UltraTech
Group of Labs

31040/SIT

C-1376

Canada
46390-2049

200093-0

00-034

SL2-IN-E-1119R

entela

Nov. 17, 2003

TIMCO ENGINEERING INC.
P.O. Box 370
849 N.W. State Road 45
Newberry, Florida

Subject:	**Type Acceptance Application under FCC CFR 47, Parts 2 and 90 (Subpart I) - Non-Broadcast Radio Transceivers Operating in the frequency bands 136-174 MHz (12.5 kHz and 25 kHz Channel Spacings).**
Applicant:	**Kaval Telecom Inc.**
Product:	**LinkNet RF Broadband Amplifier Module**
Model:	**LNKA100**
FCC ID:	**H6M-LNKA100**

Dear Sir/Madam,

As appointed agent for **Kaval Telecom Inc.**, we would like to submit the application for FCC Certification for the above Product. Please review all necessary files uploaded to TIMCO Upload Web Site.

If you have any queries, please do not hesitate to contact us by our TOLL FREE number:

OUR TELEPHONE NO.: 1-877-765-4173

Yours truly,

Tri Minh Luu, P. Eng.,
V.P., Engineering

TML/DH

Encl.

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

Tel.: (905) 829-1570
Fax.: (905) 829-8050

Website: www.ultratech-labs.com
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Nov. 17, 2003

Kaval Telecom Inc.
60 Gough Road
Markham, Ontario
Canada, L3R 8X7

Attn.: **Mr. Alan Aslett**

Subject: **Certification Testing in accordance with FCC CFR 47, Parts 2 and 90 (Subpart I) - Non-Broadcast Radio Transceivers Operating in the frequency bands 136-174 MHz (12.5 kHz and 25 kHz Channel Spacings).**

Product: **LinkNet RF Broadband Amplifier Module**
Model: **LNKA100**
FCC ID: **H6M-LNKA100**

Dear Mr. Aslett

The product sample has been tested in accordance with **FCC CFR 47, Parts 2 and 90 (Subpart I) - Non-Broadcast Radio Transceivers Operating in the frequency bands 136-174 MHz (12.5 kHz and 25 kHz Channel Spacings),** and the results and observation were recorded in the engineering report, Our File No.: KTI-036FCC90

Enclosed you will find copy of the engineering report. If you have any queries, please do not hesitate to contact us.

Yours truly,

Tri Minh Luu, P.Eng
Vice President - Engineering

Encl.

ENGINEERING TEST REPORT

LinkNet RF Broadband Amplifier Module
Model No.: LNKA100
FCC ID: H6M-LNKA100

Applicant: **Kaval Telecom Inc.**
60 Gough Road
Markham, Ontario
Canada, L3R 8X7

Tested in Accordance With

Federal Communications Commission (FCC)
CFR 47, PARTS 2 and 90 (Subpart I)

UltraTech's File No.: KTI-036FCC90

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: Nov. 17, 2003	
Report Prepared by: Tri Luu, P.Eng. Issued Date: Nov. 17, 2003	Tested by: Hung Trinh, RFI Technician Test Dates: Nov. 04, 16, 2003

- *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

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

TABLE OF CONTENTS

EXHIBIT 1. SUBMITTAL CHECK LIST

Annex No.	Exhibit Type	Description of Contents	Quality Check (OK)
--	Test Report	• Exhibit 1: Submittal check lists • Exhibit 2: Introduction • Exhibit 3: Performance Assessment • Exhibit 4: EUT Operation and Configuration during Tests • Exhibit 5: Summary of test Results • Exhibit 6: Measurement Data • Exhibit 7: Measurement Uncertainty • Exhibit 8: Measurement Methods	OK
1	Test Setup Photos	Photos # 1 and 2	OK
2	External Photos of EUT	Photos # 1 to 3	OK
3	Internal Photos of EUT	Photos of 1 to 13	OK
4	Cover Letters	• Letter from Ultratech for Certification Request • Letter from the Applicant to appoint Ultratech to act as an agent • Letter from the Applicant to request for Confidentiality Filing	OK
5	Attestation Statements		N/A
6	ID Label/Location Info	ID Label/Location Info	OK
7	Block Diagrams	Block Diagrams	OK
8	Schematic Diagrams	Schematic Diagrams	OK
9	Parts List/Tune Up Info	Parts List/Tune Up Info	OK
10	Operational Description	Operational Description	OK
11	RF Exposure Info	RF Exposure Info	OK
12	Users Manual	Users Manual	OK

EXHIBIT 2. INTRODUCTION

2.1. SCOPE

Reference:	FCC Parts 2 and 90
Title:	Telecommunication - Code of Federal Regulations, CFR 47, Parts 2 & 90
Purpose of Test:	To gain FCC Certification Authorization for Radio operating in the frequency bands 136-174 MHz (12.5 kHz and 25 kHz Channel Spacings).
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with TIA/EIA Standard TIA/EIA- 603 (01-Nov-2002) - Land Mobile FM or PM Communications Equipment Measurement and Performance Standards.

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

None

2.3. NORMATIVE REFERENCES

Publication	Year	Title
FCC CFR Parts 0-19, 80-End	2002	Code of Federal Regulations – Telecommunication
ANSI C63.4	1992	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
CISPR 16-1	1999	Specification for Radio Disturbance and Immunity measuring apparatus and methods
TIA/EIA 603, Edition B	01-Nov-2002	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards

EXHIBIT 3. PERFORMANCE ASSESSMENT

3.1. CLIENT INFORMATION

APPLICANT	
Name:	Kaval Telecom Inc.
Address:	60 Gough Road Markham, Ontario Canada, L3R 8X7
Contact Person:	Mr. Alan Aslett Phone #: 905-946-3397 Fax #: 905-946-3392 Email Address: asslet@kaval.com

MANUFACTURER	
Name:	Kaval Telecom Inc.
Address:	60 Gough Road Markham, Ontario Canada, L3R 8X7
Contact Person:	Mr. Alan Aslett Phone #: 905-946-3397 Fax #: 905-946-3392 Email Address: asslet@kaval.com

3.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

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

Brand Name:	Kaval Telecom Inc.
Product Name:	LinkNet RF Broadband Amplifier Module
Model Name or Number:	LNKA100
Serial Number:	Preproduction
Type of Equipment:	Non-broadcast Radio Communication Equipment
External Power Supply:	120 60Hz from a host system
Transmitting/Receiving Antenna Type:	Non-integral

3.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	Base station (fixed use)
Intended Operating Environment:	Commercial, Light Industry & Heavy Industry
Power Supply Requirement:	120 V 60 Hz from a host system
RF Output Power Rating:	+38 dBm at the Amplifier's RF Output Port / Multiplexer's RF Input Port
Operating Frequency Range:	136-174 MHz
RF Output Impedance:	50 Ohms
Channel Spacing:	12.5 kHz and 25 kHz Channel Spacing
Occupied Bandwidth (99%):	11.8 kHz (12.5 Channel Spacing) 16.1 kHz (25 Channel Spacing)
Emission Designation*:	11K0F3E, 16K0F3E, 14K6F1D, 19K6F1D
Antenna Connector Type:	SMA Connectors
Antenna Description:	No specific antenna: • Maximum 20 dBi for outdoor roof top antenna • 0 dBi (1/4 Wave Dipole Antenna) for indoor with maximum 0.63 Watts EIRP.

* For an average case of commercial telephony, the Necessary Bandwidth is calculated as follows:

1. For FM Voice Modulation:

(a) Channel Spacing = 12.5 KHz, D = 2.5 KHz max, K = 1, M = 3 KHz
B_n = 2M + 2DK = 2(3) + 2(2.5)(1) = **<u>11 KHz</u>**
Emission designation: 11K0F3E

(b) Channel Spacing = 25 KHz, D = 25 KHz max, K = 1, M = 3 KHz
B_n = 2M + 2DK = 2(3) + 2(5)(1) = **<u>16 KHz</u>**
Emission designation: 16K0F3E

2. For FM Digital Modulation:

(a) 12.5 kHz Channel Spacing, M= 9.6/2 kb/s
B_n = 2M + 2DK = 2(9.6/2) + 2(2.5)(1) = **<u>14.6 KHz</u>**
Emission designation: 14K6F1D

(a) 25 kHz Channel Spacing, M= 9.6/2 kb/s
B_n = 2M + 2DK = 2(9.6/2) + 2(5)(1) = **<u>19.6 KHz</u>**
Emission designation: 14K6F1D

RECEIVER	
Operating Frequency Range:	136-174 MHz
RF Input:	50 Ohms
Channel Spacing:	12.5 kHz and 25 kHz Channel Spacing
Maximum RF Input Power:	+3 dBm with minimum gain and maximum RF Output
Antenna Connector Type:	SMA Connectors

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 Input Port	1	SMA	Shielded coaxial
2	RF Output Port	1	SMA	Shielded coaxial
3	Power & I/O Ports	1	Backplane edge	No cable

3.5. ANCILLARY EQUIPMENT

None

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:	120 V 60 Hz

4.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TEST SIGNALS

Operating Modes:	The transmitter was operated in a continuous transmission mode with the carrier modulated as specified in the Test Data.
Special Test Software:	Utility software provided by Kaval was used for selecting frequency bands of the amplifier.
Special Hardware Used:	None
Transmitter Test Antenna:	The EUT is tested with the transmitter antenna port terminated to a 50 Ohms RF Load.

Transmitter Test Signals	
Frequency Band(s): ▪ 136-174 MHz band:	Near lowest, near middle & near highest frequencies in each frequency bands that the transmitter covers: ▪ 136 MHz, 160 MHz and 174 MHz
Transmitter Wanted Output Test Signals: ▪ RF Power Output (measured maximum output power): ▪ Normal Test Modulation ▪ Modulating signal source:	 ▪ 38 dBm ▪ Unmodulated, FM ▪ 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 Powerline Conducted Emissions were performed in UltraTech's shielded room, 16'(L) by 12'(W) by 12'(H).

- Radiated Emissions were performed at the Ultratech's 3 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: Nov. 03, 2004.

5.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC PARAGRAPH.	TEST REQUIREMENTS	APPLICABILITY (YES/NO)
90.205 & 2.1046	RF Power Output	Yes
1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes
90.213 & 2.1055	Frequency Stability	Yes
90.242(b)(8) & 2.1047(a)	Audio Frequency Response	Not applicable for a RF amplifier
90.210 & 2.1047(b)	Modulation Limiting	Not applicable for a RF amplifier
90.210 & 2.1049	Emission Limitation & Emission Mask	Yes
90.210, 2.1057 & 2.1051	Emission Limits - Spurious Emissions at Antenna Terminal	Yes
90.210, 2.1057 & 2.1053	Emission Limits - Field Strength of Spurious Emissions	Yes
90.214	Transient Frequency Behavior	Not applicable for a RF amplifier
LinkNet RF Broadband Amplifier Module, **Model No.: LNKA100**, by **Kaval Telecom 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 kept in file and it is available anytime upon FCC request.		

5.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None

5.4. DEVIATION OF STANDARD TEST PROCEDURES

None

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

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: 1992 and CISPR 16-1.

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

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

6.5. RF POWER OUTPUT @ FCC 2.1046 & 90.205

6.5.1. Limits @ FCC 90.205

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

6.5.2. Method of Measurements

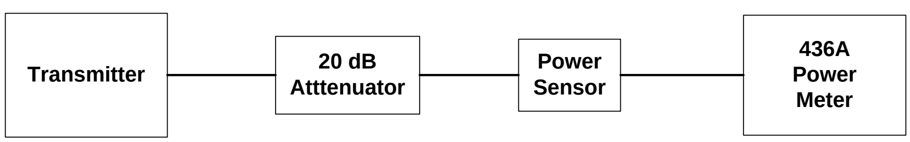
Please refer to Exhibit 8, § 8.1 (Conducted) and § 8.2 (Radiated) for test procedures and test setup.

