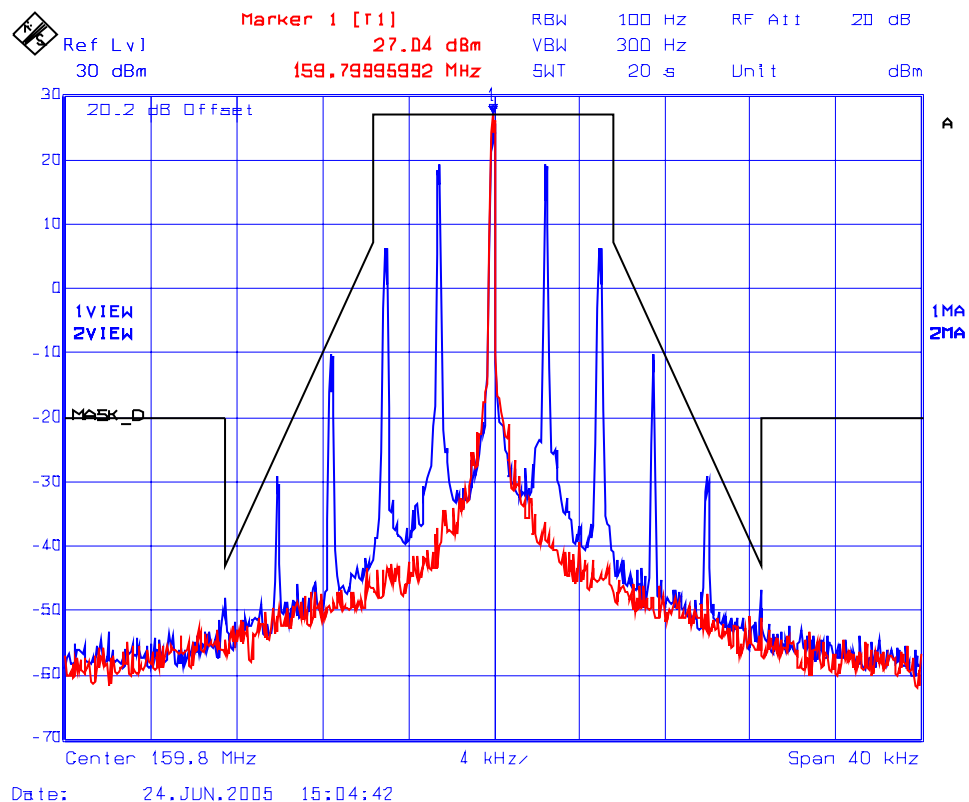
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**PLOT # 30**      **Emission Mask D - RF Output signal**  
**Frequency: 159.8 MHz, 12.5 kHz Channel Spacing**  
**Modulation: FM modulation with 2.5 kHz Sine wave signal**



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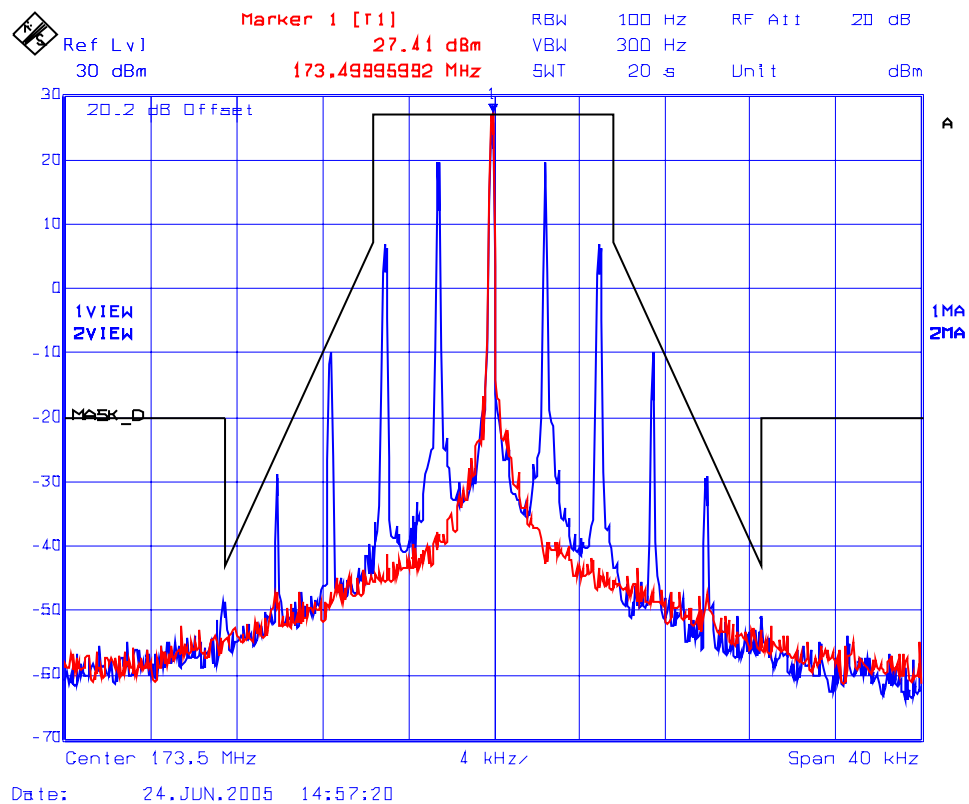
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4  
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Website: <http://www.ultratech-labs.com>

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**PLOT # 31**      **Emission Mask D - RF Output signal**  
**Frequency: 173.5 MHz, 12.5 kHz Channel Spacing**  
**Modulation: FM modulation with 2.5 kHz Sine wave signal**



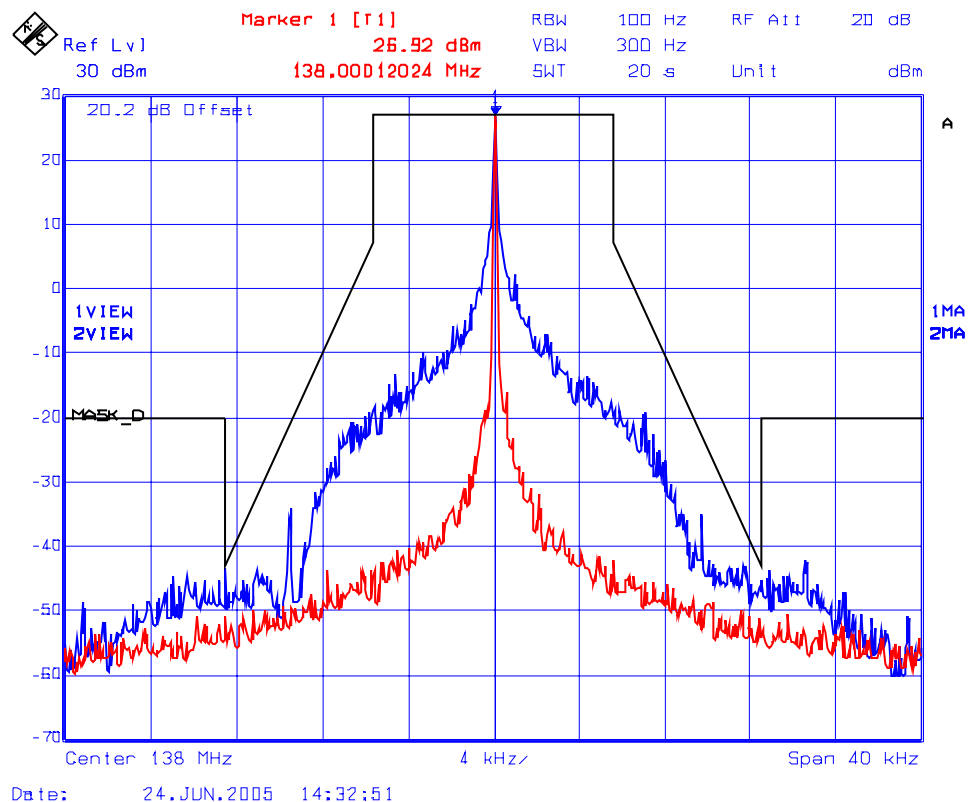
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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Website: <http://www.ultratech-labs.com>

File #: TXRX-011FCC90  
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**PLOT # 32**      **Emission Mask D- RF Output signal**  
**Frequency: 138 MHz, 12.5 kHz Channel Spacing**  
**Modulation: FM modulation with an external 9600 b/s random data source**



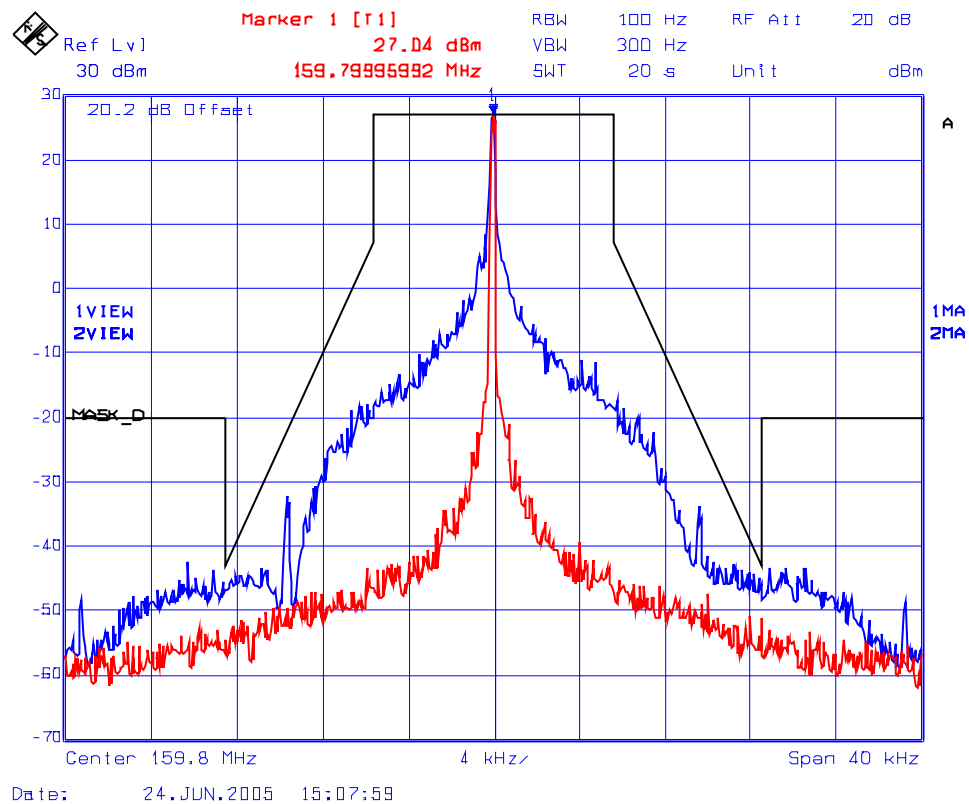
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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Website: <http://www.ultratech-labs.com>

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**PLOT # 33**      **Emission Mask D - RF Output signal**  
**Frequency: 159.8 MHz, 12.5 kHz Channel Spacing**  
**Modulation: FM modulation with an external 9600 b/s random data source**



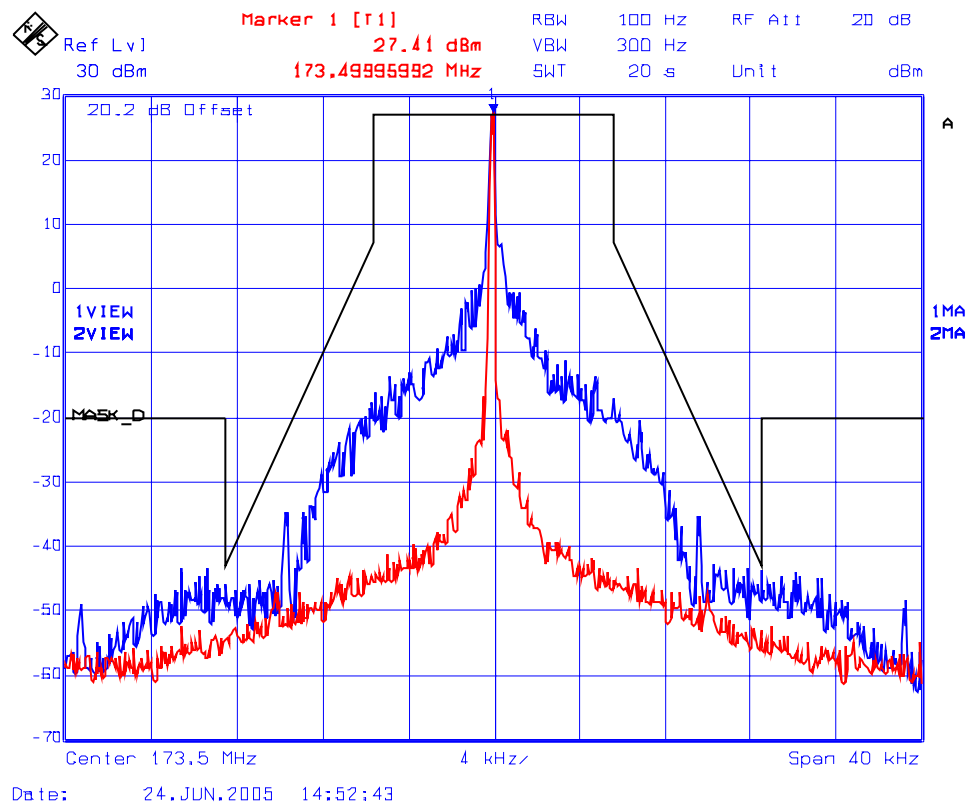
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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Website: <http://www.ultratech-labs.com>