6.5.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Hewlett Packard	HP 8546A	…	9 kHz to 5.6 GHz with built-in 30 dB Gain Pre-selector, QP, Average & Peak Detectors.
Attenuator(s)	Bird	…	…	DC – 22 GHz
Spectrum Analyzer/ EMI Receiver	Advantest	R3271	15050203	100 Hz – 26.5 GHz
Attenuator(s)	Weinschel Corp	24-20-34	BJ2357	DC – 8.5 GHz
Dipole Antenna	EMCO	3121C	8907-440	30 MHz – 1 GHz
Dipole Antenna	EMCO	3121C	8907-434	30 MHz – 1 GHz
Power Meter	Hewlett Packard	436A	1725A02249	10 kHz – 50 GHz, sensor dependent
Power Sensor	Hewlett Packard	8481A	2702A68983	10 MHz – 18 GHz
Synthesize Sweeper	Hewlett Packard	83752B	3610A00457	0.01 – 20 GHz

6.5.4. Test Arrangement

- Power at RF Power Output Terminals



6.5.5. Test Data

Conducted Power

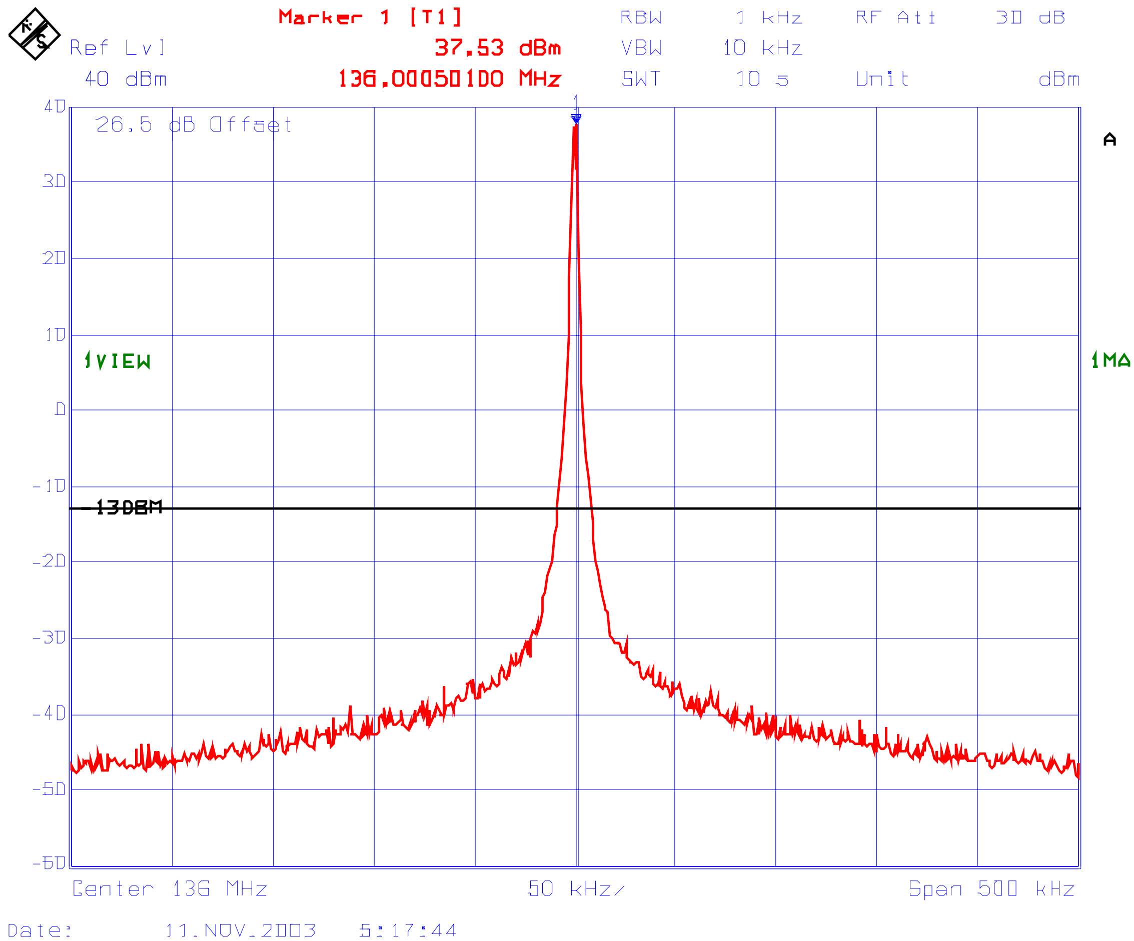
Operating Frequency Bands (MHz)	Test Frequency (MHz)	Modulation	Total RF Output Power at Antenna Port (dBm)	Maximum Antenna Gain (dBi)	Maximum ERP (dBm)	RF Output Power Ratings at Antenna Port (dBm)
136-174	136.0	F1D / F3E	37.8	20	55.7	37
	160.0	F1D / F3E	38.0	20	55.9	37
	173.5	F1D / F3E	37.7	20	55.6	37

6.5.5.1. INTERMODULATION IN & PEAK POWERS IN 136-174 MHz Band – NO MODUALTION

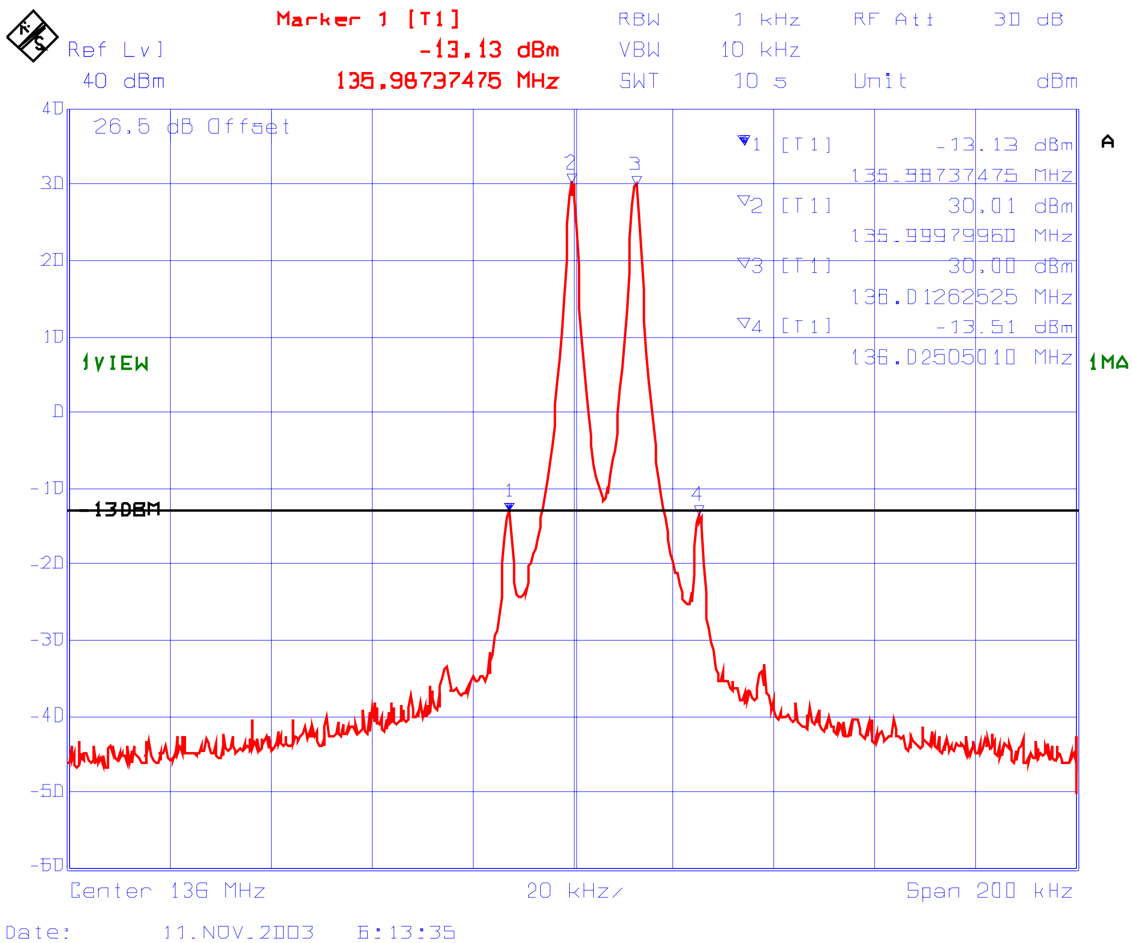
Frequency (MHz)	Number of In/Out Channels	Modulation	Maximum RF Input (conducted) (dBm)	Maximum RF Output (conducted) (dBm)	Maximum Antenna Gain allowed (dBi)	Maximum ERP Measured (dBm)	Manufacturer's Maximum RF Output Rating (conducted) (dBm)
136	1	unmodulated	3.0	37.8	20	55.7	37
136, 136.0125	2	unmodulated	-4.4	30.0	20	47.9	26
136, 136.0125, 136.025	3	unmodulated	-7.3	27.1	20	45.0	24
160	1	unmodulated	3.0	38.0	20	55.9	37
160, 160.0125	2	unmodulated	-3.2	31.0	20	48.9	26
160, 160.0125, 159.9875	3	unmodulated	-6.3	28.2	20	46.1	24
173.5	1	unmodulated	3.0	37.7	20	55.6	37
173.5, 173.4875	2	unmodulated	-3.5	30.6	20	48.5	26
173.5, 173.4875, 173.4750	3	unmodulated	-6.5	27.9	20	45.8	24

Please Refer to Plots # 1-9 for Intermodulation in the Band 136-174 MHz.

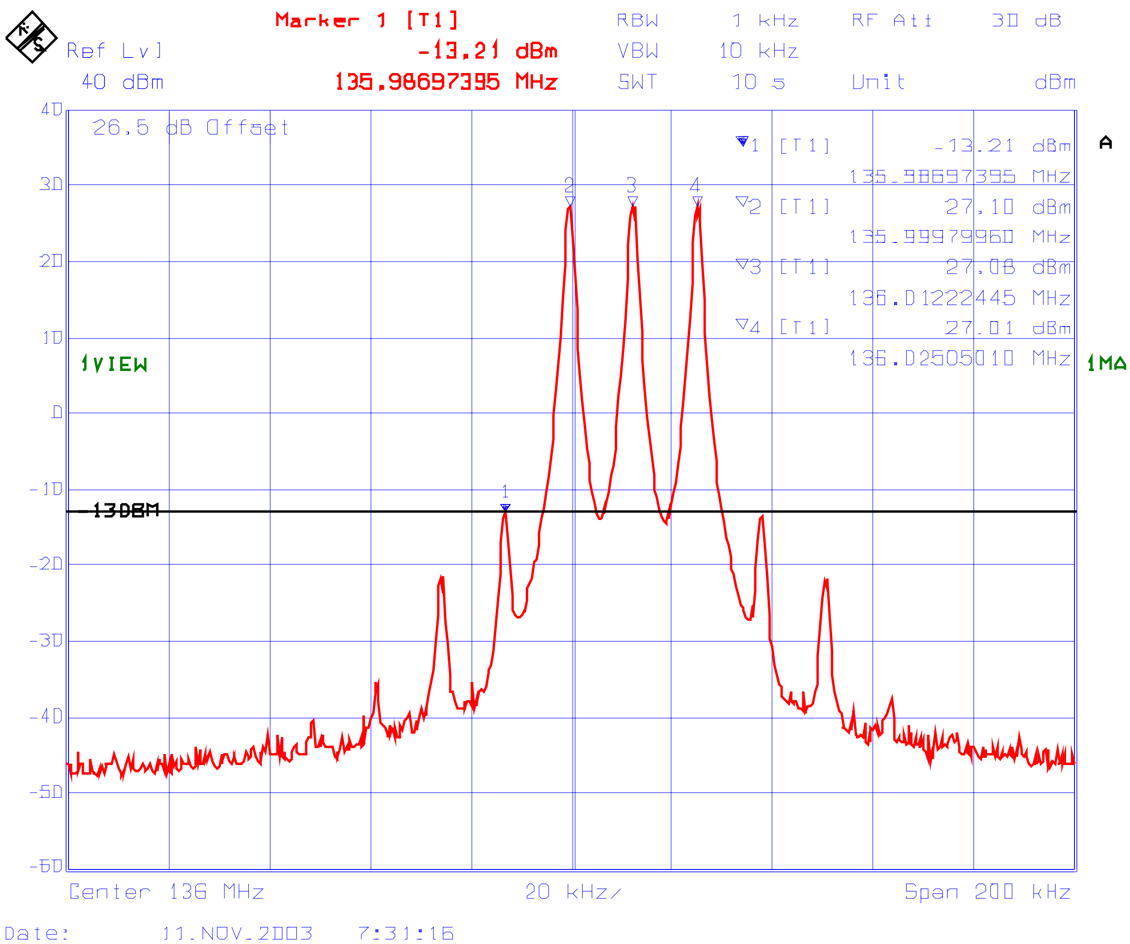
PLOT#: 1 Intermodulation with 1 RF signal input
Fc: 136 MHz, RF Input: 3 dBm



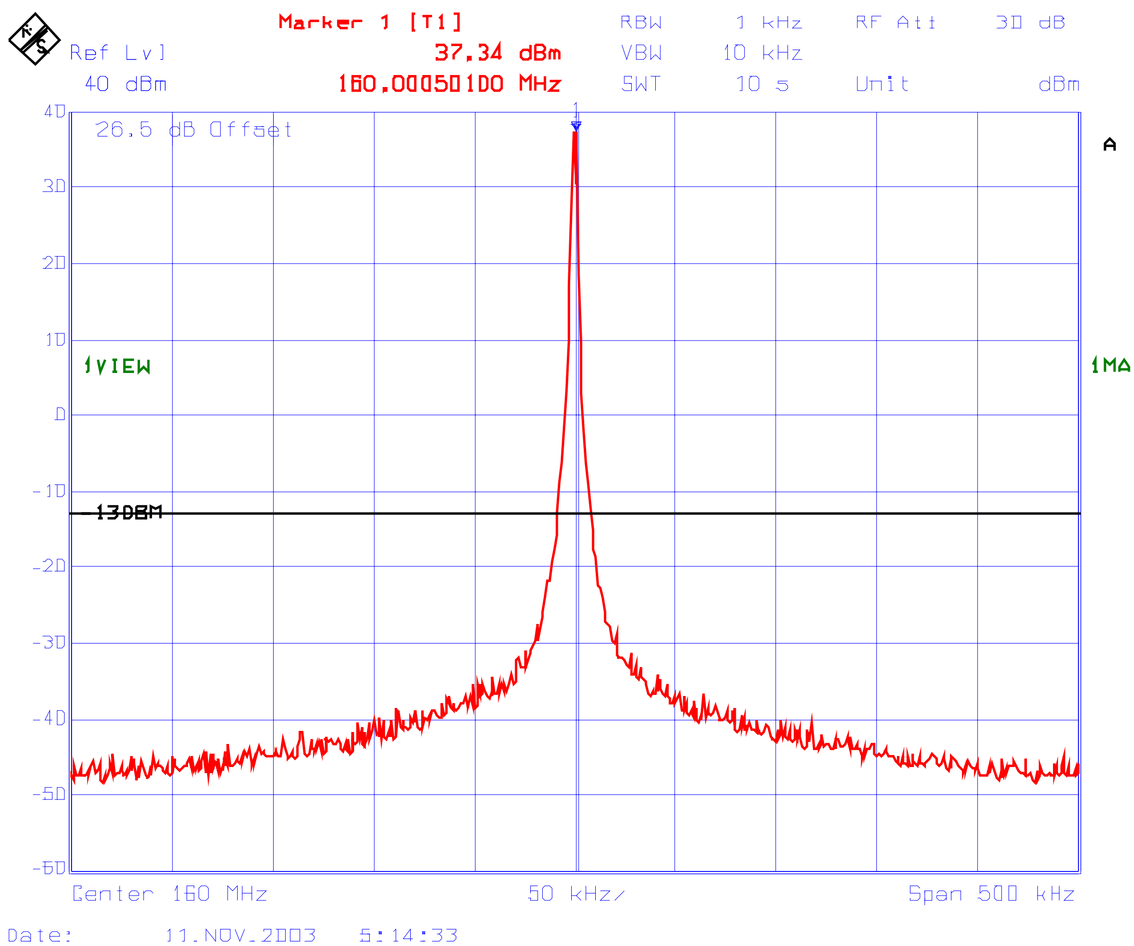
PLOT#: 2 Intermodulation with 2 RF signal input
Fc: 136 MHz, Fc + 12.5 kHz, RF Input 1: -4.35 dBm, RF Input 2: -4.41 dBm



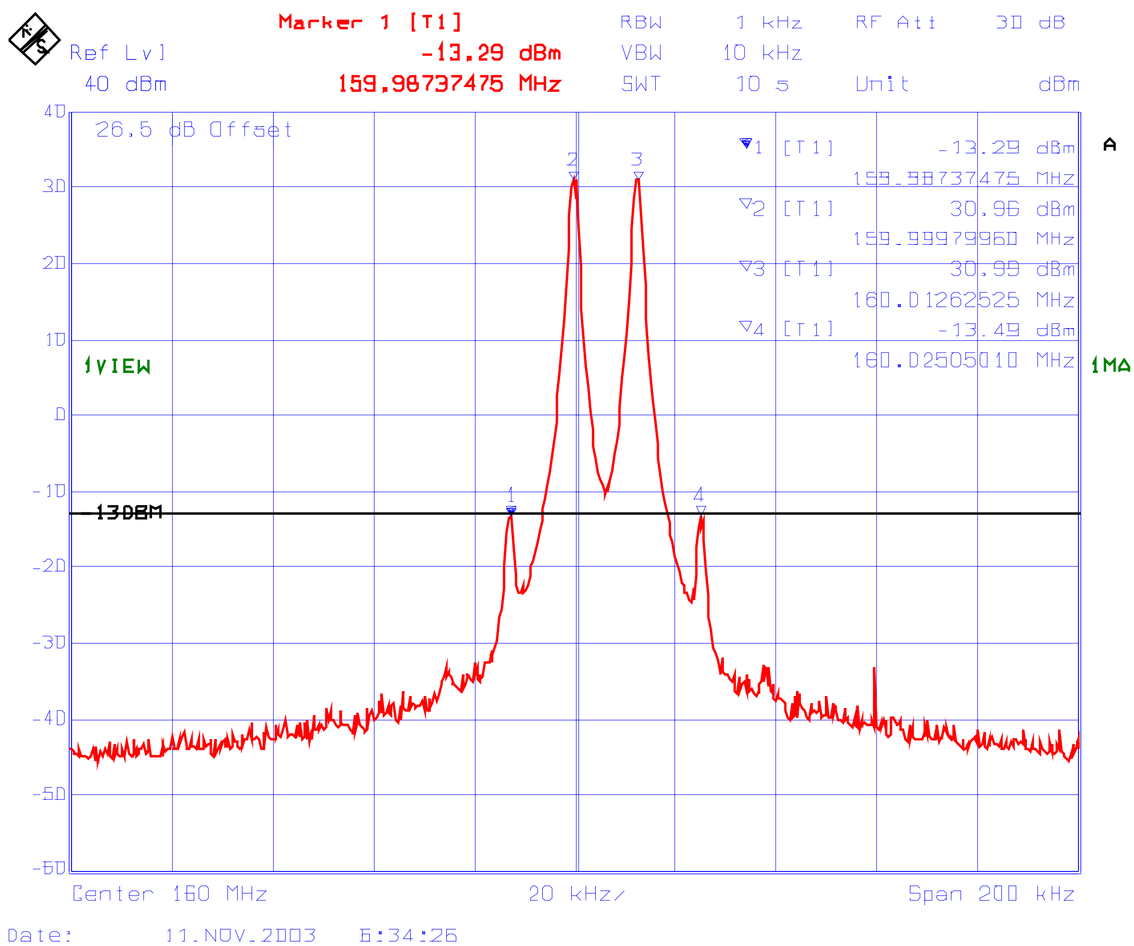
PLOT#: 3 Intermodulation with 3 RF signal input
Fc: 136 MHz, Fc + 12.5 kHz, Fc + 25 kHz
RF Input 1: -7.33 dBm, RF Input 2: -7.42 dBm, RF Input 3: -7.51 dBm



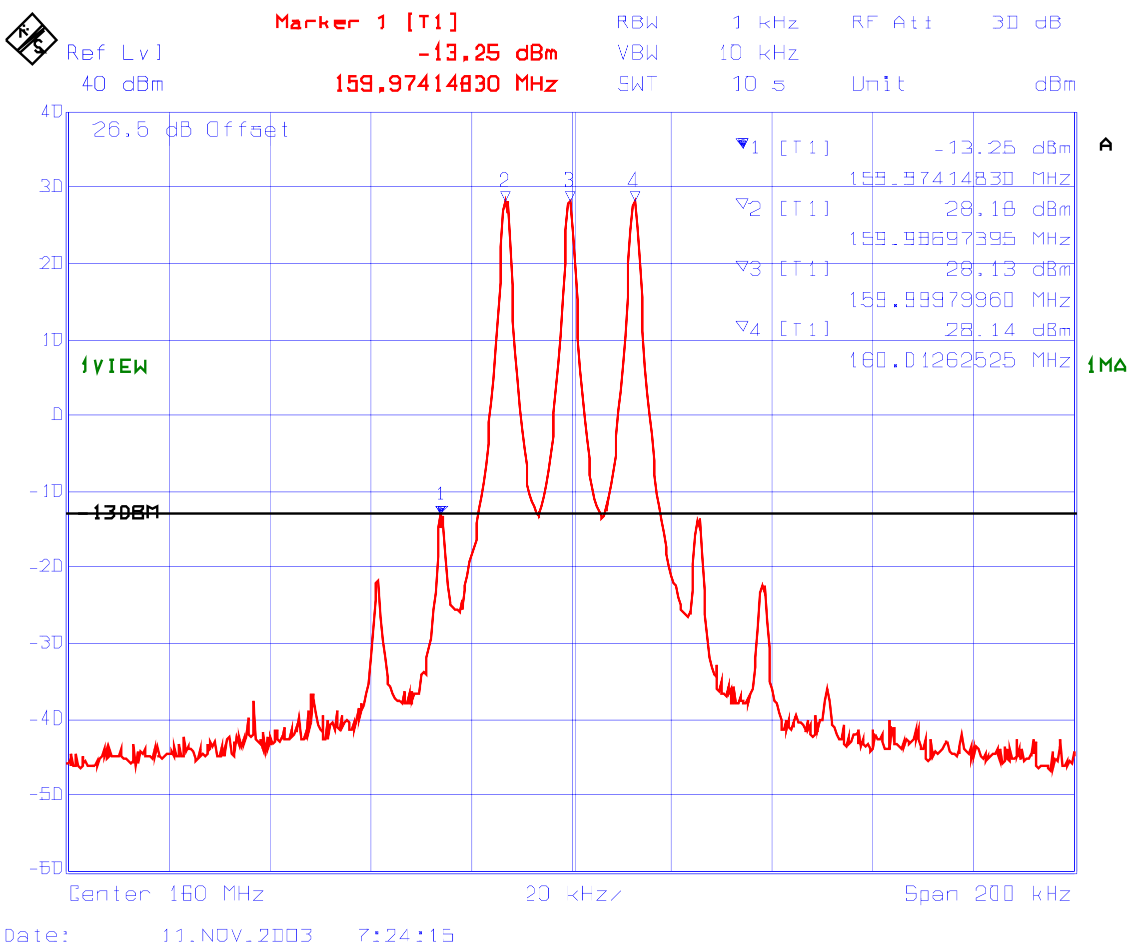
PLOT#: 4 Intermodulation with 1 RF signal input
Fc: 160 MHz, RF Input: 3 dBm



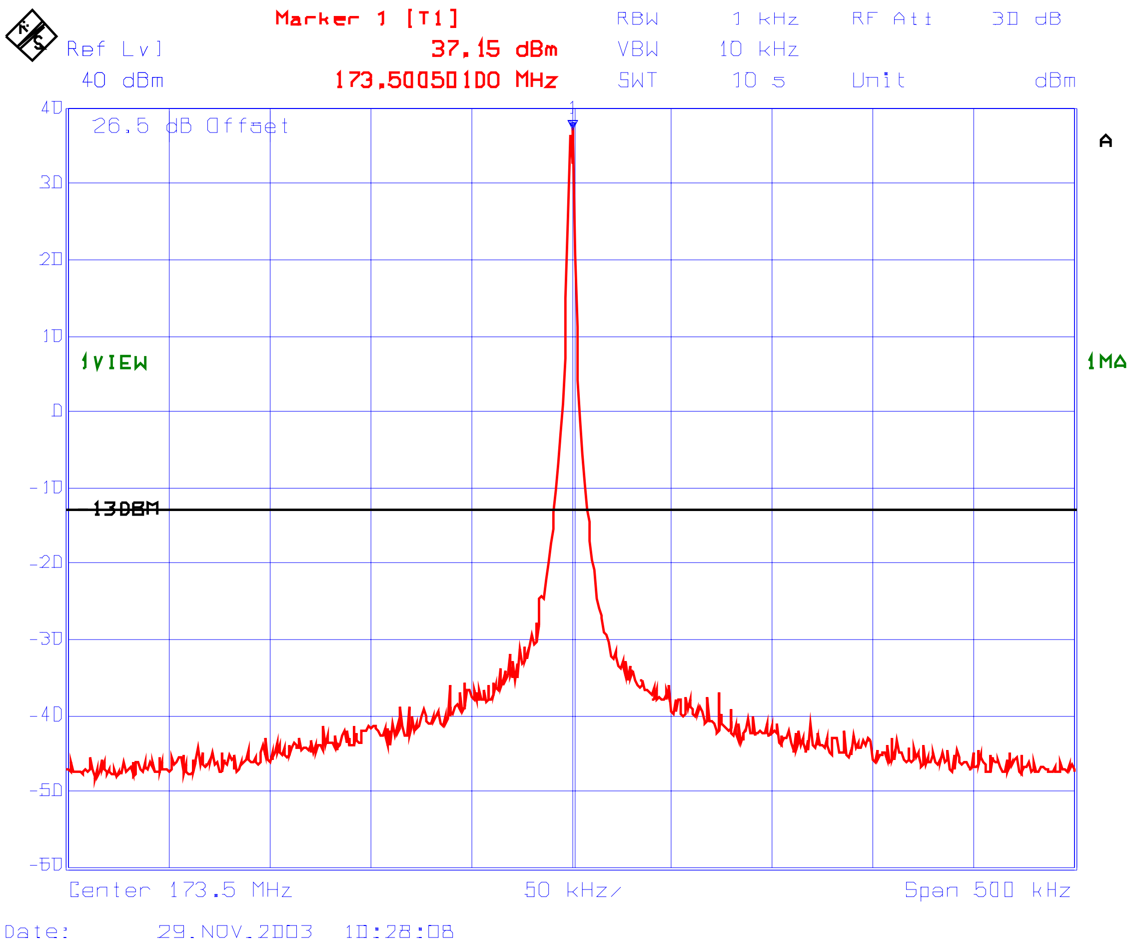
PLOT#: 5 Intermodulation with 2 RF signal inputs
Fc: 160 MHz, Fc + 12.5 kHz, RF Input 1: -3.31 dBm, RF Input 2: -3.21 dBm