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**PLOT # 34**      **Emission Mask D - RF Output signal**  
**Frequency: 173.5 MHz, 12.5 kHz Channel Spacing**  
**Modulation: FM modulation with an external 9600 b/s random data source**



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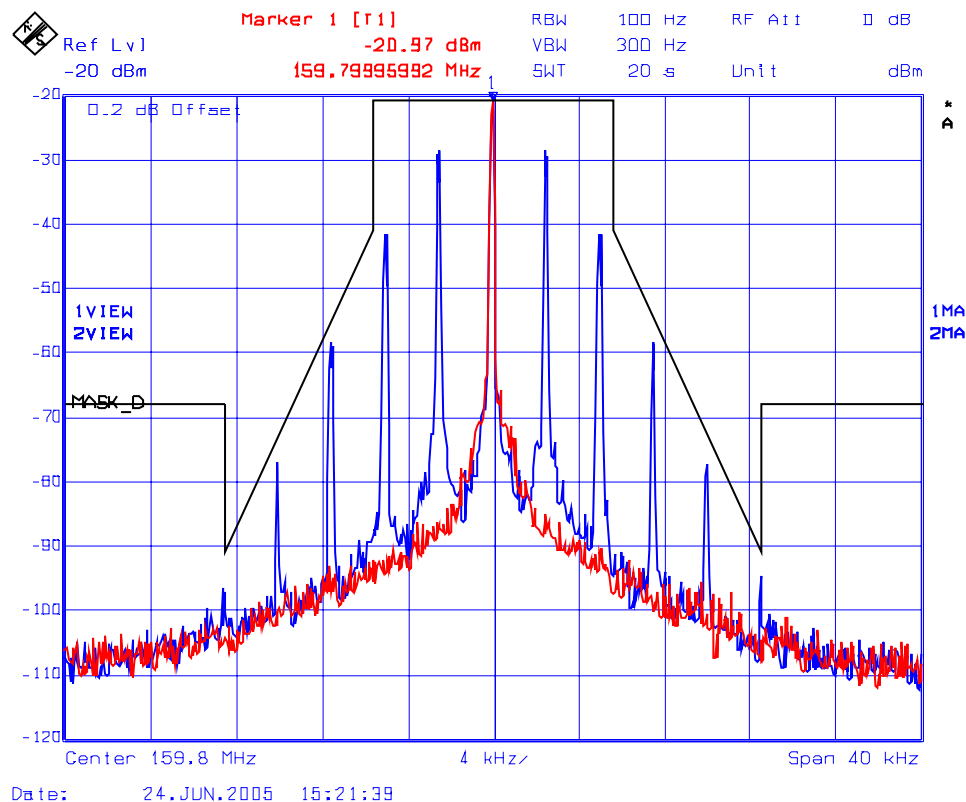
File #: TXRX-011FCC90  
June 29, 2005

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

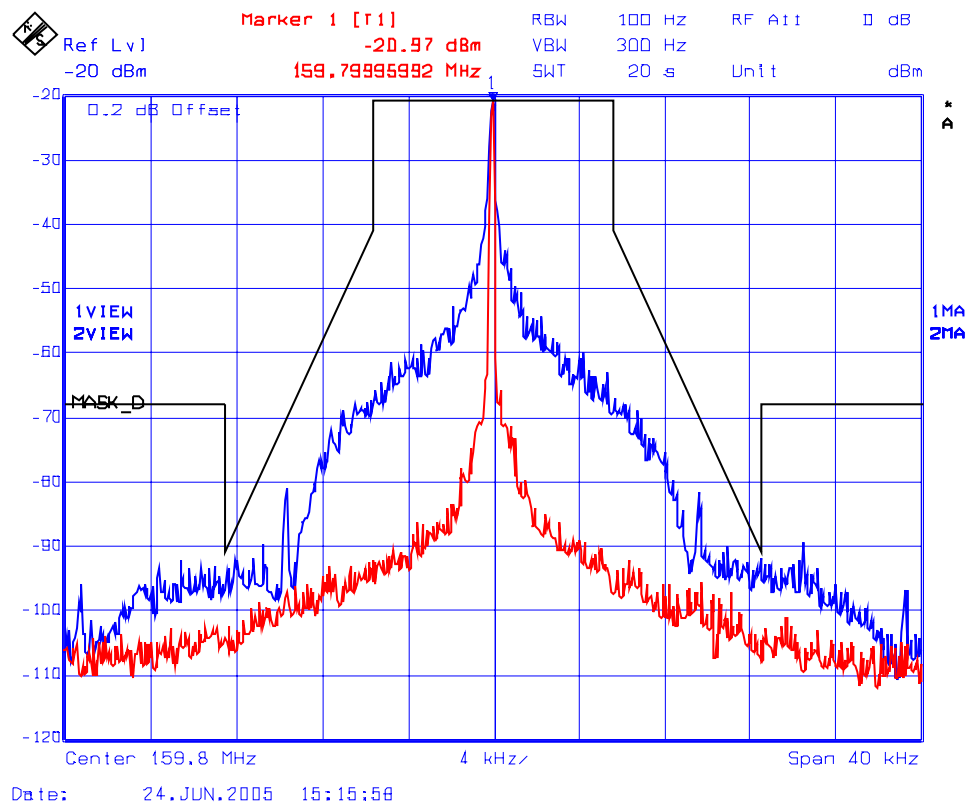
**6.7.5.3.2. Emission Mask D, RF Input signal**

See the following plots (35 and 36) for details.

**PLOT # 35**      **Frequency: 159.8 MHz, 12.5 kHz Channel Spacing**  
**Modulation: FM modulation with 2.5 kHz Sine wave signal**



**PLOT # 36**      **Frequency: 159.8 MHz, 12.5 kHz Channel Spacing**  
**Modulation: FM modulation with an external 9600 b/s random data source**



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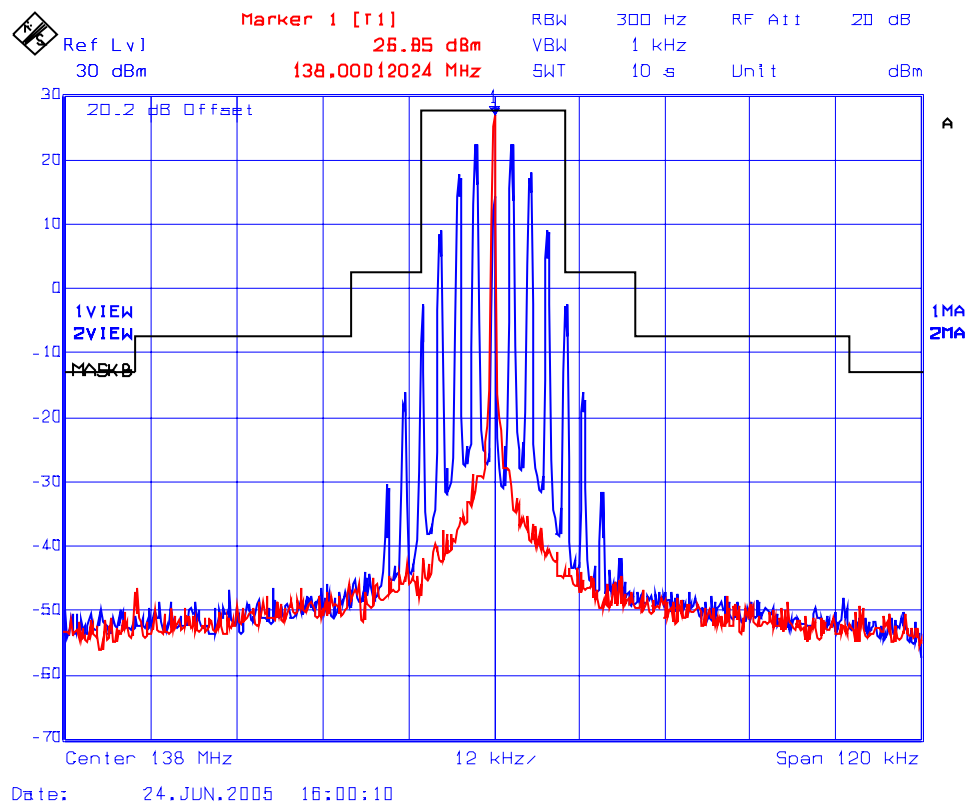
File #: TXRX-011FCC90  
June 29, 2005

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**6.7.5.3.3. Emission Mask B, RF Output signal**

See the following plots (37 through 39) for details.

**PLOT # 37**      **Frequency: 138 MHz, 25 kHz Channel Spacing**  
**Modulation: FM modulation with 2.5 kHz Sine wave signal**



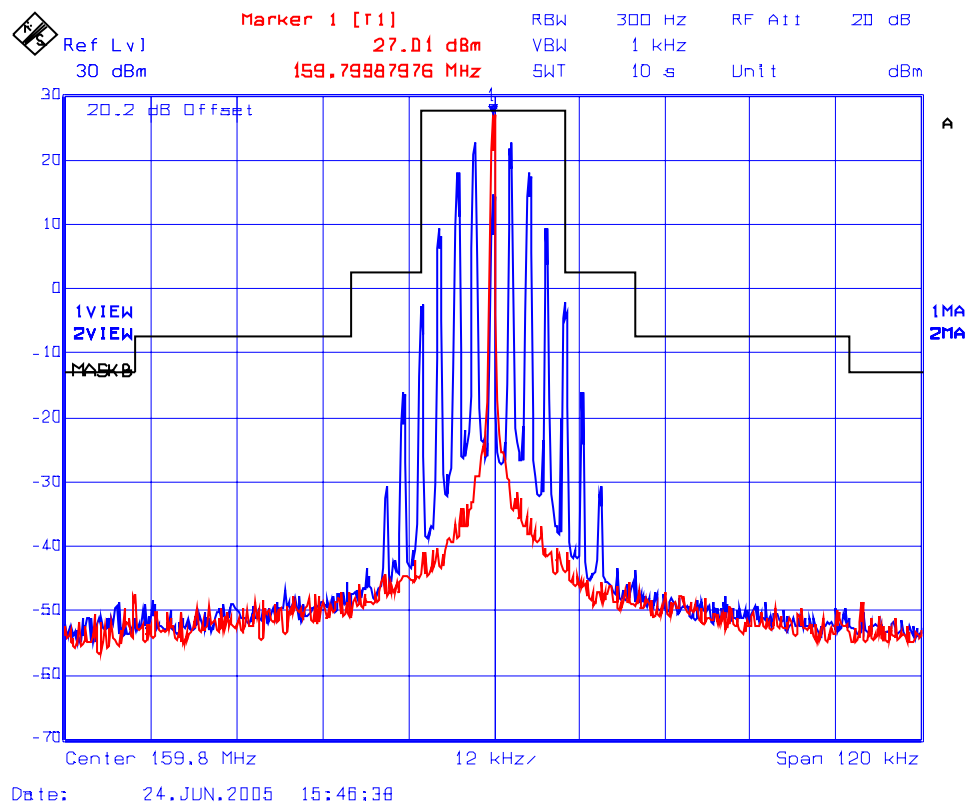
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**PLOT # 38**      **Frequency: 159.8 MHz, 25 kHz Channel Spacing**  
**Modulation: FM modulation with 2.5 kHz Sine wave signal**