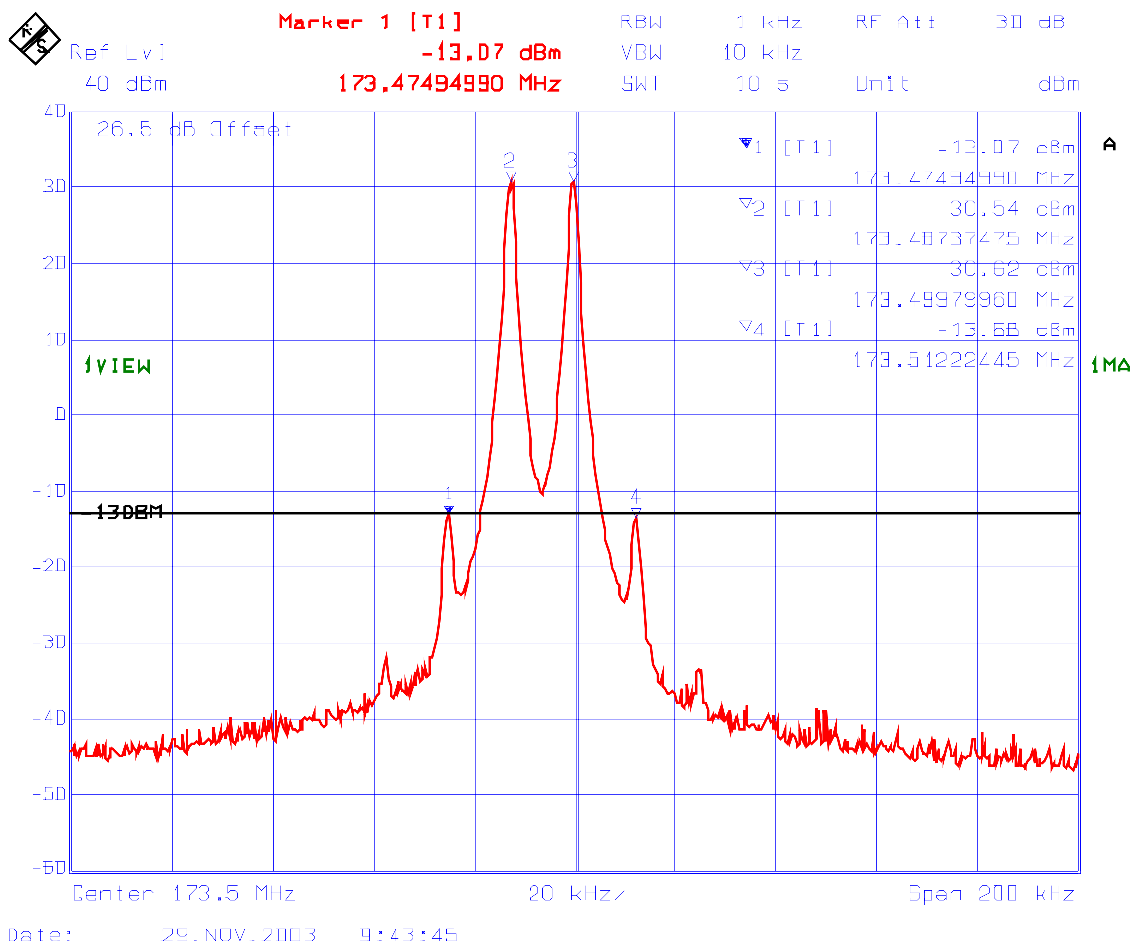
PLOT#: 6 **Intermodulation with 3 RF signal inputs**
Fc: 160 MHz, Fc - 12.5 kHz, Fc + 12.5 kHz
RF Input 1: -6.32 dBm, RF Input 2: -6.44 dBm, RF Input 3: -6.38 dBm



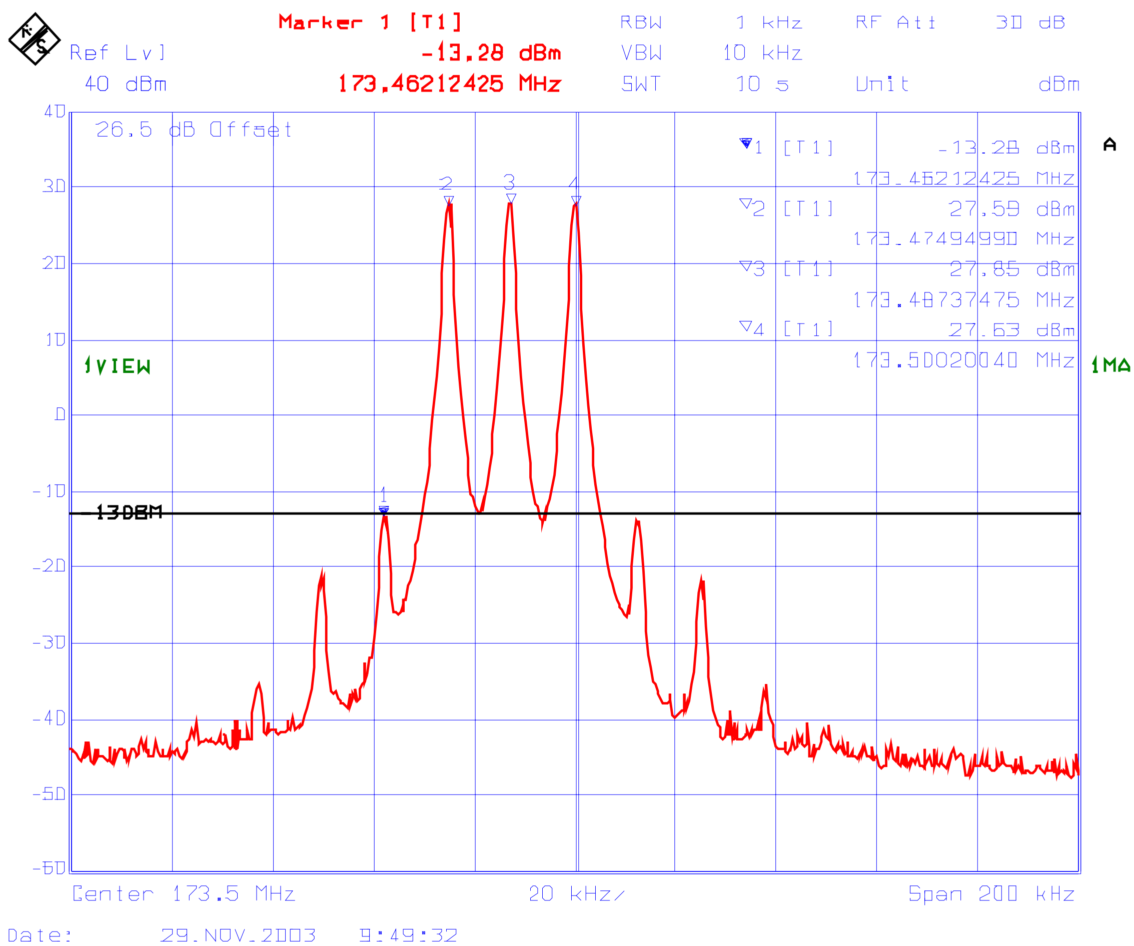
PLOT#: 7 Intermodulation with 1 RF signal input
Fc: 173.5 MHz, RF Input: 3 dBm



PLOT#: 8 **Intermodulation with 2 RF signal inputs**
Fc: 173.5 MHz, Fc - 12.5 kHz
RF Input 1: -3.49 dBm, RF Input 2: -3.62 dBm



PLOT#: 9 Intermodulation with 3 RF signal inputs
Fc: 173.5 MHz, Fc - 12.5 kHz, Fc - 25 kHz
RF Input 1: -6.63 dBm, RF Input 2: -6.46 dBm, RF Input 3: -6.50 dBm



6.6. RF EXPOSURE REQUIRMENTS @ 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).

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (minutes)
(A) Limits for Occupational/Control Exposures				
30-300	61.4	0.163	1.0	6
(B) Limits for General Population/Uncontrolled Exposure				
30-300	27.5	0.073	0.2	30

F = Frequency in MHz

6.6.2. Method of Measurements

Refer to FCC @ 1.1310, 2.1091

- Spread spectrum transmitters operating under section 15.247 are categorically from routine environmental evaluation to demonstrating RF exposure compliance with respect to MPE and/or SAR limits. These devices are not exempted from compliance (As indicated in Section 15.247(b)(4), these transmitters are required to operate in a manner that ensures that exposure to public users and nearby persons) does not exceed the Commission's RF exposure guidelines (see Section 1.1307 and 2.1093). Unless a device operates at substantially low power levels, with a low gain antenna(s), supporting information is generally needed to establish the various potential operating configurations and exposure conditions of a transmitter and its antenna(s) in order to determine compliance with the RF exposure guidelines.
- In order to demonstrate compliance with MPE requirements (see Section 2.1091), the following information is typically needed:

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

Calculation Method of RF Safety Distance:

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

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

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

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

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

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

6.6.3. Test Data

Antenna Gain Limit specified by Manufactuer: 20 dBi (Outdoor roof top Antenna)

Minimum Frequency (MHz)	Measured RF Conducted (Watts)	Calculated EIRP (Watts)	Calculated RF Safety Distance r (cm)	Manufacturer' Specified Separation Distance (cm)
136	6.3	631	501	1000

Note 1: RF EXPOSURE DISTANCE LIMITS: $r = (PG/4\Pi S)^{1/2} = (EIRP/4\Pi S)^{1/2}$
$S = 0.2\ mW/cm^2$

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

Minimum Frequency (MHz)	Measured RF Conducted (Watts)	Calculated EIRP (Watts)	Calculated RF Safety Distance r (cm)	Manufacturer' Specified Separation Distance (cm)
136	0.63	0.63	15.8	20

Note 1: RF EXPOSURE DISTANCE LIMITS: $r = (PG/4\Pi S)^{1/2} = (EIRP/4\Pi S)^{1/2}$
$S = 0.2\ mW/cm^2$

6.7. FREQUENCY STABILITY @ FCC 2.1055 & 90.213

6.7.1. Limits

Please refer to FCC CFR 47, Part 90, Subpart I, Para. 90.213 for specification details.

FREQUENCY RANGE (MHz)	FIXED & BASE STATIONS (ppm)
150-174	2.5

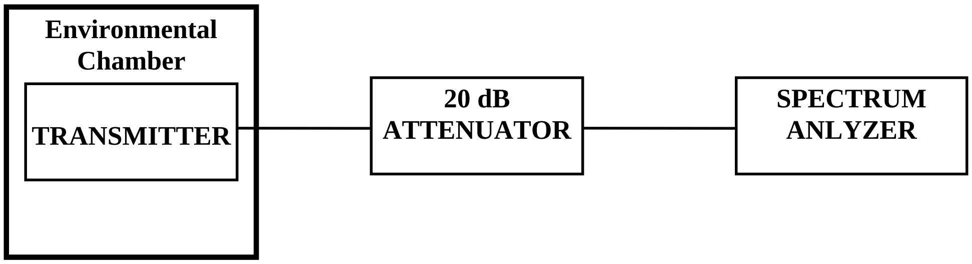
6.7.2. Method of Measurements

Refer to Exhibit 8, § 8.3 of this report for measurement details

6.7.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
EMI Receiver/ EMI Receiver	Hewlett Packard	HP 8593EM	3412A00103	9 kHz – 26.5 GHz
Attenuator(s)	Bird	..	…	DC – 22 GHz
Temperature & Humidity Chamber	Tenney	T5	9723B	-40^{o} to +60^{o} C range

6.7.4. Test Arrangement



6.7.5. Test Data

6.7.5.1. Frequency Stability in 136-174 MHz Band

Center Frequency:	136 MHz
Full Power Level:	6.3 W
Frequency Tolerance Limit:	± 2.5 ppm
Max. Frequency Tolerance Measured:	0 Hz or 0.0 ppm
Input Voltage Rating:	120 V 60 Hz

CENTER FREQUENCY & RF POWER OUTPUT VARIATION

Ambient Temperature (°C)	**Supply Voltage (Nominal) 120 Volts AC**	**Supply Voltage (85% of Nominal) 102 Volts AC**	**Supply Voltage (115% of Nominal) 138 Volts AC**
	Hz	**Hz**	**Hz**
-30	0	N/A	N/A
-20	0	N/A	N/A
-10	0	N/A	N/A
0	0	N/A	N/A
+10	0	N/A	N/A
+20	0	0	0
+30	0	N/A	N/A
+40	0	N/A	N/A
+50	0	N/A	N/A

6.8. EMISSION MASK @ FCC 2.1049, 90.208 & 90.210

6.8.1. Limits @ FCC 90.209 & 90.210

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

Frequency Range (MHz)	Maximum Authorized BW (KHz)	Channel Spacing (KHz)	Recommended Frequency Deviation (KHz)	FCC Applicable Mask
136-174	20.0	25.0	5.0	• 90.210(b): Mask B – Voice • 90.210(c): Mask C – Data
136-174	11.25	12.5	2.5	• 90.210(d): Mask D – Voice & Data

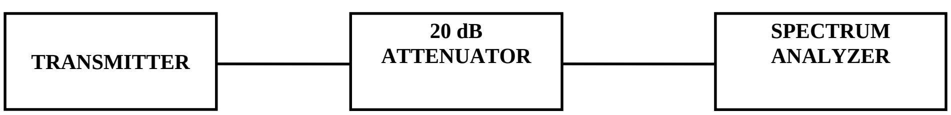
6.8.2. Method of Measurements

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

6.8.3. Test Equipment List

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

6.8.4. Test Arrangement



6.8.5. Test Data

6.8.5.1. 99% Occupied Bandwidth – 25 kHz Channel Spacings

EUT's Subband (MHz)	Frequency (MHz)	Channel Spacing (kHz)	Modulation	RF IN Measured 99% OBW (kHz)	RF OUT Measured 99% OBW (kHz)
136-174	136	25.0	FM with 2.5 kHz Sine wave signal	15.9	15.9
	160	25.0	FM with 2.5 kHz Sine wave signal	15.9	15.9
	173.5	25.0	FM with 2.5 kHz Sine wave signal	15.9	15.9

Please Refer to Plots # 10-13 for 99% Occupied Bandwidth in the Band 136-174 MHz.

EUT's Subband (MHz)	Frequency (MHz)	Channel Spacing (kHz)	Modulation	RF IN Measured 99% OBW (kHz)	RF OUT Measured 99% OBW (kHz)
136-174	136	25.0	FM with an External 9600 b/s random data source	15.9	15.4
	160	25.0	FM with an External 9600 b/s random data source	15.9	15.4
	173.5	25.0	FM with an External 9600 b/s random data source	15.9	16.1

Please Refer to Plots # 14-17 for 99% Occupied Bandwidth in the Band 136-174 MHz.

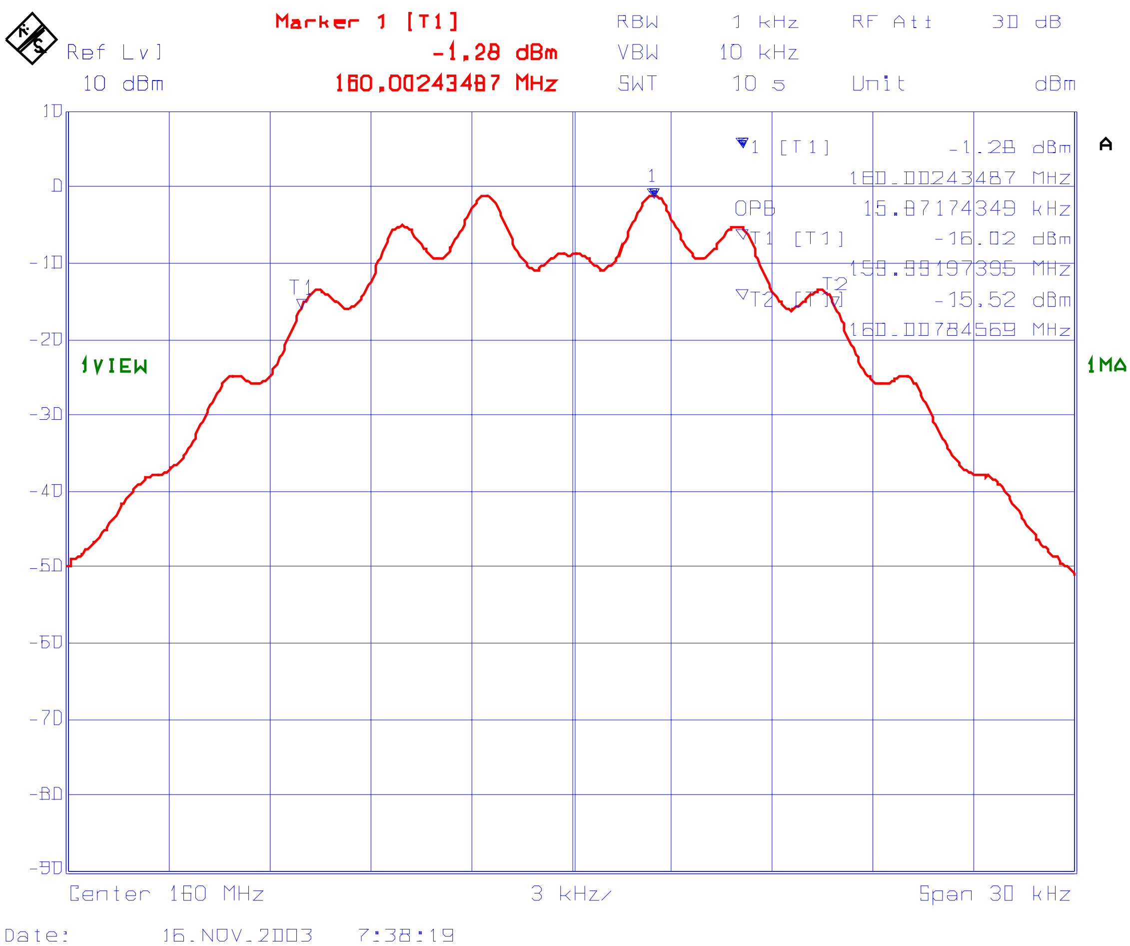
6.8.5.2. 99% Occupied Bandwidth – 12.5 kHz Channel Spacings

EUT's Subband (MHz)	Frequency (MHz)	Channel Spacing (kHz)	Modulation	RF IN Measured 99% OBW (kHz)	RF OUT Measured 99% OBW (kHz)
136-174	136.0	12.5	FM with 2.5 kHz Sine wave signal	10.6	10.6
	160.0	12.5	FM with 2.5 kHz Sine wave signal	10.6	10.6
	173.5	12.5	FM with 2.5 kHz Sine wave signal	10.6	10.5

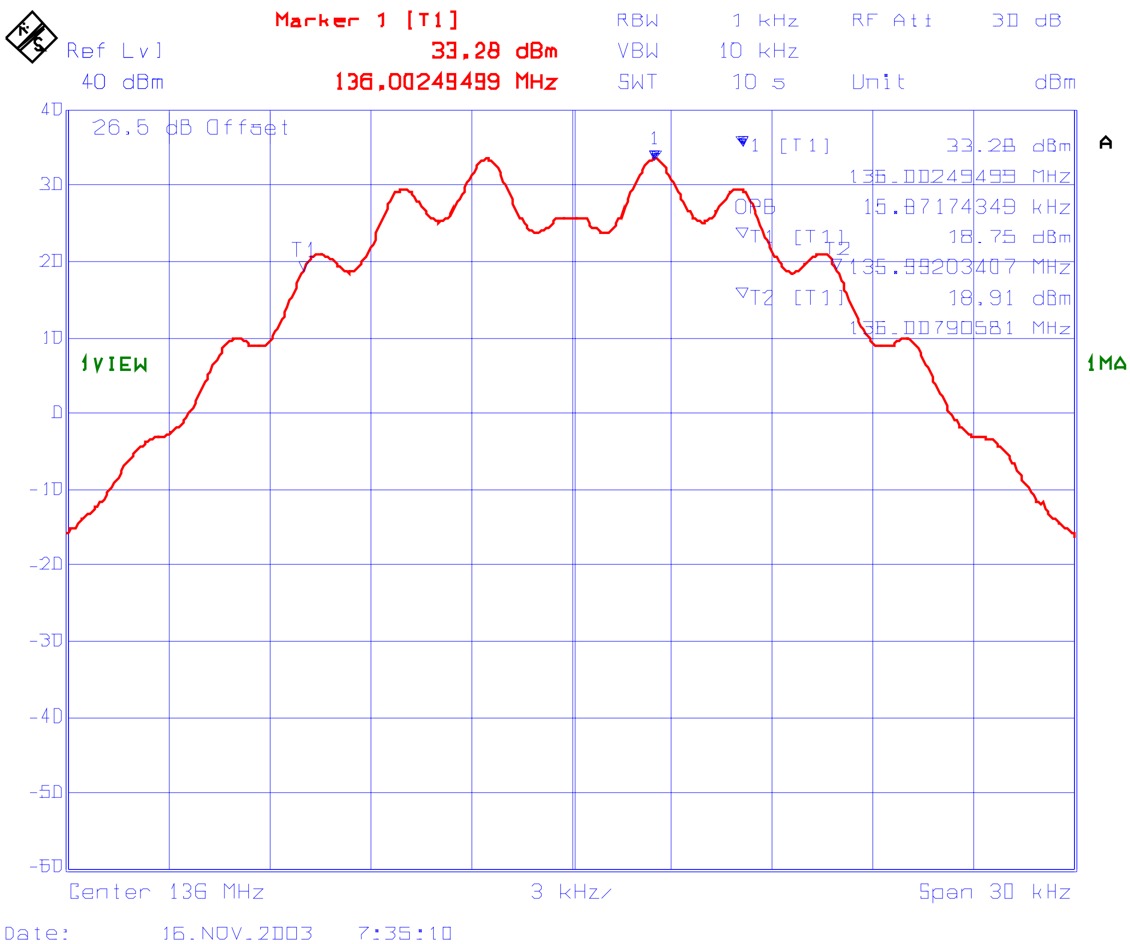
Please Refer to Plots # 18-21 for 99% Occupied Bandwidth in the Band 136-174 MHz.

EUT's Subband (MHz)	Frequency (MHz)	Channel Spacing (kHz)	Modulation	RF IN Measured 99% OBW (kHz)	RF OUT Measured 99% OBW (kHz)
136-174	136.0	12.5	FM with an External 9600 b/s random data source	11.0	11.1
	160.0	12.5	FM with an External 9600 b/s random data source	11.0	11.1
	173.5	12.5	FM with an External 9600 b/s random data source	11.0	11.8

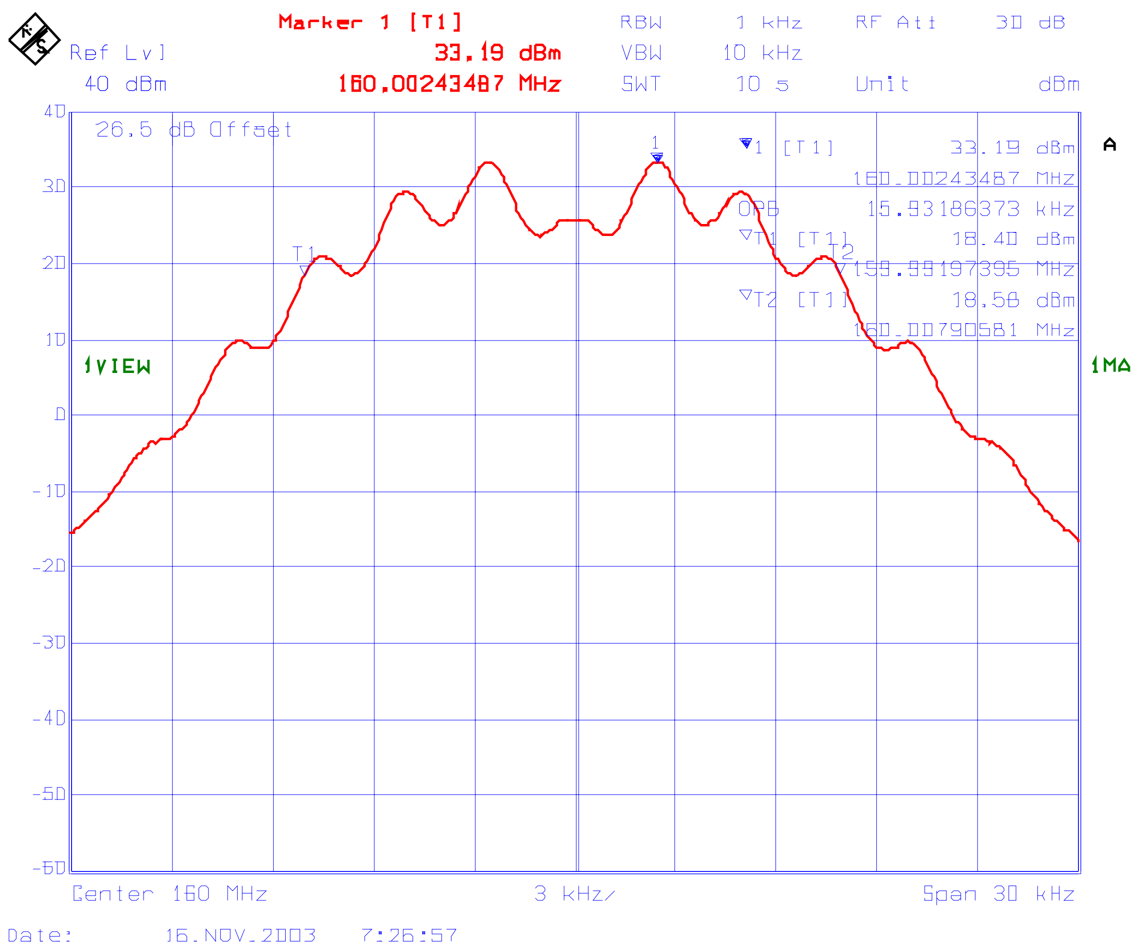
PLOT #: 10 99% OBW, RF Input
Frequency: 160 MHz, 25 kHz Channel Spacing
Modulation: FM modulation with 2.5 kHz Sine wave signal



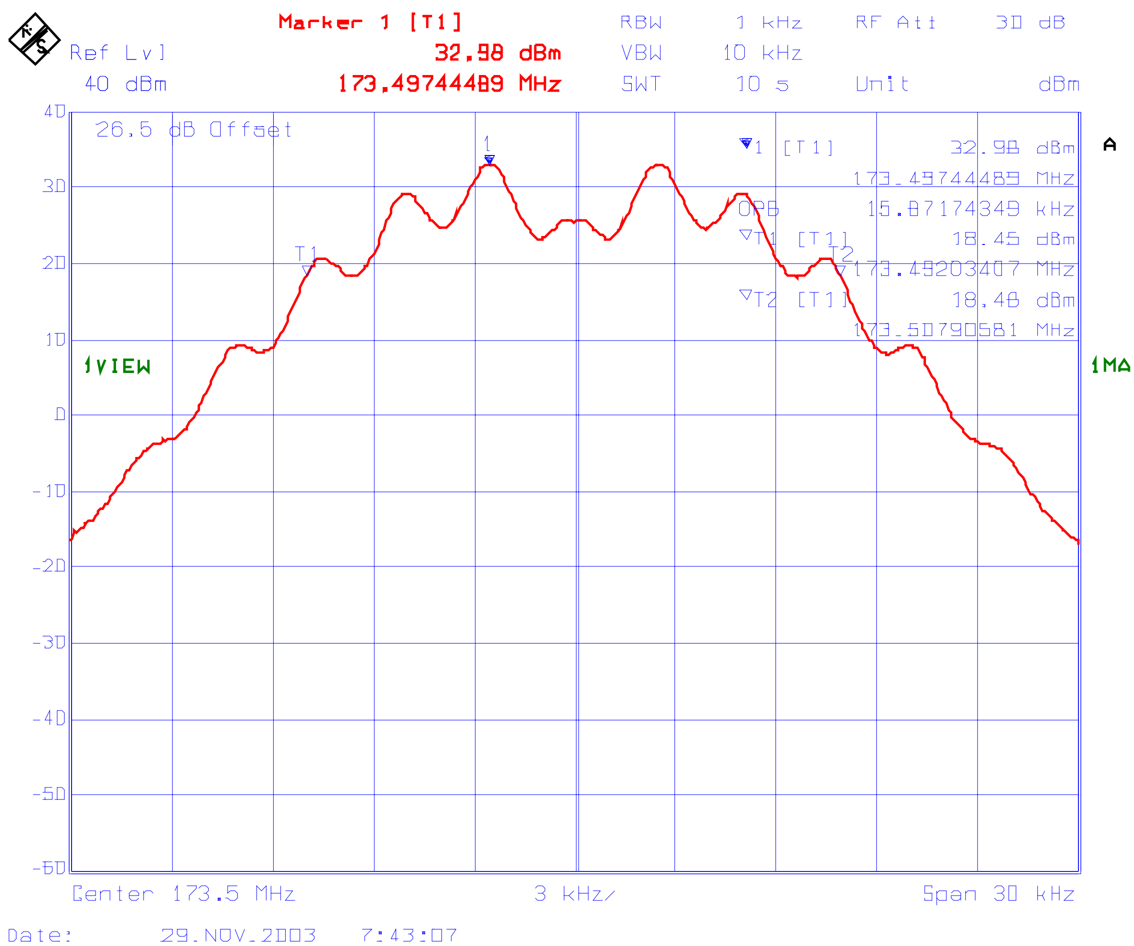
PLOT #: 11 99% OBW, RF Output
Frequency: 136 MHz, 25 kHz Channel Spacing
Modulation: FM modulation with 2.5 kHz Sine wave signal