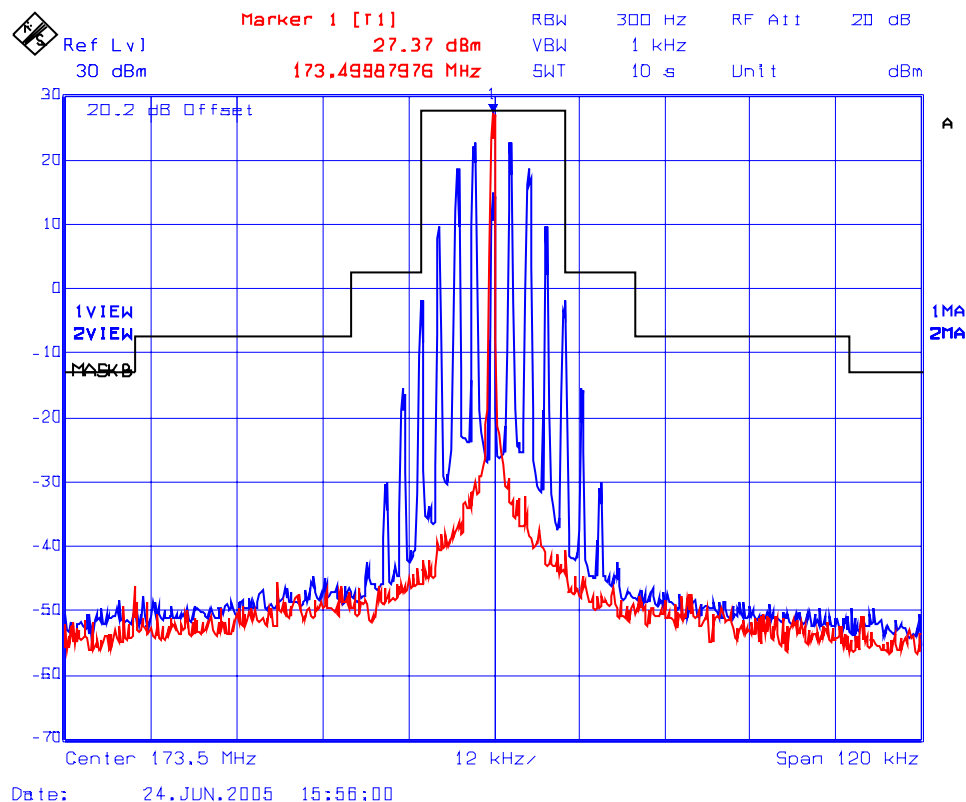
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**PLOT # 39**      **Frequency: 173.5 MHz, 25 kHz Channel Spacing**  
**Modulation: FM modulation with 2.5 kHz sine wave signal**



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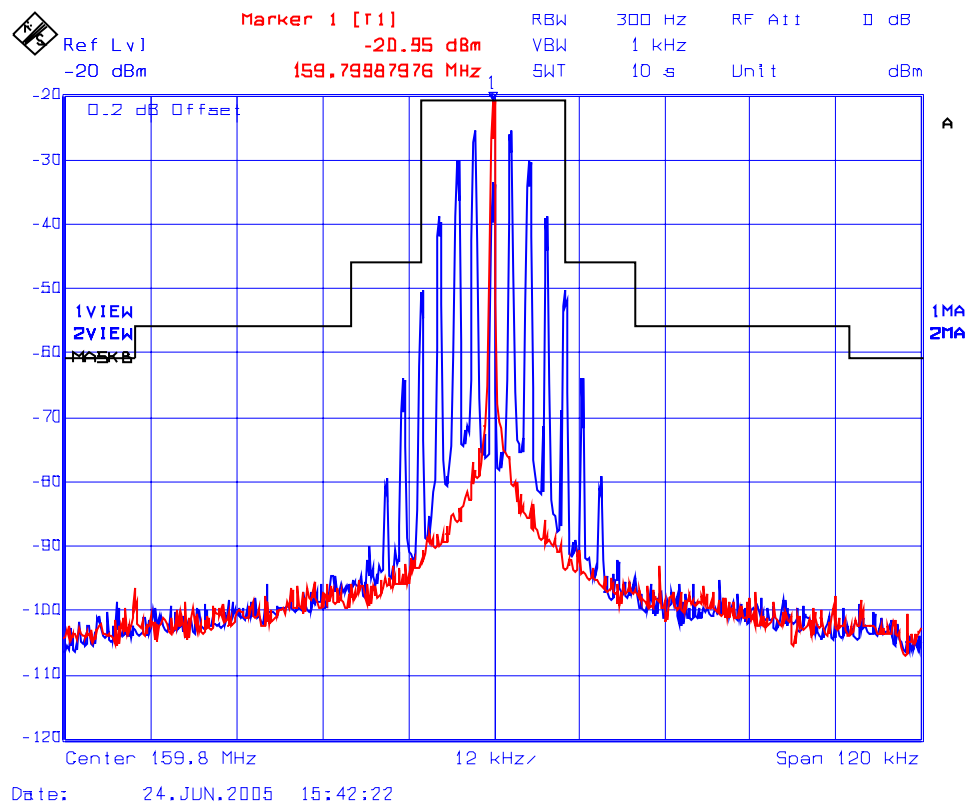
File #: TXRX-011FCC90  
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#### 6.7.5.3.4. Emission Mask B, RF Input signal

See the following plot for details.

**PLOT # 40**      **Frequency: 159.8 MHz, 25 kHz Channel Spacing**  
**Modulation: FM modulation with 2.5 kHz sine wave signal**



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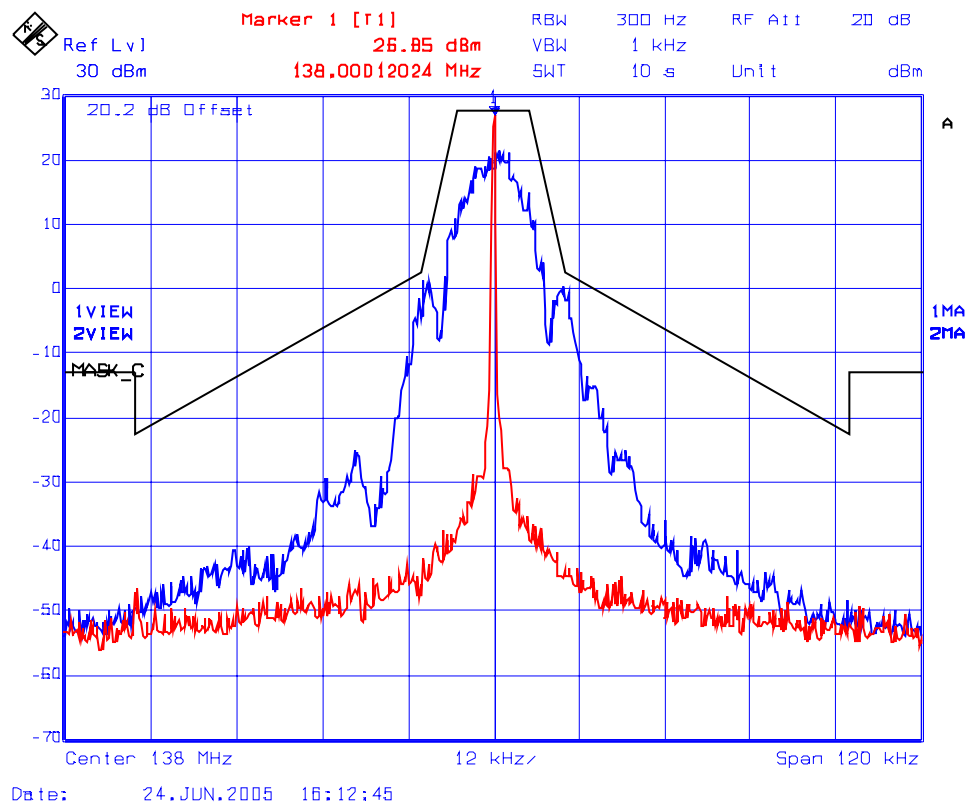
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4  
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Website: <http://www.ultratech-labs.com>

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6.7.5.3.5. Emission Mask C, RF Output signal

PLOT # 41 Frequency: 138 MHz, 25 kHz Channel Spacing  
Modulation: FM modulation with an external 9600 b/s random data source



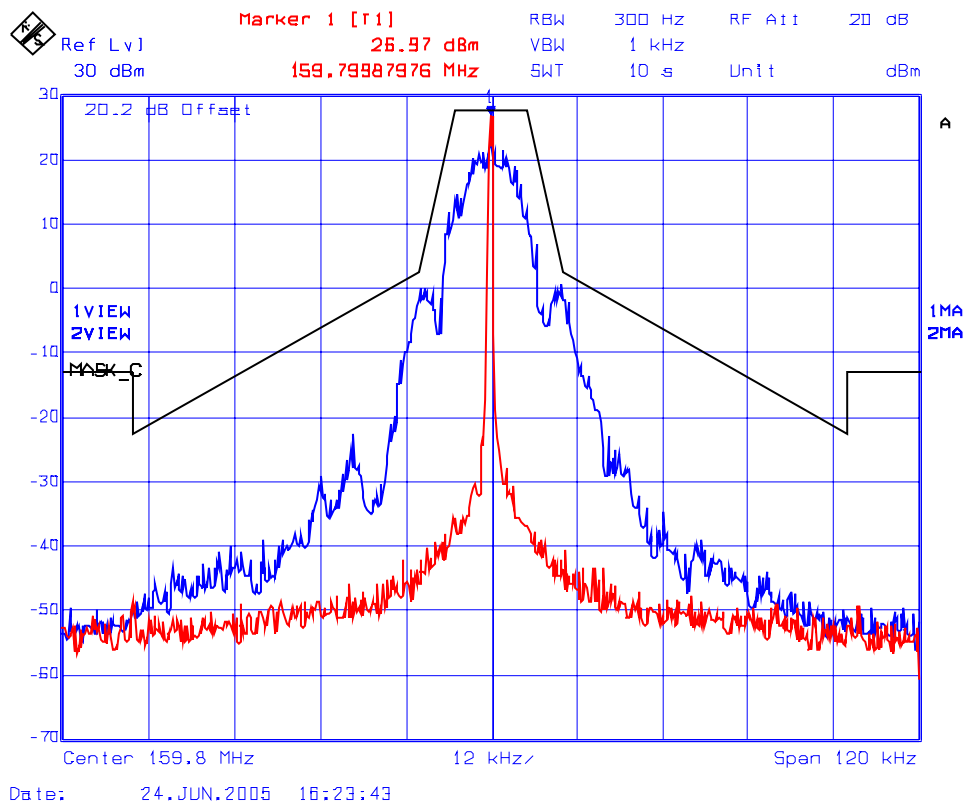
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Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Website: <http://www.ultratech-labs.com>

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**PLOT # 42**      **Frequency: 159.8 MHz, 25 kHz Channel Spacing**  
**Modulation: FM modulation with an external 9600 b/s random data source**



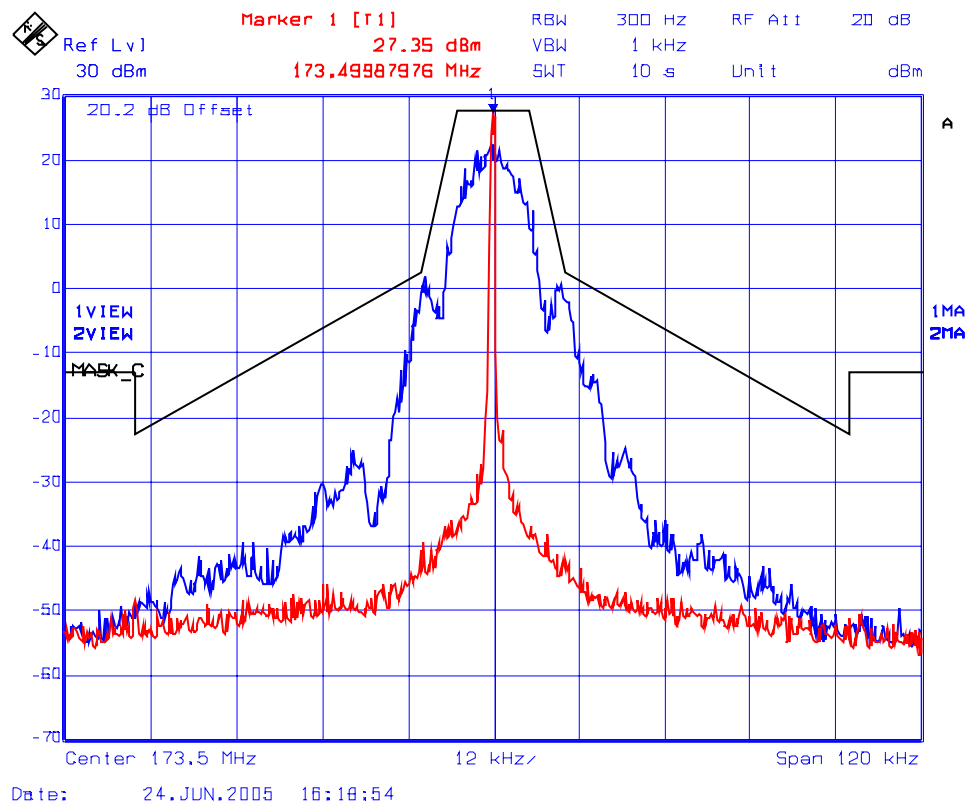
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**PLOT # 43**      **Frequency: 173.5 MHz, 25 kHz Channel Spacing**  
**Modulation: FM modulation with an external 9600 b/s random data source**