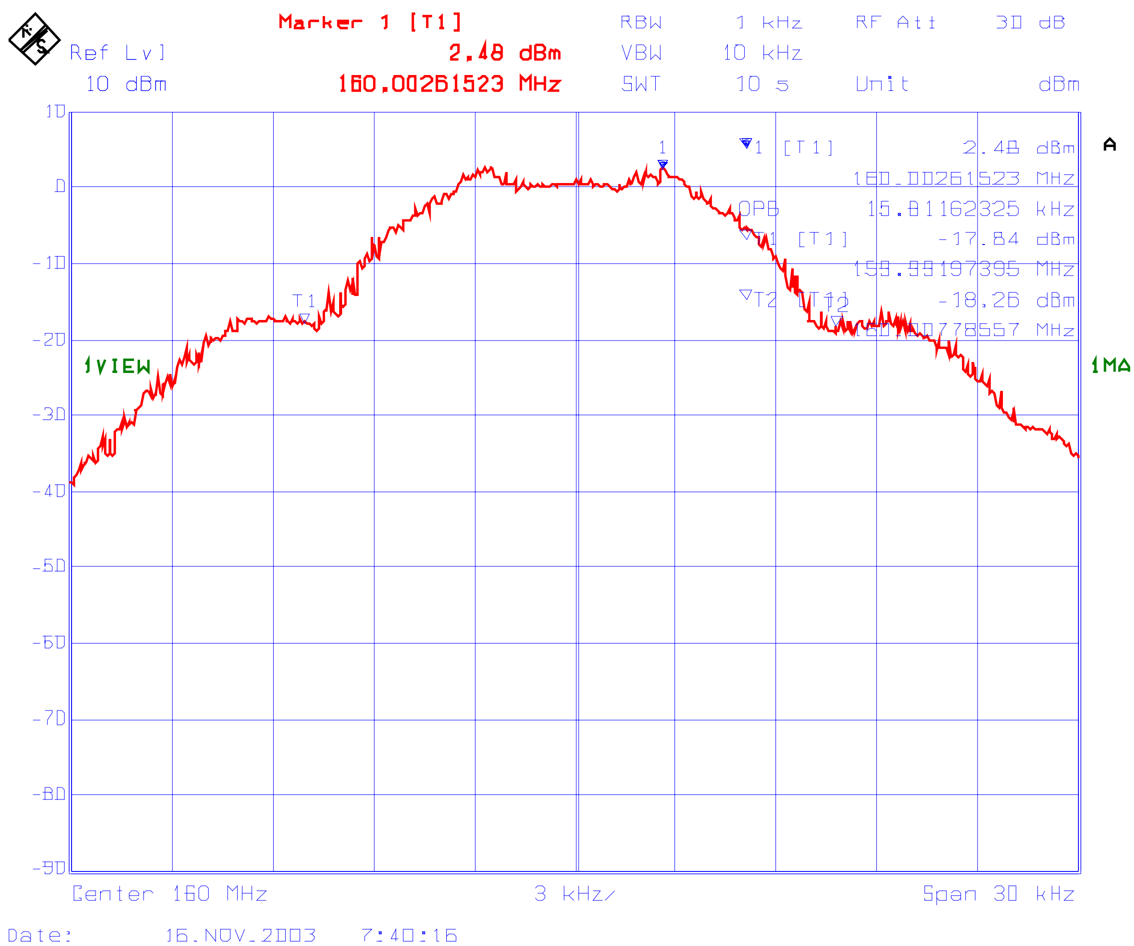
PLOT #: 12 99% OBW, RF Output
Frequency: 160 MHz, 25 kHz Channel Spacing
Modulation: FM modulation with 2.5 kHz Sine wave signal



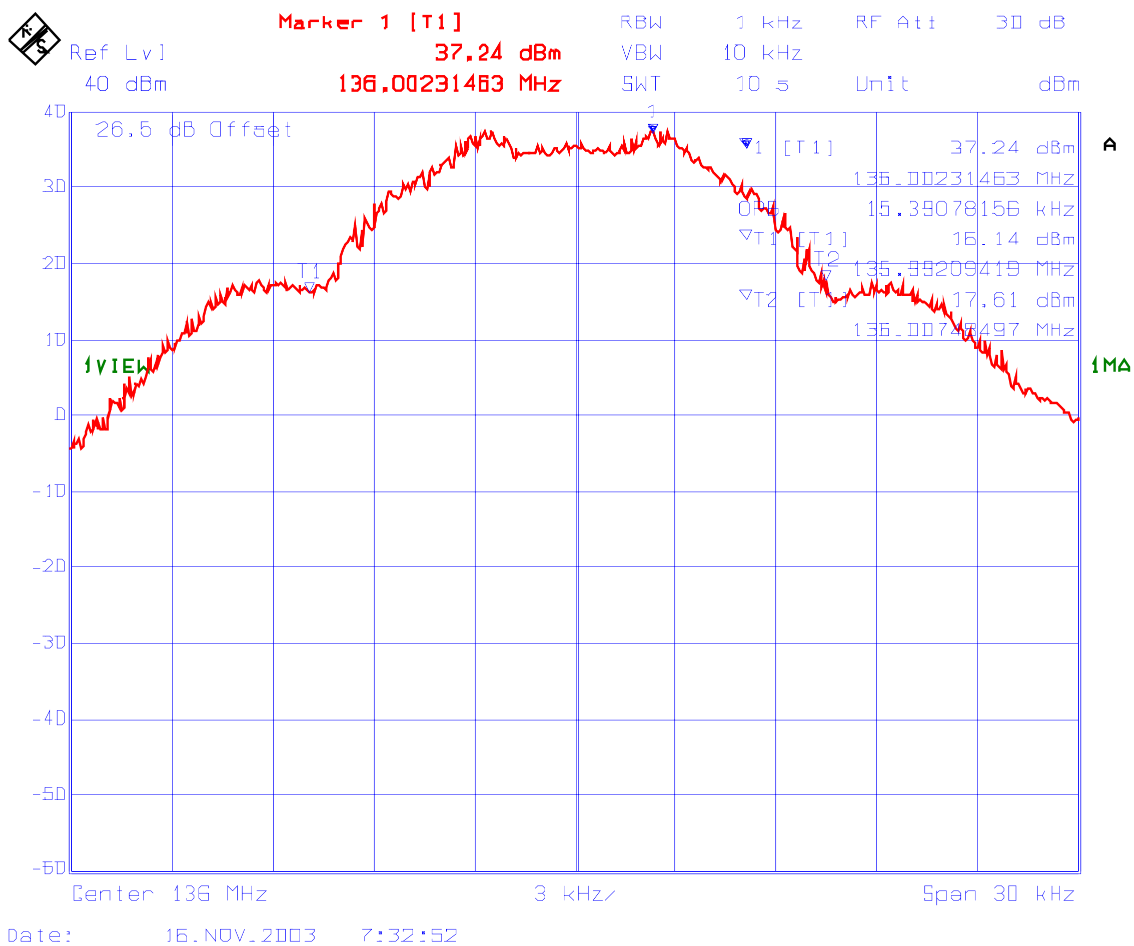
PLOT #: 13 99% OBW, RF Output
Frequency: 173.5 MHz, 25 kHz Channel Spacing
Modulation: FM modulation with 2.5 kHz Sine wave signal



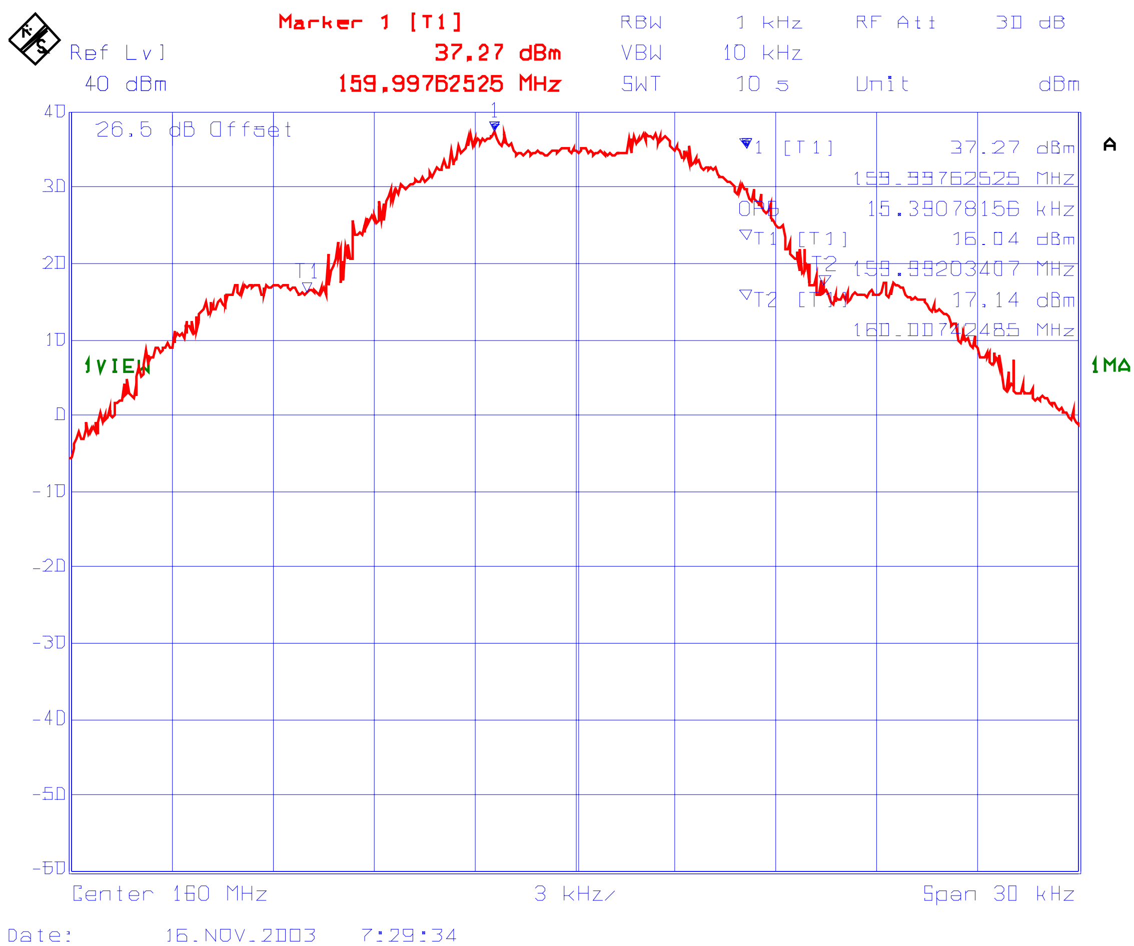
PLOT #: 14 99% OBW, RF Input
Frequency: 160 MHz, 25 kHz Channel Spacing
Modulation: FM modulation with an external 9600 b/s random data source