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June 29, 2005

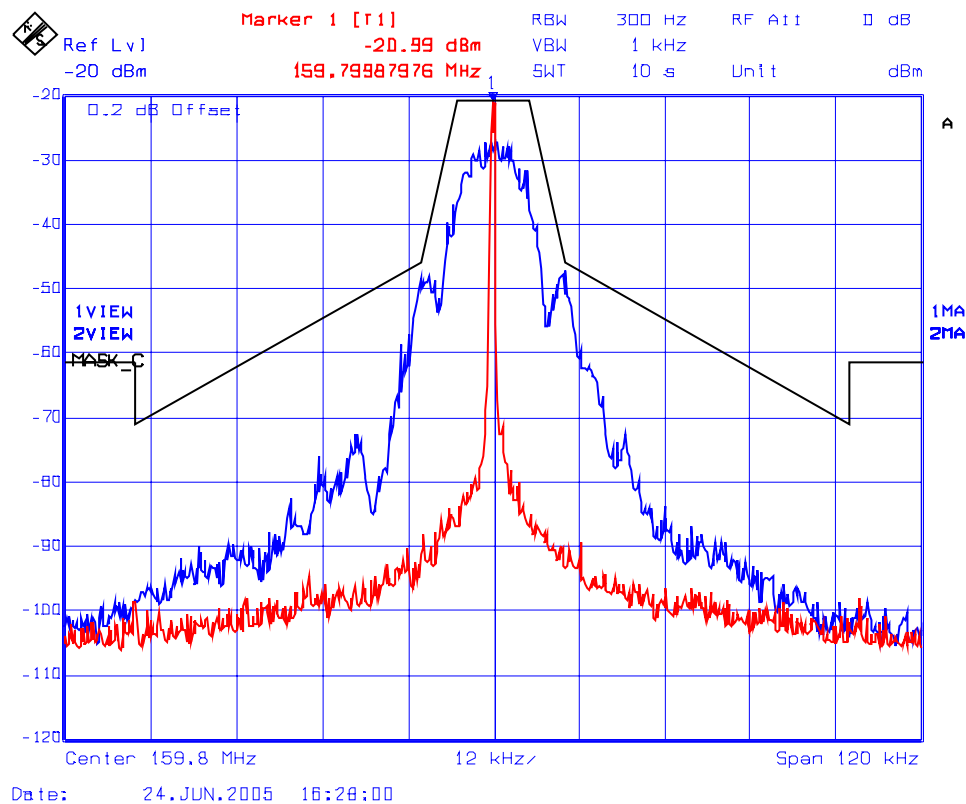
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

6.7.5.3.6. *Emission Mask C, RF Input signal*

PLOT # 44

Frequency: 159.8 MHz, 25 kHz Channel Spacing

Modulation: FM modulation with an external 9600 b/s random data source



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## 6.8. TRANSMITTER ANTENNA POWER SPURIOUS/HARMONIC CONDUCTED EMISSIONS [§§ 2.1051, 90.209 & 90.210]

### 6.8.1. Limits

At least  $50 + 10 \cdot \log(P \text{ in Watts})$  dBc.

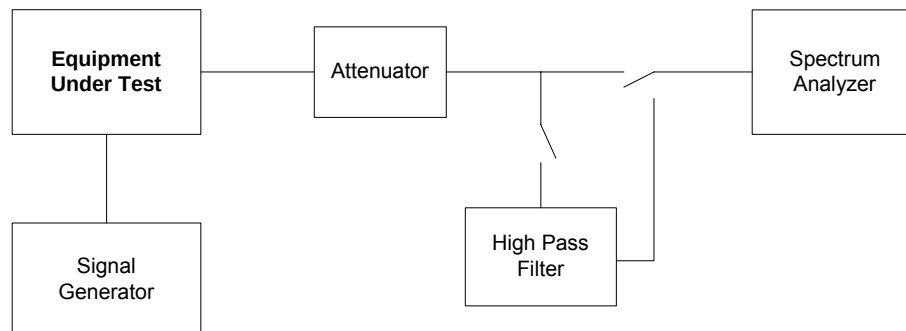
### 6.8.2. Method of Measurements

Refer to ULTRATECH Test Procedures, File # ULTR P001-2004 and Exhibit 8 of this report for measurement details.

### 6.8.3. 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    |
| Attenuator        | Weinschel Corp  | 46-20-34              | BM1347     | DC - 18 GHz       |
| High Pass Filter  | K & L           | 11SH10-1500/T8000-O/O | 2          | 2 - 18 GHz        |
| Signal Generator  | Gigatronix      | 6061A                 | 5130586    | 10 kHz - 1050 MHz |

### 6.8.4. Test Arrangement



### 6.8.5. Test Data

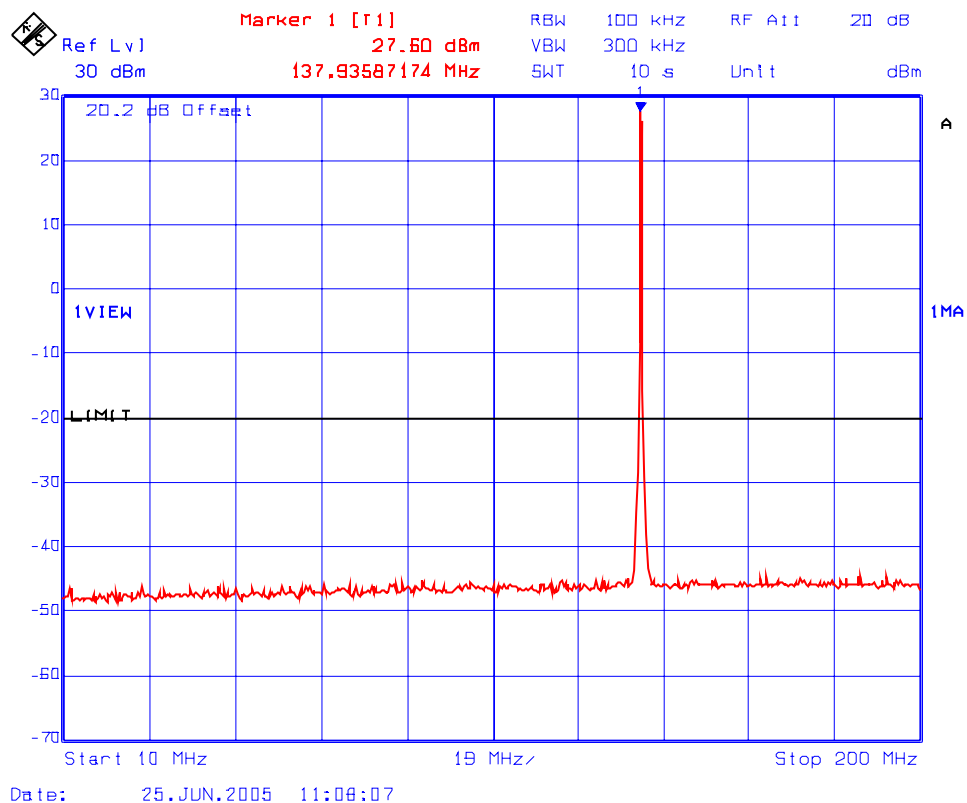
#### Remarks:

- (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 2 GHz.

Fundamental Frequency: 138 MHz, 1 RF Signal input/output  
RF Output Power: 27.4 dBm (conducted)  
Modulation: Unmodulated

See the following plots (45 to 46) for details:

**PLOT # 45 Transmitter Conducted Spurious Emissions with 1 RF signal input/output**  
**Fc: 138 MHz**



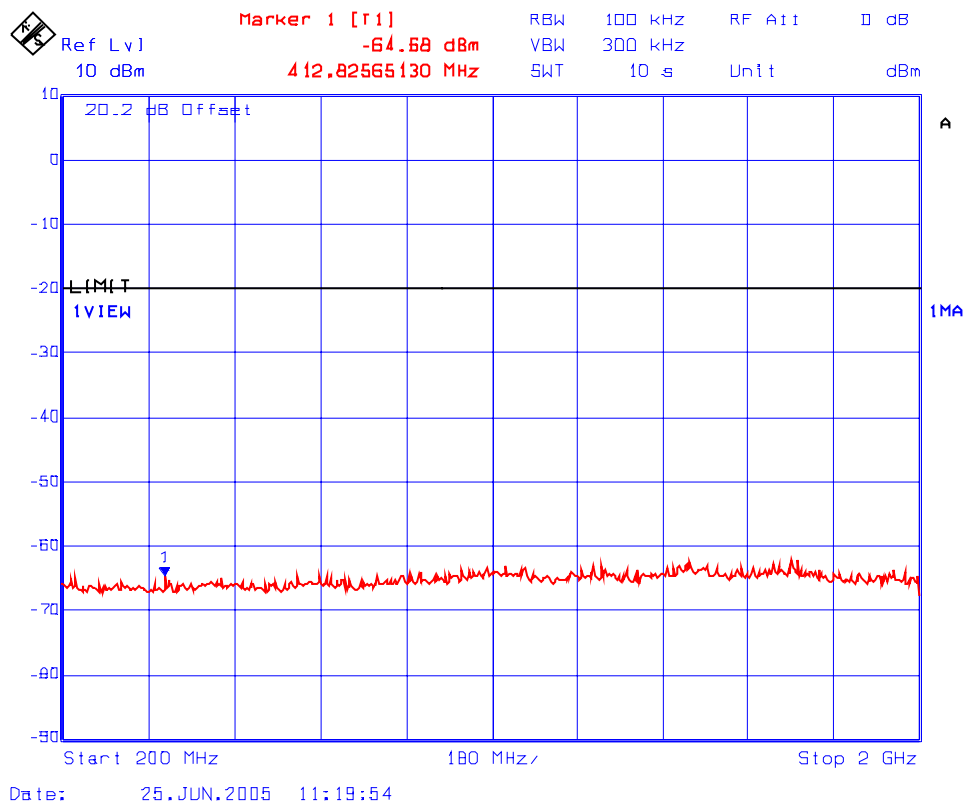
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**PLOT # 46**      **Transmitter Conducted Spurious Emissions with 1 RF signal input/output**  
**Fc: 138 MHz**



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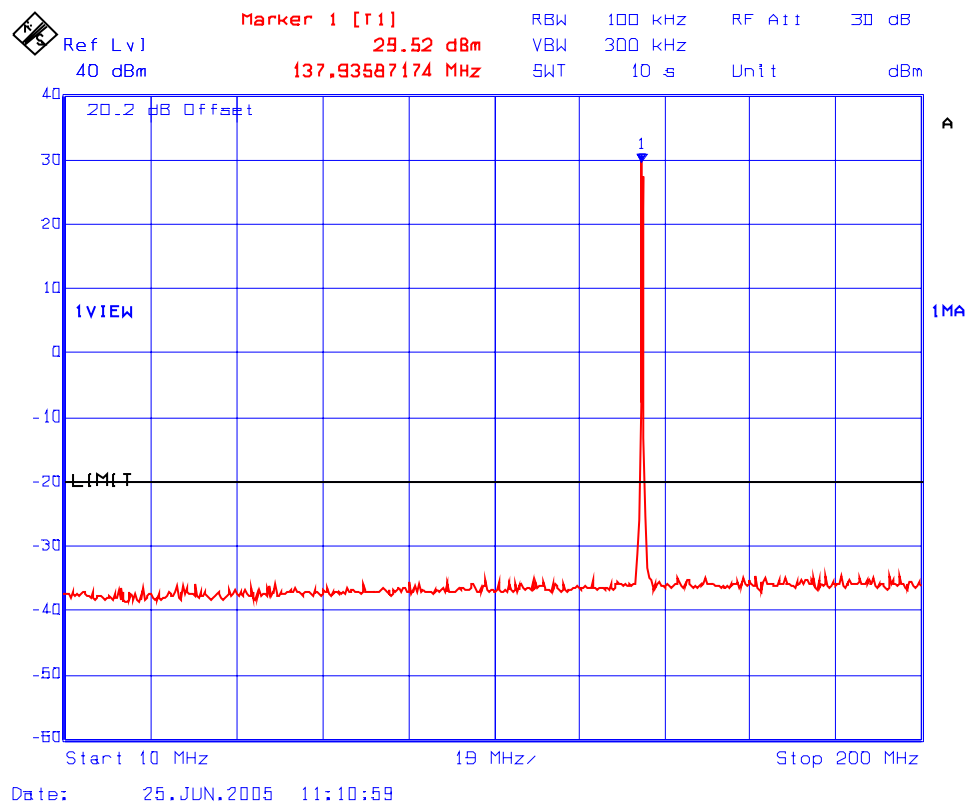
File #: TXRX-011FCC90  
June 29, 2005