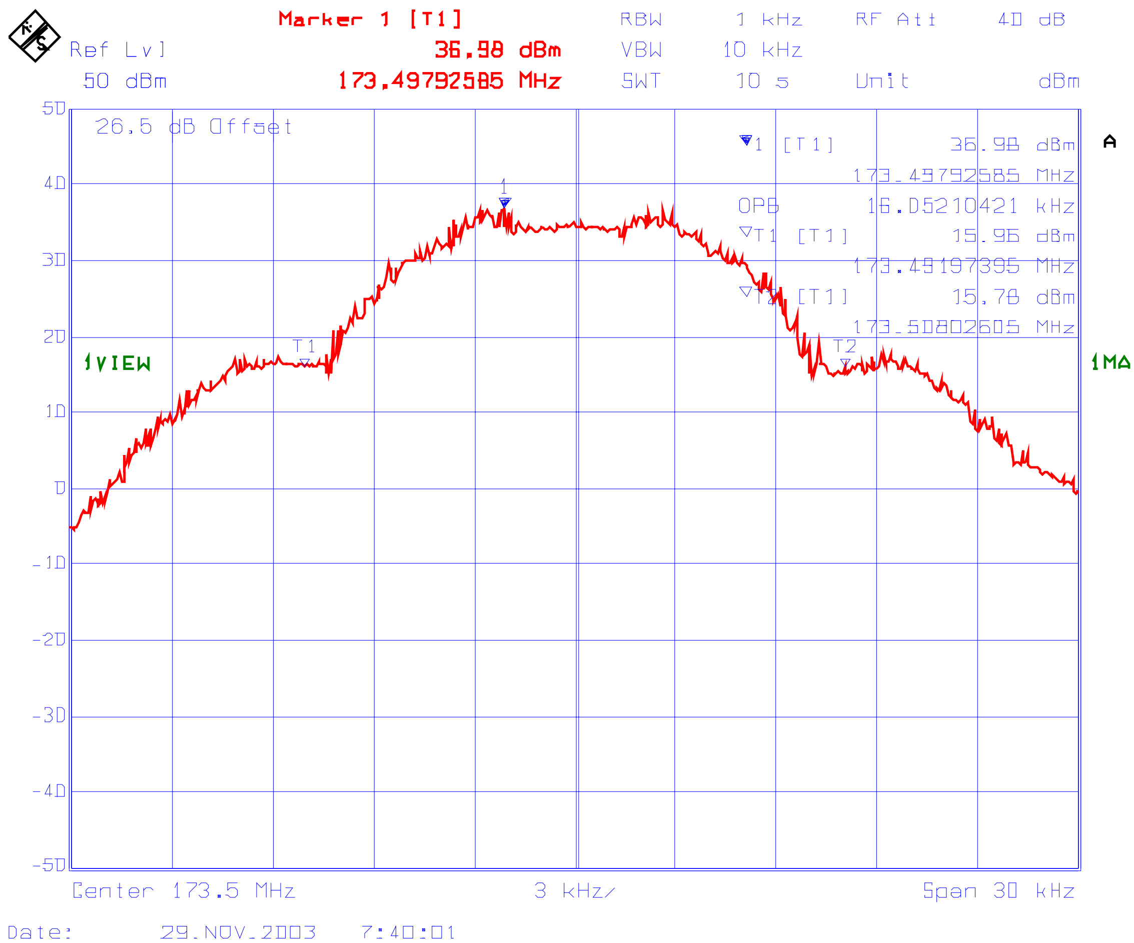
PLOT #: 15 99% OBW, RF Output
Frequency: 136 MHz, 25 kHz Channel Spacing
Modulation: FM modulation with an external 9600 b/s random data source



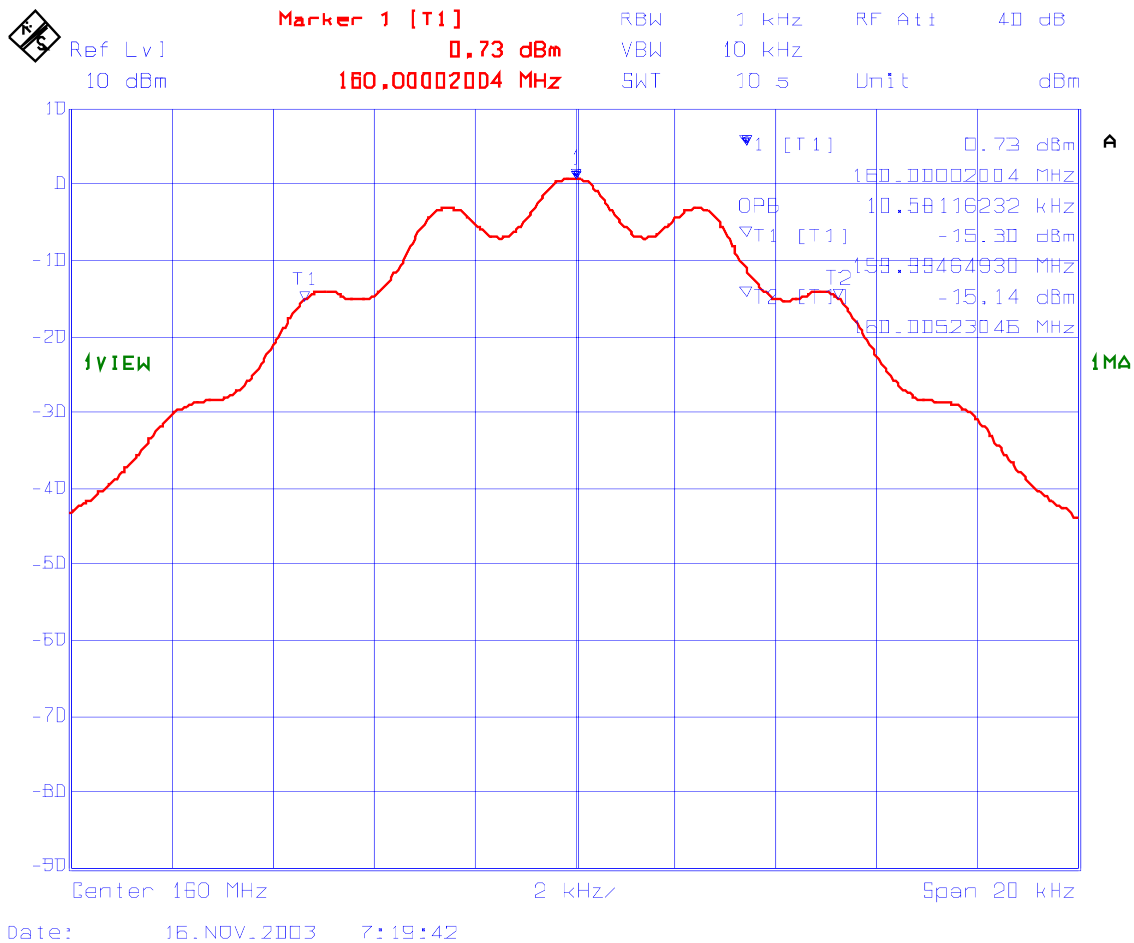
PLOT #: 16 99% OBW, RF Output
Frequency: 160 MHz, 25 kHz Channel Spacing
Modulation: FM modulation with an external 9600 b/s random data source



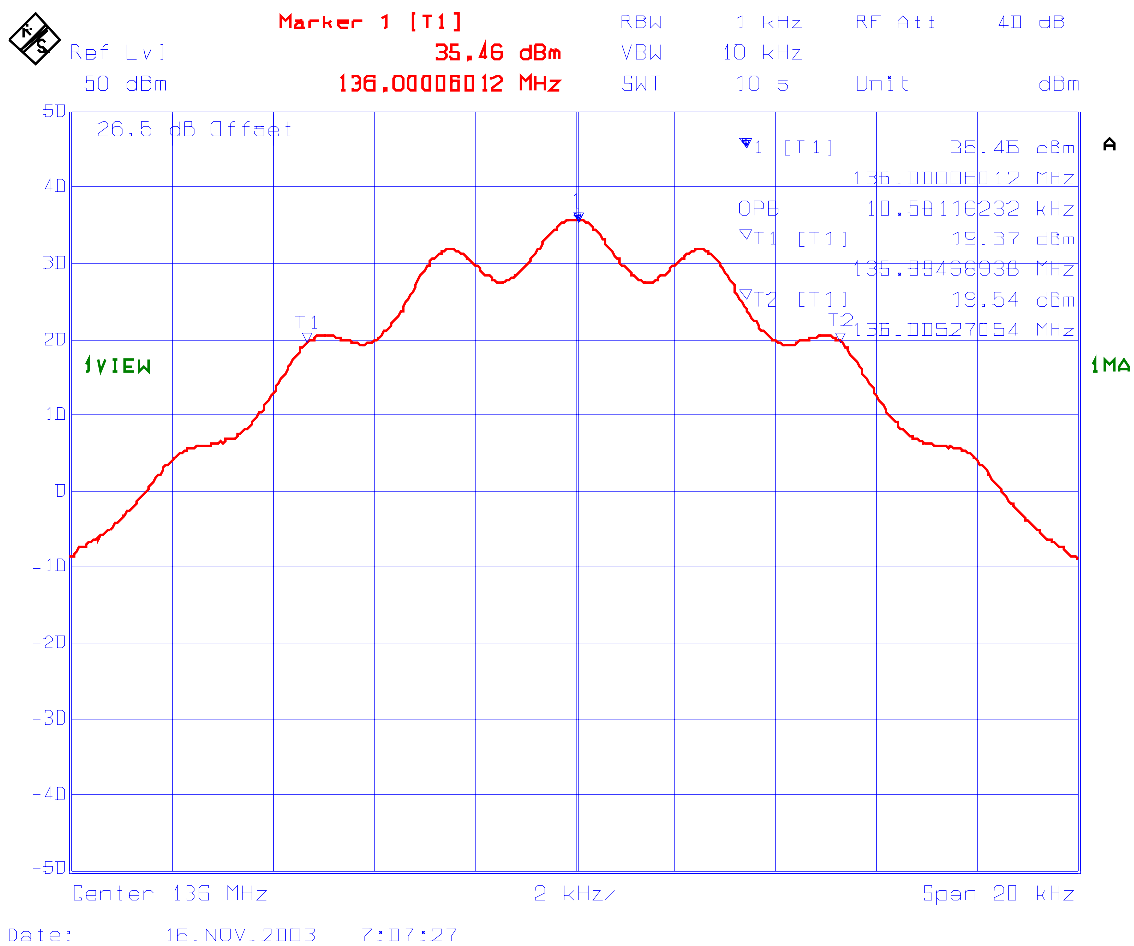
PLOT #: 17 99% OBW, RF Output
Frequency: 173.5 MHz, 25 kHz Channel Spacing
Modulation: FM modulation with an external 9600 b/s random data source



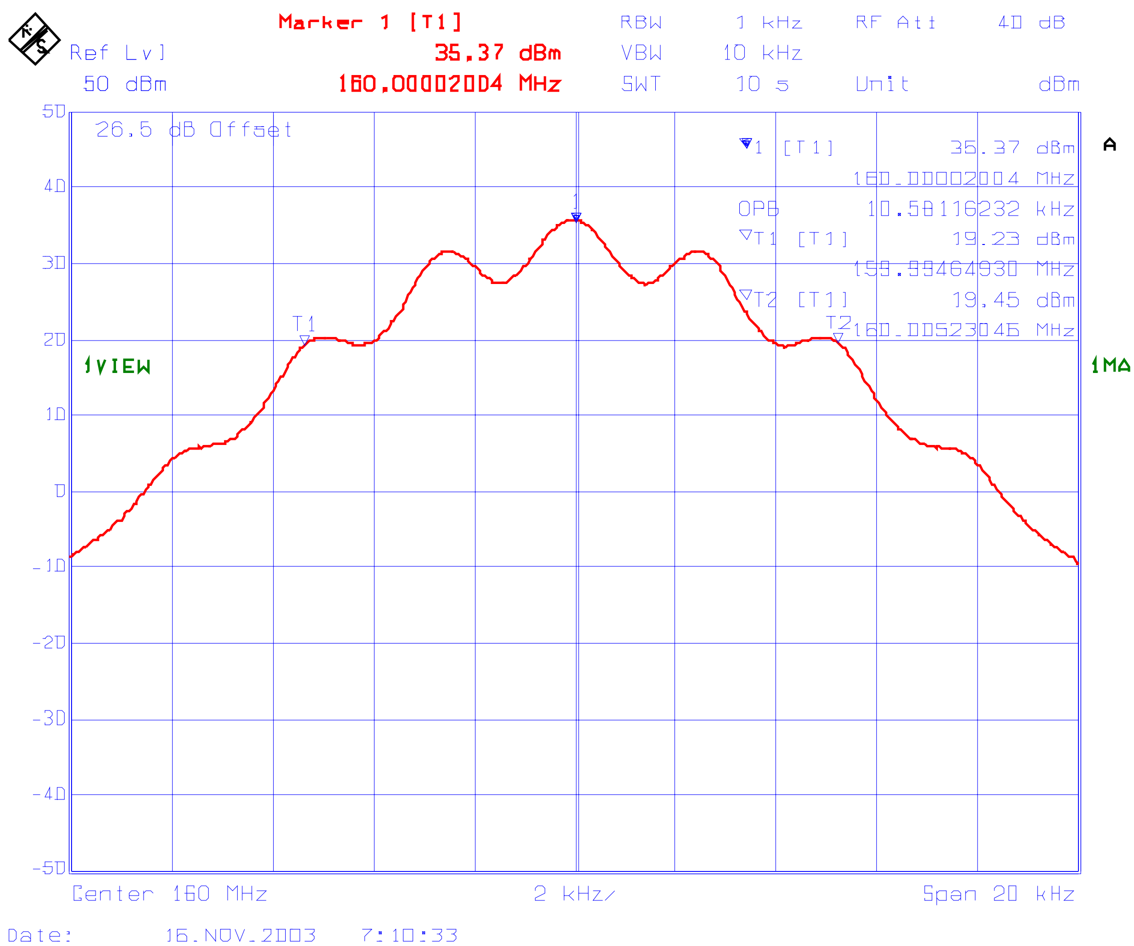
PLOT #: 18 99% OBW, RF Input
Frequency: 160 MHz, 12.5 kHz Channel Spacing
Modulation: FM modulation with 2.5 kHz Sine wave signal