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Fundamental Frequency: 138.0, 138.025 MHz (2 channel inputs/outputs)  
RF Output Power: 24.4 dBm (conducted)  
Modulation: Unmodulated

See the following plots (47 to 48) for details:

**PLOT # 47 Transmitter Conducted Spurious Emissions with 2 RF signal inputs/outputs**  
**Fc: 138 MHz, Fc + 25 kHz**



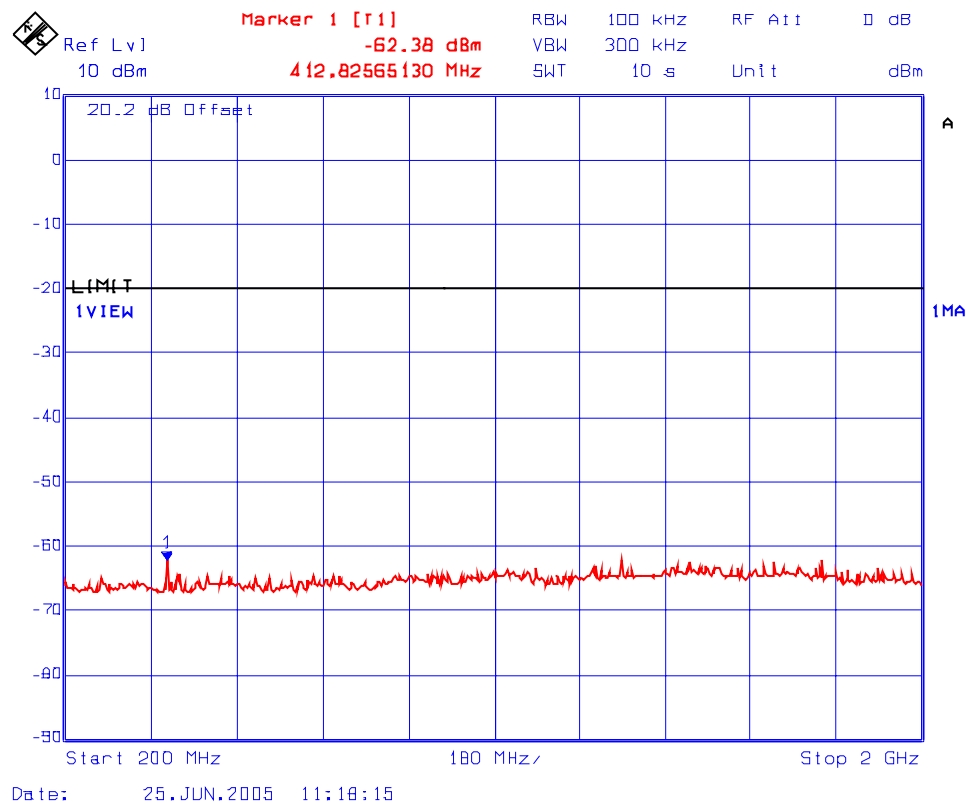
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**PLOT # 48**      **Transmitter Conducted Spurious Emissions with 2 RF signal inputs/outputs**  
**Fc: 138 MHz, Fc + 25 kHz**



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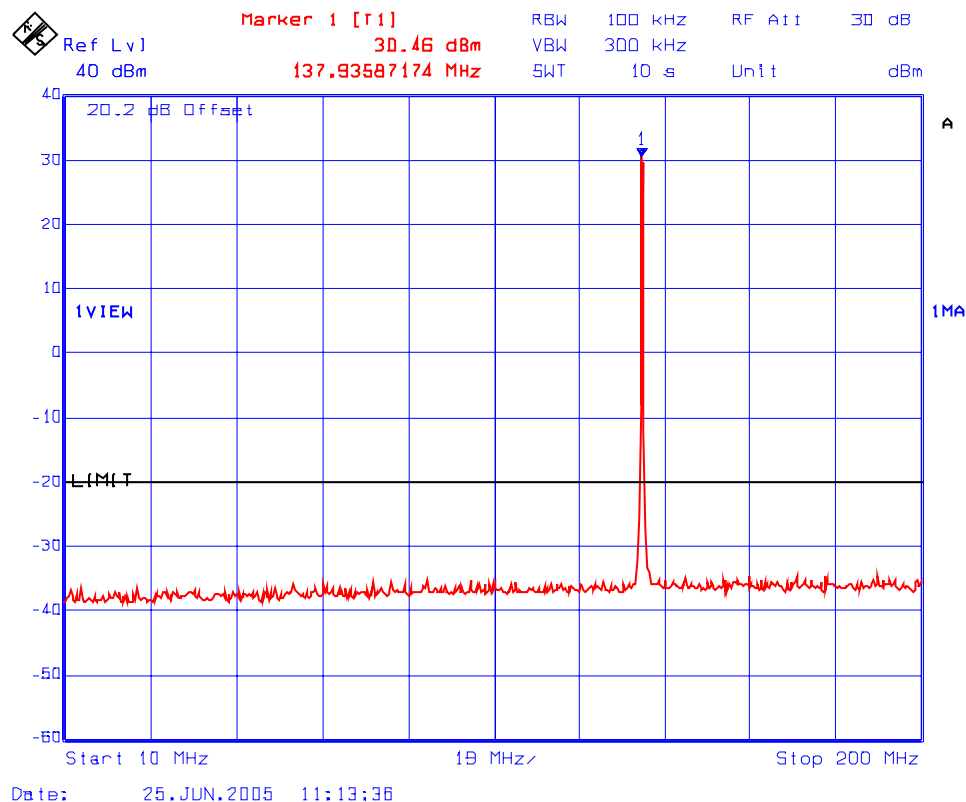
File #: TXRX-011FCC90  
June 29, 2005

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Fundamental Frequency: 138.0, 138.025, 138.050 MHz (3 channel inputs/outputs)  
RF Output Power: 21.5 dBm (conducted)  
Modulation: Unmodulated

See the following plots (49 to 50) for details:

**PLOT # 49 Transmitter Conducted Spurious Emissions with 3 RF signal inputs/outputs**  
**Fc: 138 MHz, Fc + 25 kHz, Fc + 50 kHz**



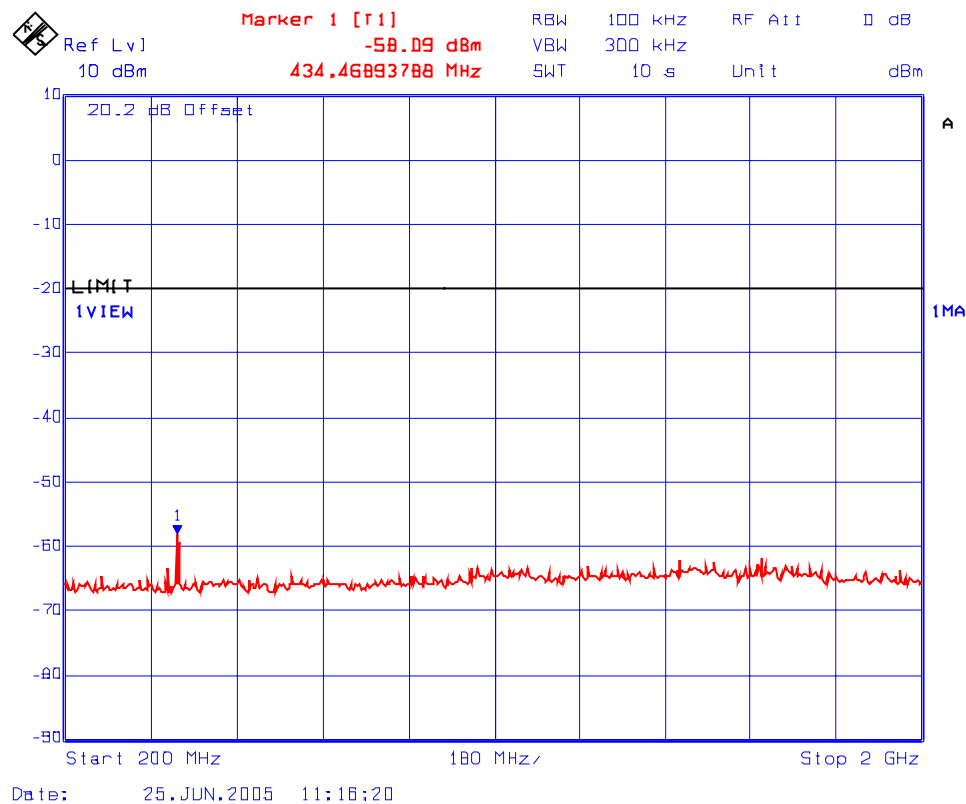
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**PLOT # 50**      **Transmitter Conducted Spurious Emissions with 3 RF signal inputs/outputs**  
**Fc: 138 MHz, Fc + 25 kHz, Fc + 50 kHz**



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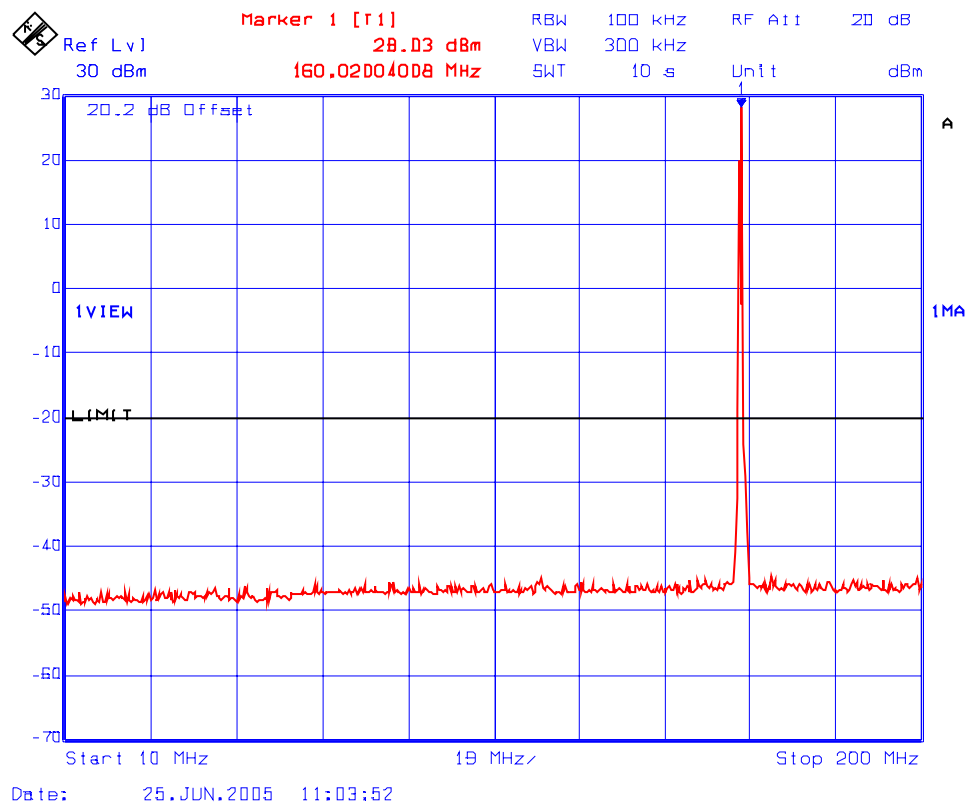
File #: TXRX-011FCC90  
June 29, 2005

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

Fundamental Frequency: 159.8 MHz, 1 RF Signal input/output  
RF Output Power: 27.8 dBm (conducted)  
Modulation: Unmodulated

See the following plots (51 to 52) for details:

**PLOT # 51 Transmitter Conducted Spurious Emissions with 1 RF signal input/output  
Fc: 159.8 MHz**



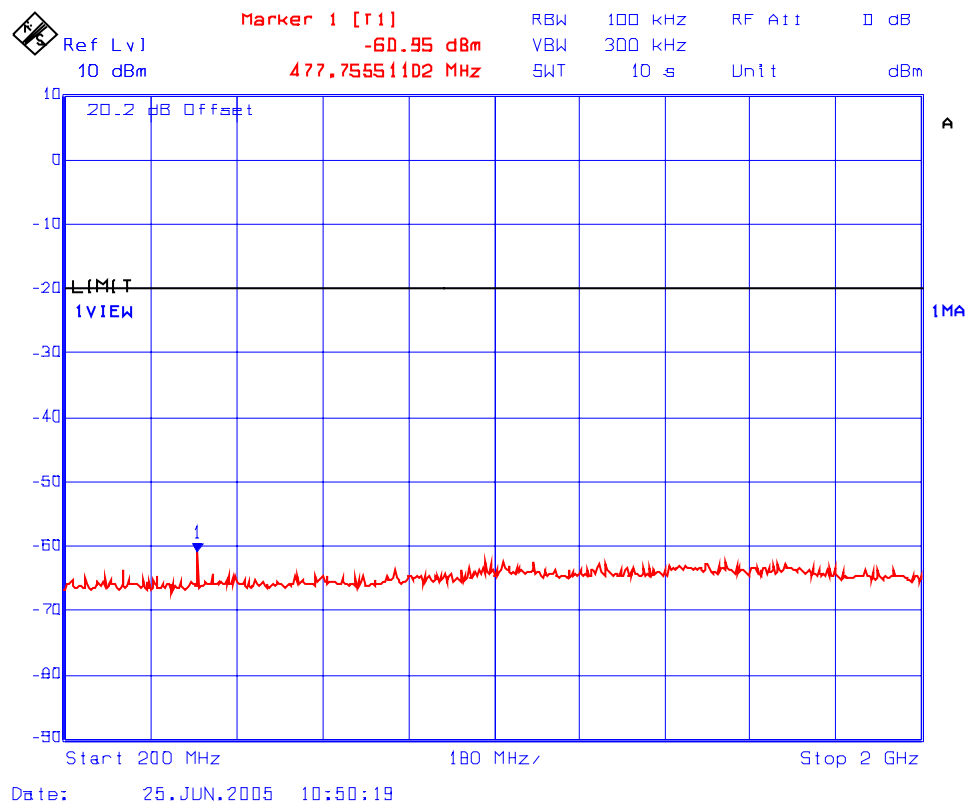
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**PLOT # 52**      **Transmitter Conducted Spurious Emissions with 1 RF signal input/output**  
**Fc: 159.8 MHz**



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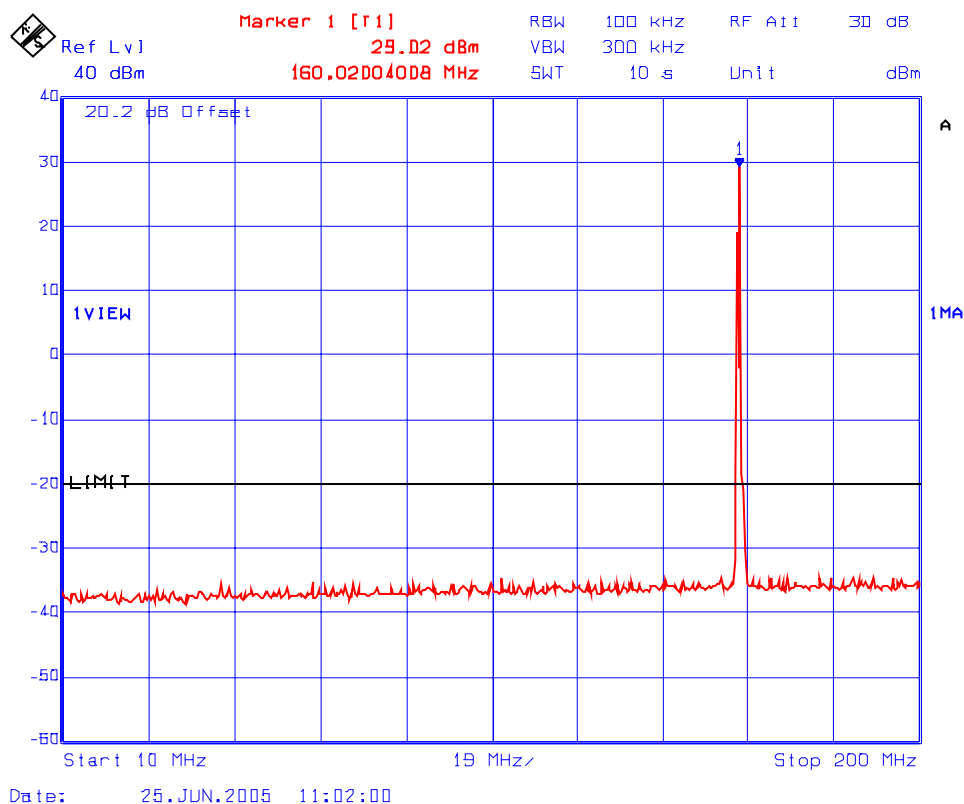
File #: TXRX-011FCC90  
June 29, 2005

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

Fundamental Frequency: 159.800, 159.825 MHz (2 channel inputs/outputs)  
RF Output Power: 23.01 dBm (conducted)  
Modulation: Unmodulated

See the following plots (53 to 54) for details:

**PLOT # 53 Transmitter Conducted Spurious Emissions with 2 RF signal input/output**  
**Fc: 159.8 MHz, Fc + 25 kHz**



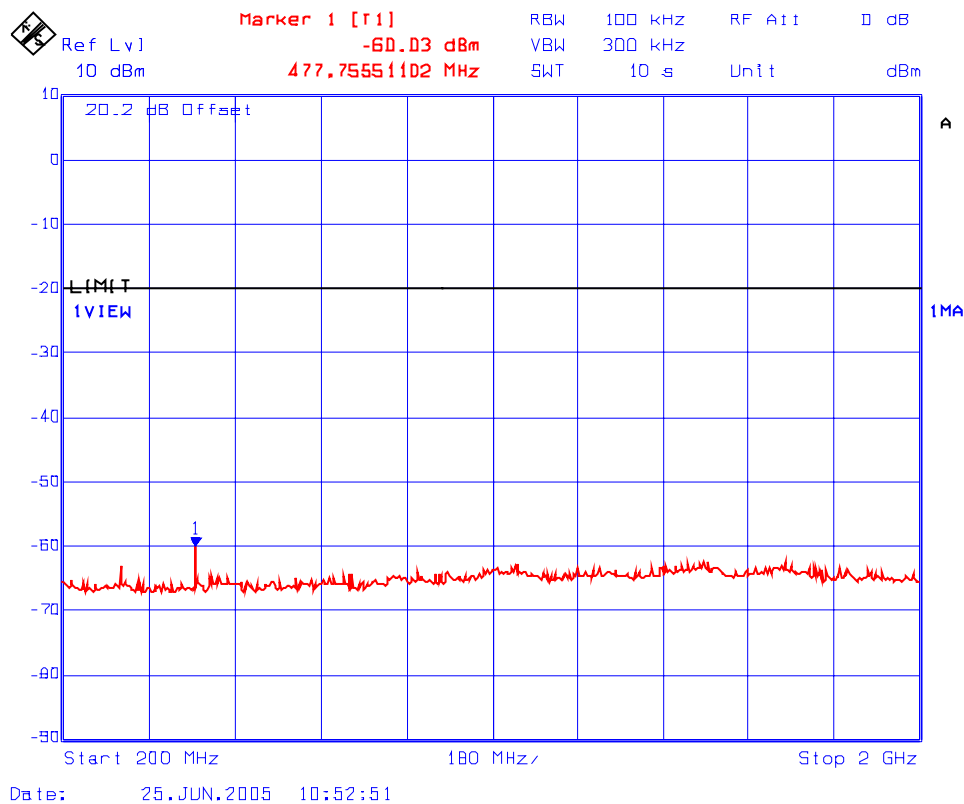
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**PLOT # 54**      **Transmitter Spurious Emissions with 2 RF signal input/output**  
**Fc: 159.8 MHz, Fc + 25 kHz**



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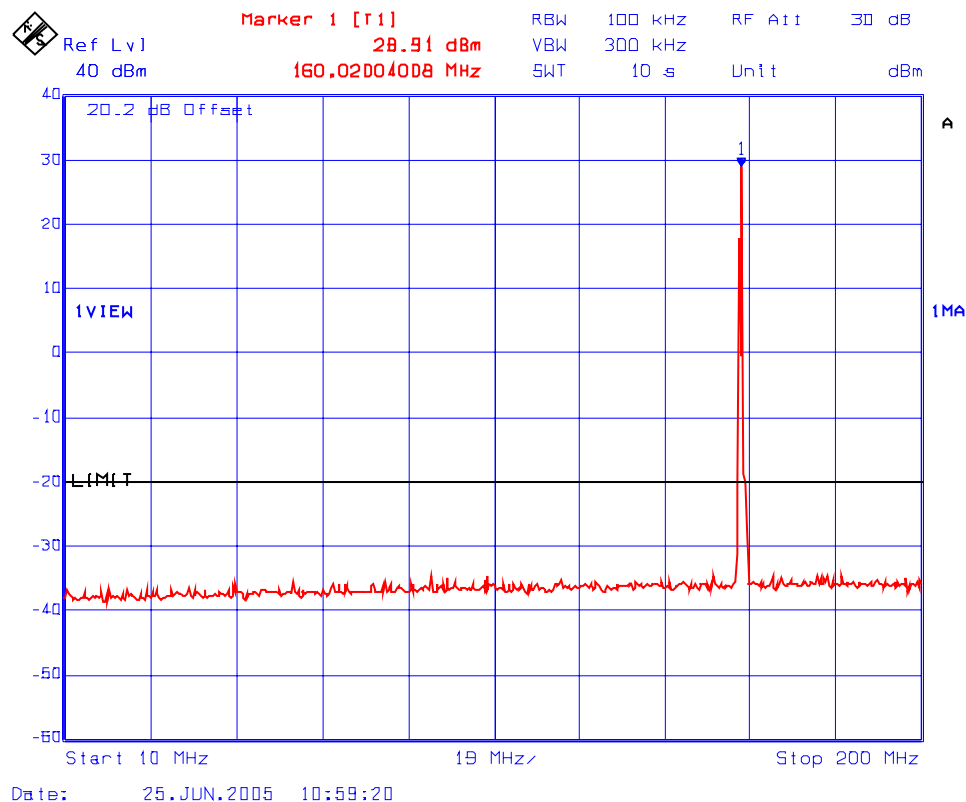
File #: TXRX-011FCC90  
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Fundamental Frequency: 159.800, 159.825, 159.850 MHz (3 channel inputs/outputs)  
RF Output Power: 20.02 dBm (conducted)  
Modulation: Unmodulated

See the following plots (55 to 56) for details:

**PLOT # 55 Transmitter Conducted Spurious Emissions with 3 RF signal input/output**  
**Fc: 159.8 MHz, Fc + 25 kHz, Fc + 50 kHz**



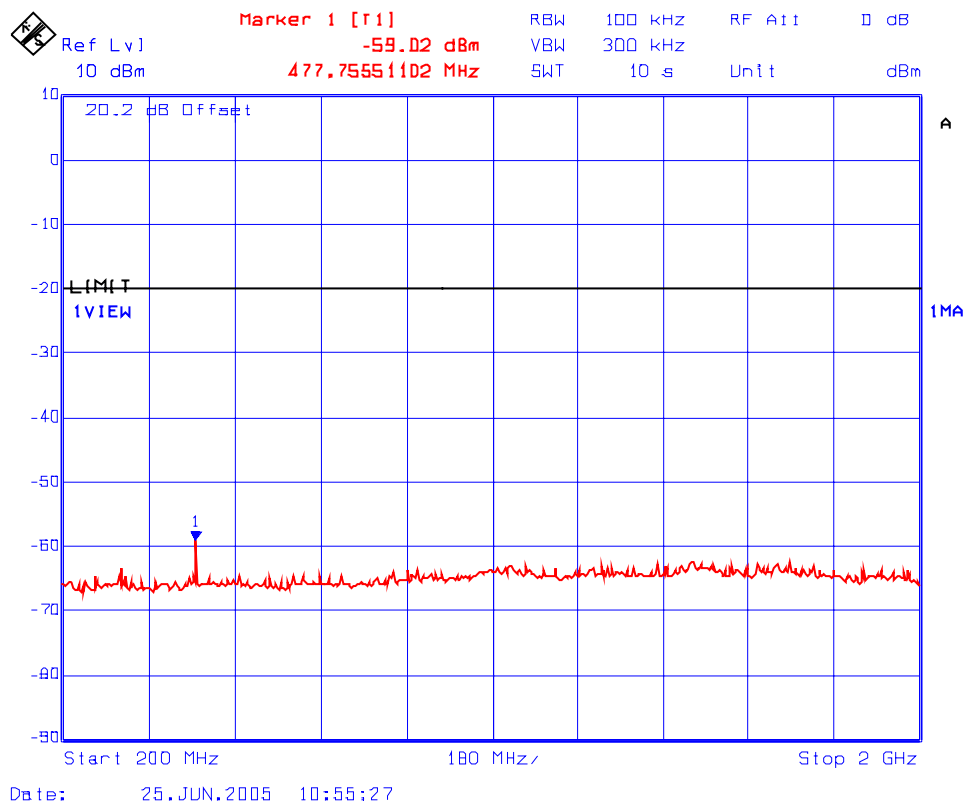
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**PLOT # 56**      **Transmitter Conducted Spurious Emissions with 3 RF signal input/output**  
**Fc: 159.8 MHz, Fc + 25 kHz, Fc + 50 kHz**



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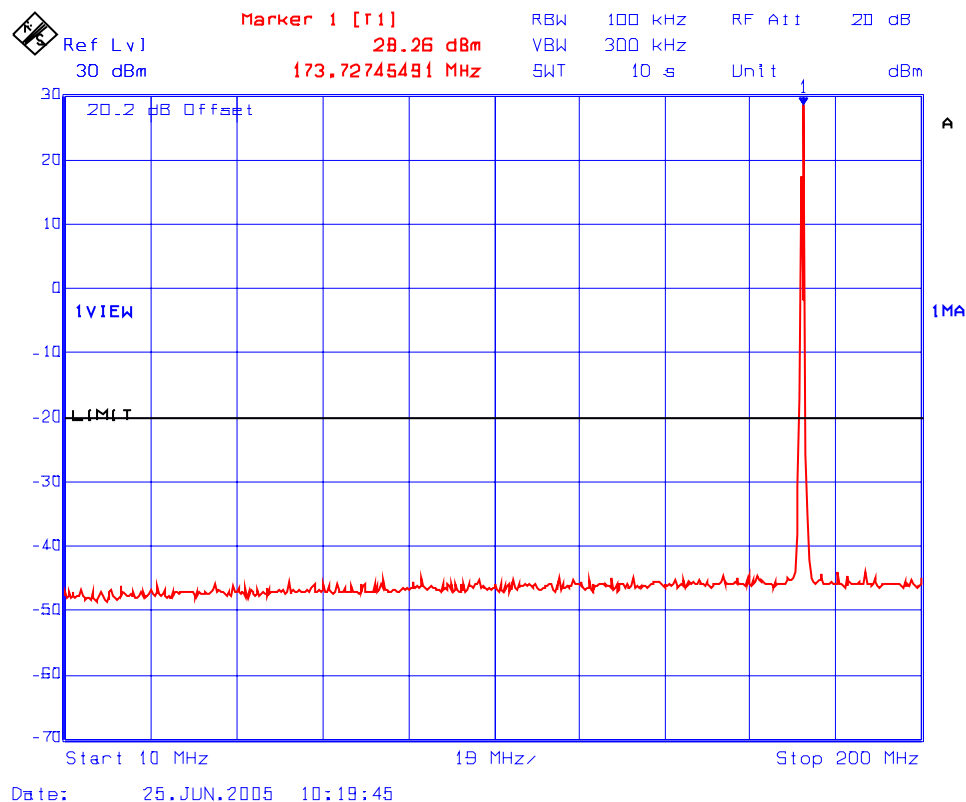
File #: TXRX-011FCC90  
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All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Fundamental Frequency: 173.5 MHz, 1 RF Signal input/output  
RF Output Power: 28.03 dBm (conducted)  
Modulation: Unmodulated

See the following plots (57 to 58) for details:

**PLOT # 57 Transmitter Conducted Spurious Emissions with 1 RF signal input/output**  
**Fc: 173.5 MHz**



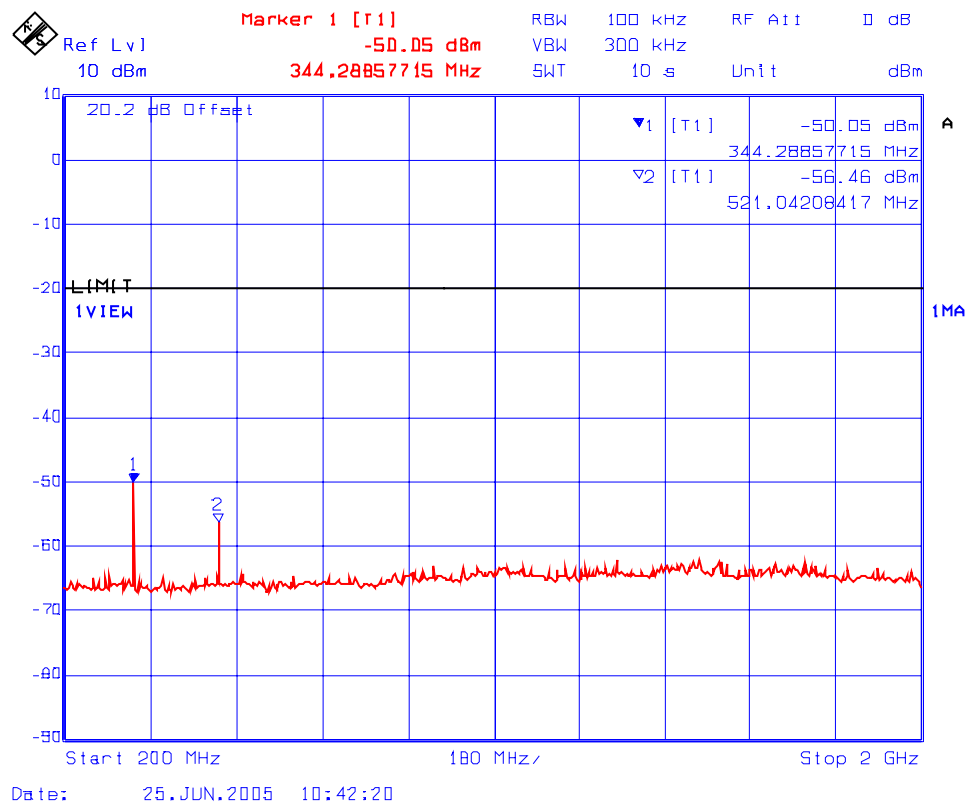
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**PLOT # 58**      **Transmitter Conducted Spurious Emissions with 1 RF signal input/output**  
**Fc: 173.5 MHz**



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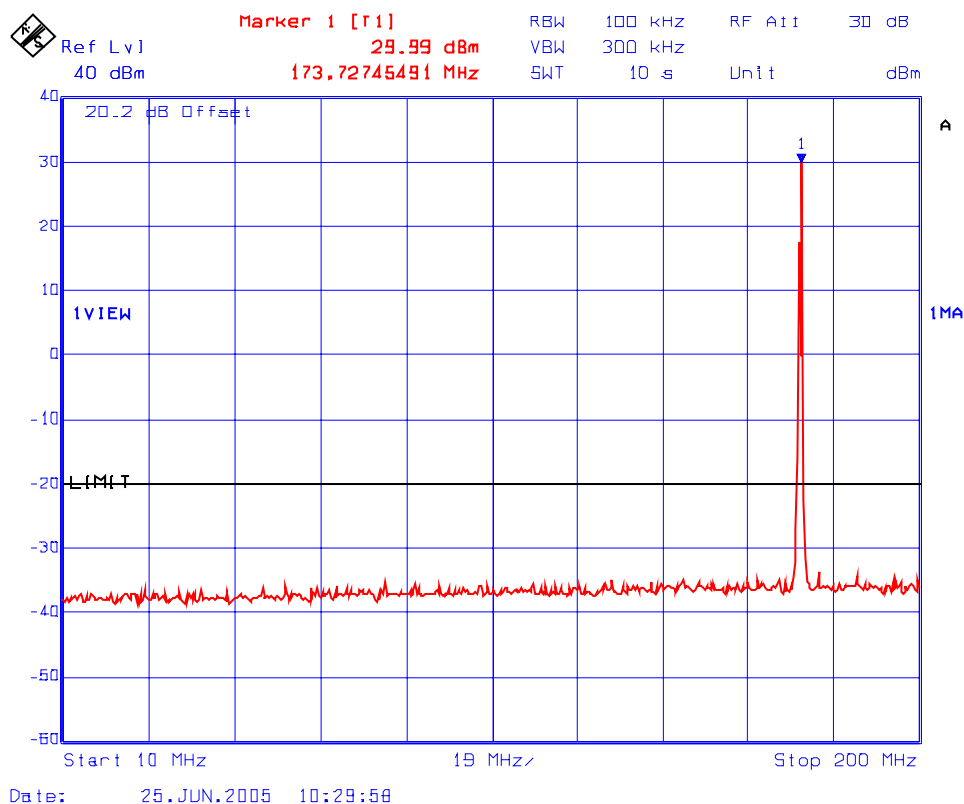
File #: TXRX-011FCC90  
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All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Fundamental Frequency: 173.500, 173.525 MHz, (2 channel inputs/outputs)  
RF Output Power: 24.1 dBm (conducted)  
Modulation: Unmodulated

See the following plots (59 to 60) for details:

**PLOT # 59 Transmitter Conducted Spurious Emissions with 2 RF signal input/output**  
**Fc: 173.5 MHz, Fc + 25 kHz**



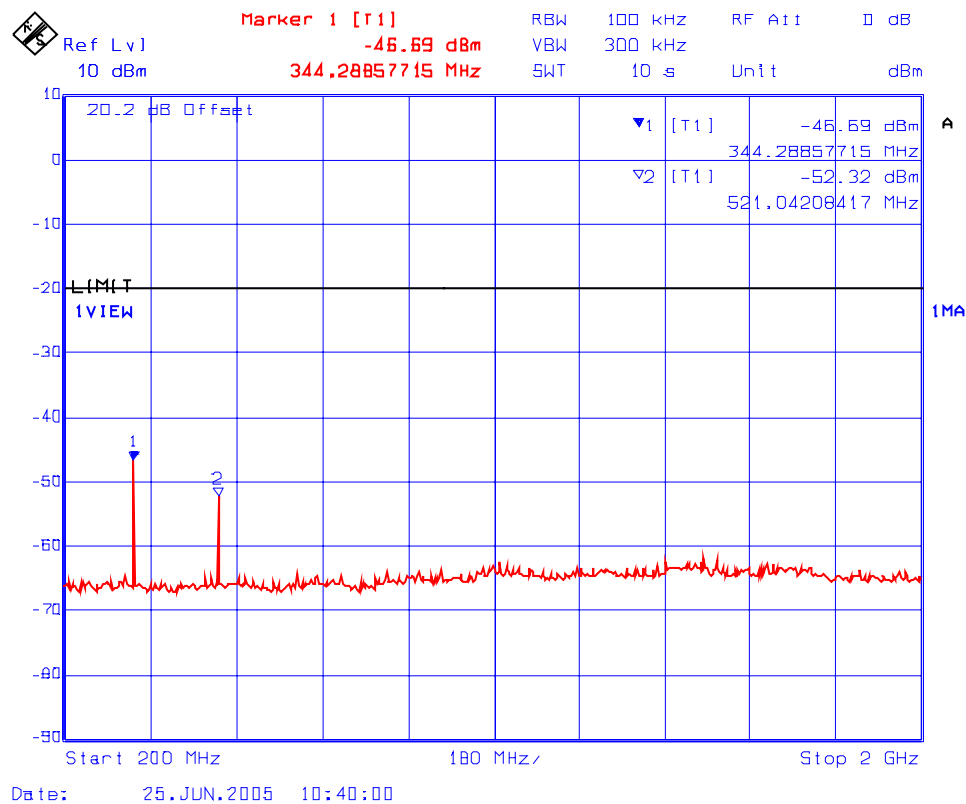
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**PLOT # 60**      **Transmitter Conducted Spurious Emissions with 2 RF signal input/output**  
**Fc: 173.5 MHz, Fc + 25 kHz**



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File #: TXRX-011FCC90

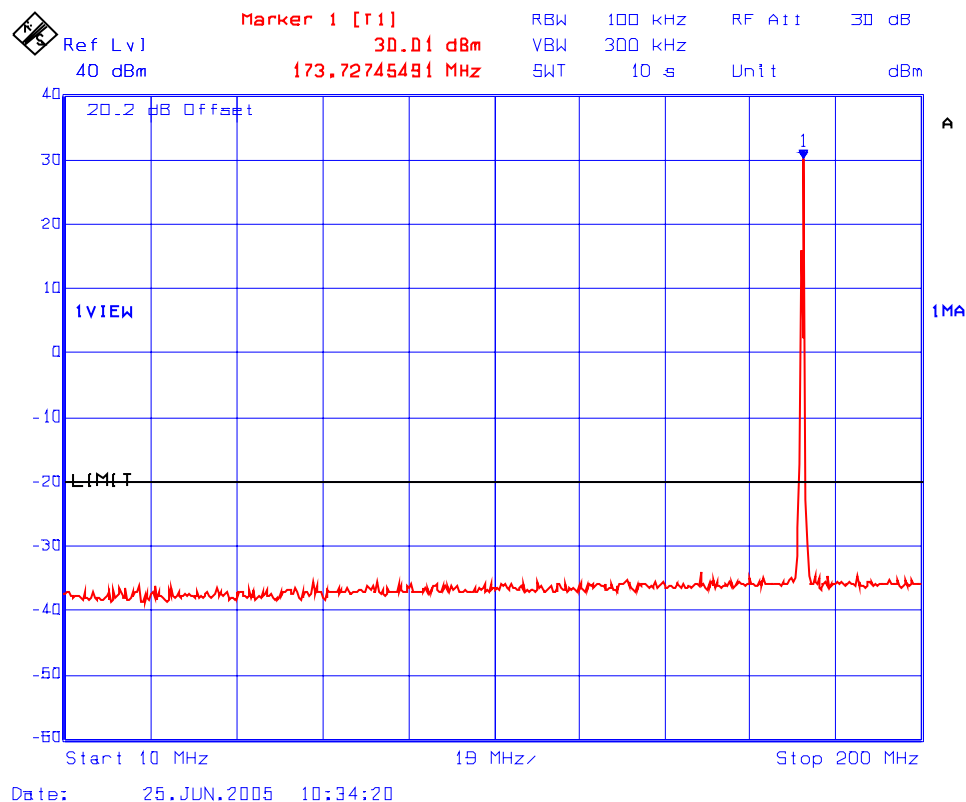
June 29, 2005

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

Fundamental Frequency: 173.500, 173.525, 173.550 (3 channel inputs/outputs)  
RF Output Power: 21.01 dBm (conducted)  
Modulation: Unmodulated

See the following plots (61 to 62) for details:

**PLOT # 61 Transmitter Conducted Spurious Emissions with 3 RF signal input/output**  
**Fc: 173.500 MHz, Fc + 25 kHz, Fc + 50 kHz**



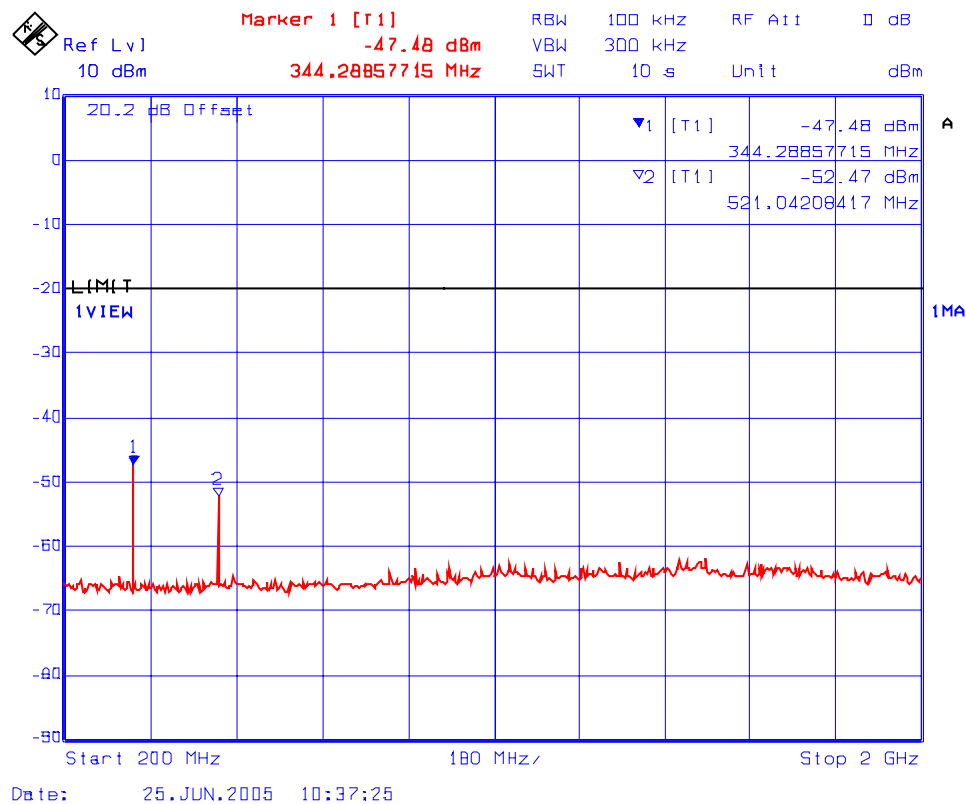
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**PLOT # 62**      **Transmitter Conducted Spurious Emissions with 3 RF signal input/output**  
**Fc: 173.5 MHz, Fc + 25 kHz, Fc + 50 kHz**



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## 6.9. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS [§§ 90.208 & 90.210]

### 6.9.1. Limits

At least  $50 + 10 \cdot \log(P \text{ in Watts})$  dBc.

### 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 =  $P_c + G - 2.15 \text{ dB} = P_c \text{ dBm (conducted)} + 0 \text{ dBi} - 2.15 \text{ dB}$
- (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:

- (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 RF spurious/harmonics emission characteristics for narrow band and wide band operation are indistinguishable. Therefore, the following radiated emission tests were performed at 12.5 kHz channel spacing (narrow band) operation, and the results were compared with the more stringent limit of  $50+10*\log(P \text{ in Watts})$  for the worst case.

##### 6.9.4.1. Near Lowest Frequency (138 MHz)

The emissions were scanned from 30 MHz to 2 GHz at 3 meters distance and all spurious emissions and harmonics were more than 20 dB below the limits.

##### 6.9.4.2. Near Middle Frequency (159.8 MHz)

The emissions were scanned from 30 MHz to 2 GHz at 3 meters distance and all spurious emissions and harmonics were more than 20 dB below the limits.

##### 6.9.4.3. Near Highest Frequency (173.5 MHz)

The emissions were scanned from 30 MHz to 2 GHz at 3 meters distance and all spurious emissions and harmonics were more than 20 dB below the limits.

## 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<br>(Radiated Emissions)                                                                                                                              | PROBABILITY<br>DISTRIBUTION | UNCERTAINTY (+ dB) |               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|--------------------|---------------|
|                                                                                                                                                                   |                             | 3 m                | 10 m          |
| Antenna Factor Calibration                                                                                                                                        | Normal (k=2)                | $\pm 1.0$          | $\pm 1.0$     |
| Cable Loss Calibration                                                                                                                                            | Normal (k=2)                | $\pm 0.3$          | $\pm 0.5$     |
| EMI Receiver specification                                                                                                                                        | Rectangular                 | $\pm 1.5$          | $\pm 1.5$     |
| Antenna Directivity                                                                                                                                               | Rectangular                 | $\pm 0.5$          | $\pm 0.5$     |
| Antenna factor variation with height                                                                                                                              | Rectangular                 | $\pm 2.0$          | $\pm 0.5$     |
| Antenna phase center variation                                                                                                                                    | Rectangular                 | 0.0                | $\pm 0.2$     |
| Antenna factor frequency interpolation                                                                                                                            | Rectangular                 | $\pm 0.25$         | $\pm 0.25$    |
| Measurement distance variation                                                                                                                                    | Rectangular                 | $\pm 0.6$          | $\pm 0.4$     |
| Site imperfections                                                                                                                                                | Rectangular                 | $\pm 2.0$          | $\pm 2.0$     |
| Mismatch: Receiver VRC $\Gamma_1 = 0.2$<br>Antenna VRC $\Gamma_R = 0.67(\text{Bi}) 0.3 (\text{Lp})$<br>Uncertainty limits $20\text{Log}(1 \pm \Gamma_1 \Gamma_R)$ | U-Shaped                    | +1.1<br>-1.25      | $\pm 0.5$     |
| System repeatability                                                                                                                                              | Std. Deviation              | $\pm 0.5$          | $\pm 0.5$     |
| 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:

$$U = 2u_c(y) = 2x(+2.19) = +4.38 \text{ dB} \quad \text{And} \quad U = 2u_c(y) = 2x(-2.21) = -4.42 \text{ dB}$$

## 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).
- If 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,  $x = T_x \text{ on} / (T_x \text{ on} + T_x \text{ off})$  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.

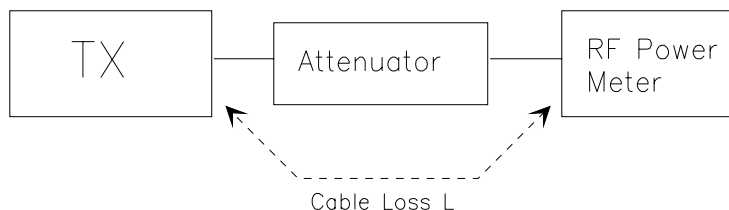
**Step 2:** Calculation of Average EIRP. See Figure 1

- 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:

$$\text{EIRP} = A + G + 10\log(1/x)$$

{  $X = 1$  for continuous transmission  $\Rightarrow 10\log(1/x) = 0 \text{ dB}$  }

**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  
 $E \text{ (dBuV/m)} = \text{Reading (dBuV)} + \text{Total Correction Factor (dB/m)}$

- (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° 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  
 $E \text{ (dBuV/m)} = \text{Reading (dBuV)} + \text{Total Correction Factor (dB/m)}$

- (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:

$$P = P1 - L1 = (P2 + L2) - L1 = P3 + A + L2 - L1$$

$$EIRP = P + G1 = P3 + L2 - L1 + A + G1$$

$$ERP = EIRP - 2.15 \text{ dB}$$

$$\text{Total Correction factor in EMI Receiver \# 2} = L2 - L1 + G1$$

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

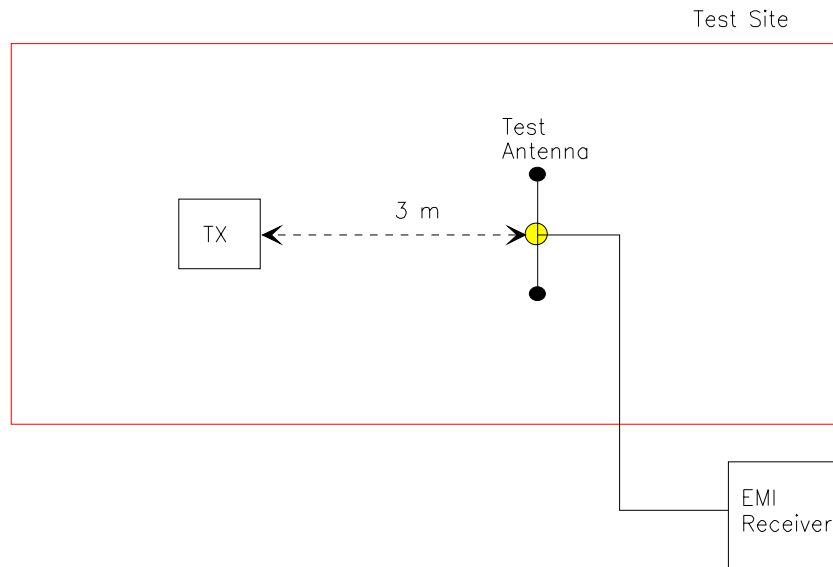
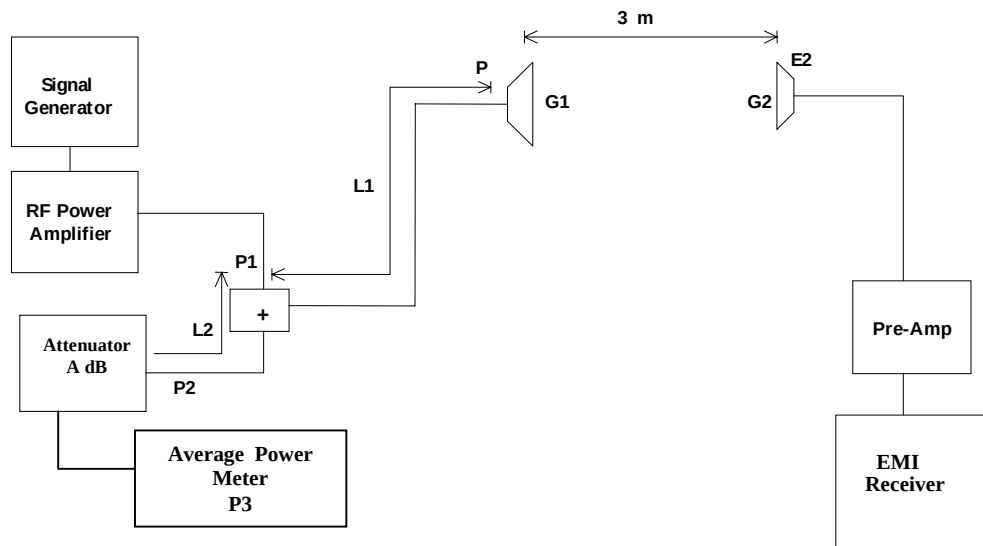


Figure 3



### 8.3. 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.:  $\pm 2.5$  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.

### 8.4. 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  $\geq$  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<sup>th</sup> 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.