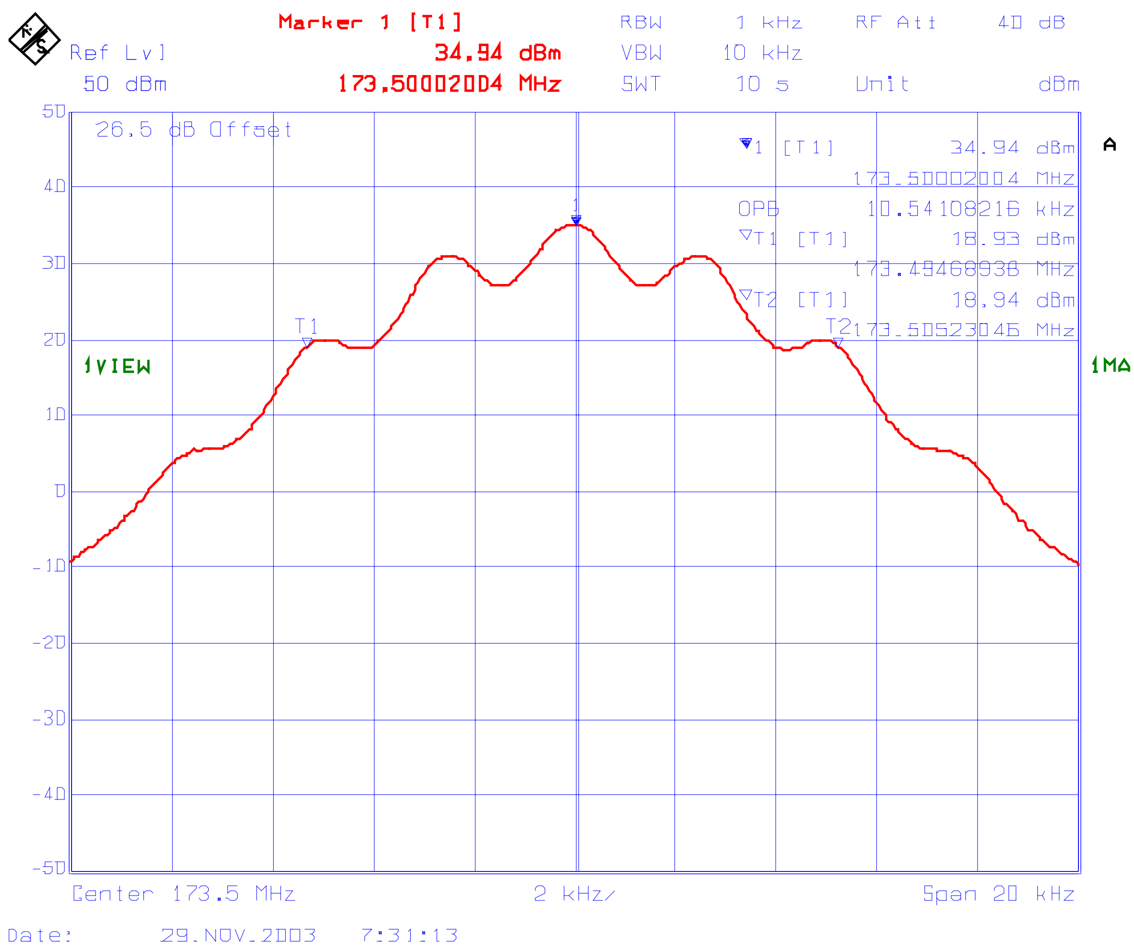
PLOT #: 19 99% OBW, RF Output
Frequency: 136 MHz, 12.5 kHz Channel Spacing
Modulation: FM modulation with 2.5 kHz Sine wave signal



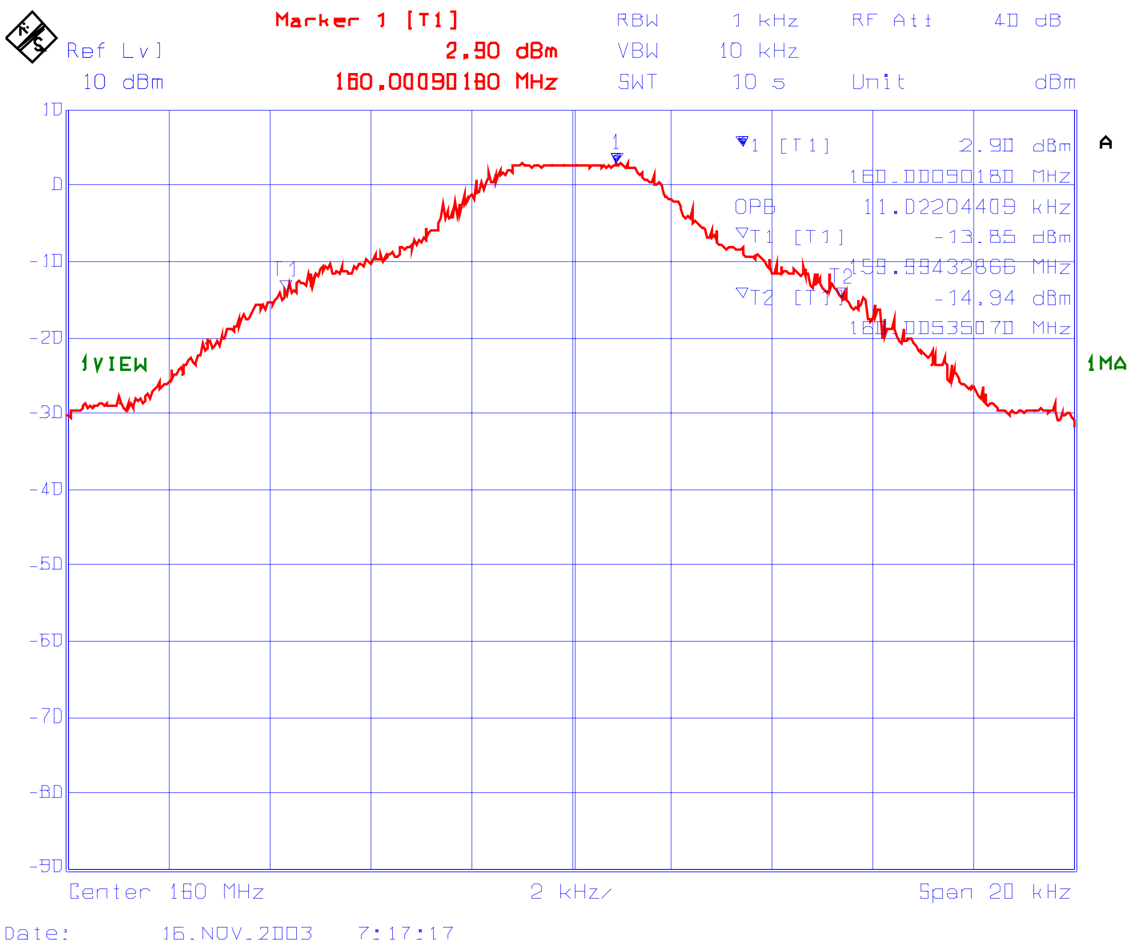
PLOT #: 20 99% OBW, RF Output
Frequency: 160 MHz, 12.5 kHz Channel Spacing
Modulation: FM modulation with 2.5 kHz Sine wave signal



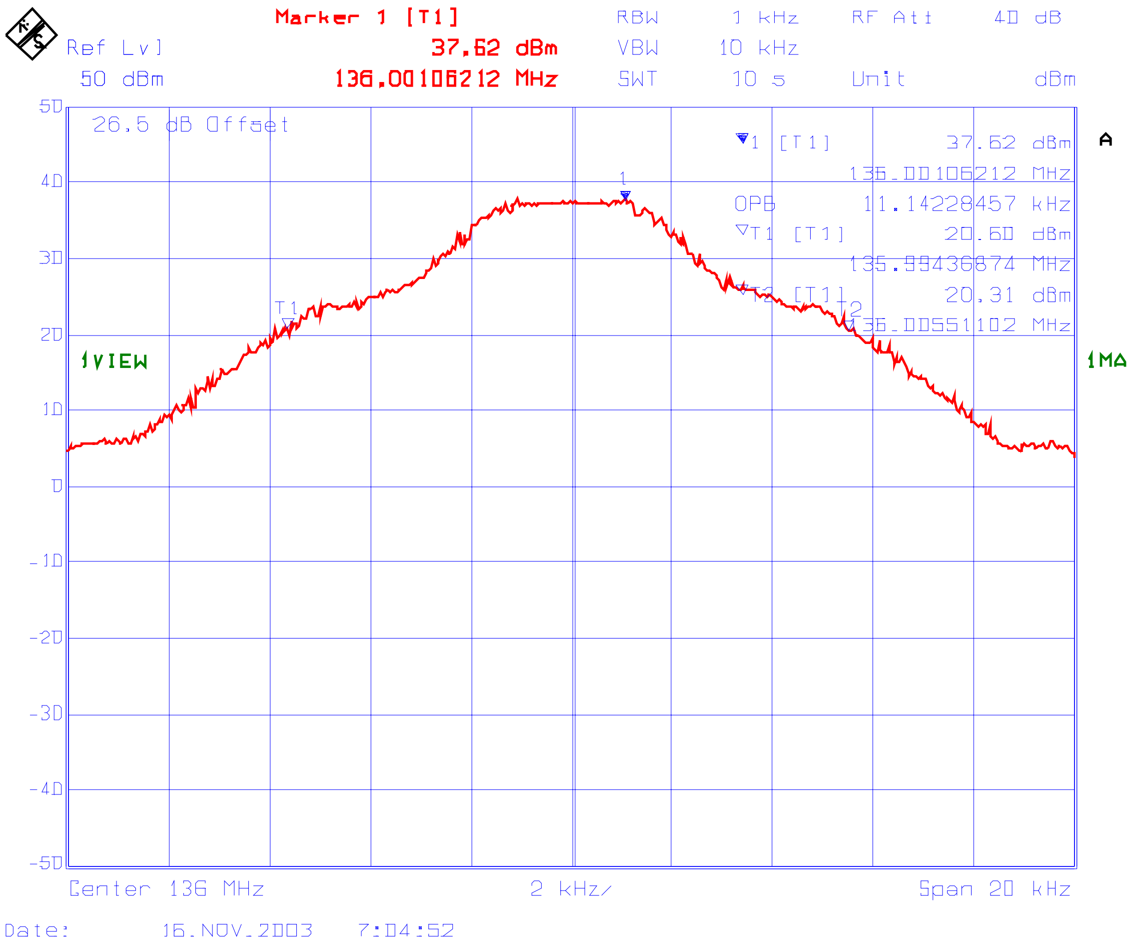
PLOT #: 21 99% OBW, RF Output
Frequency: 173.5 MHz, 12.5 kHz Channel Spacing
Modulation: FM modulation with 2.5 kHz Sine wave signal



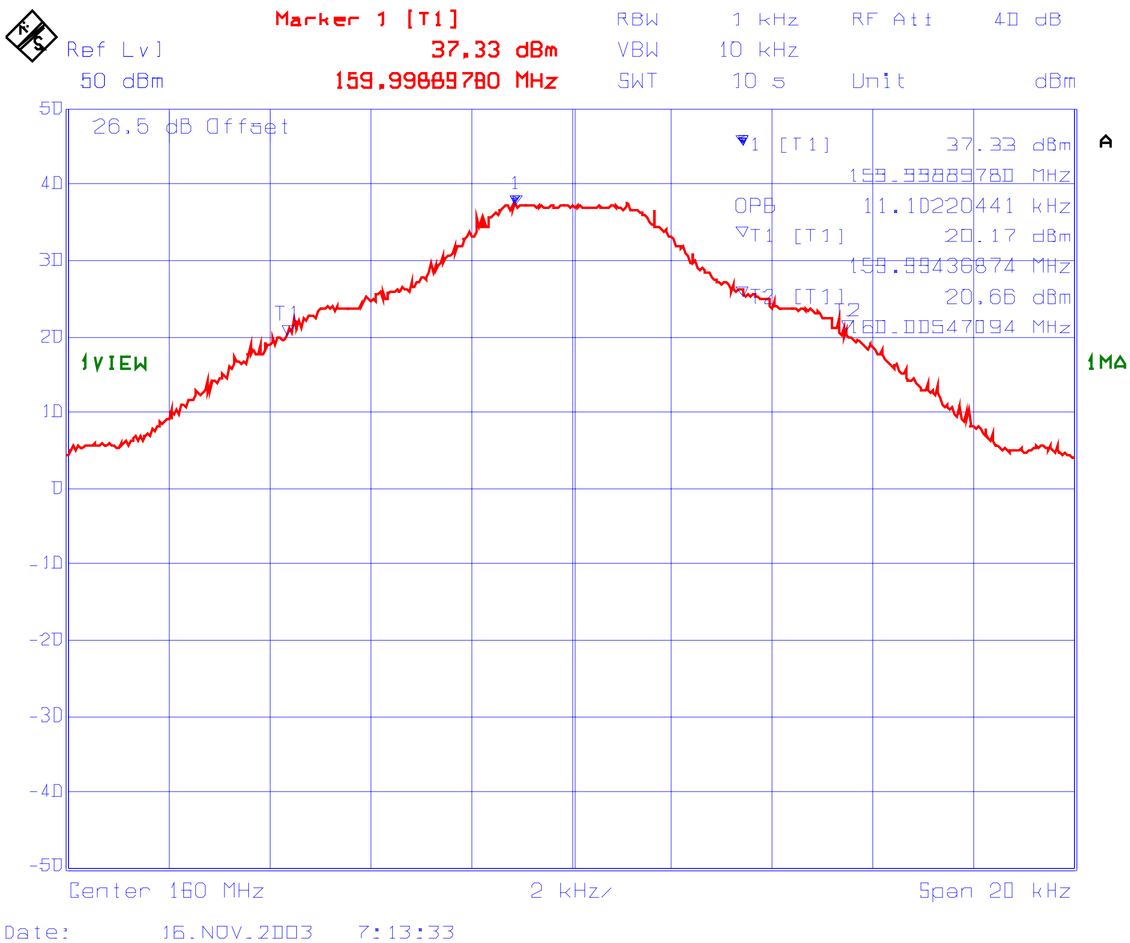
PLOT #: 22 99% OBW, RF Input
Frequency: 160 MHz, 12.5 kHz Channel Spacing
Modulation: FM modulation with an external 9600 b/s random data source



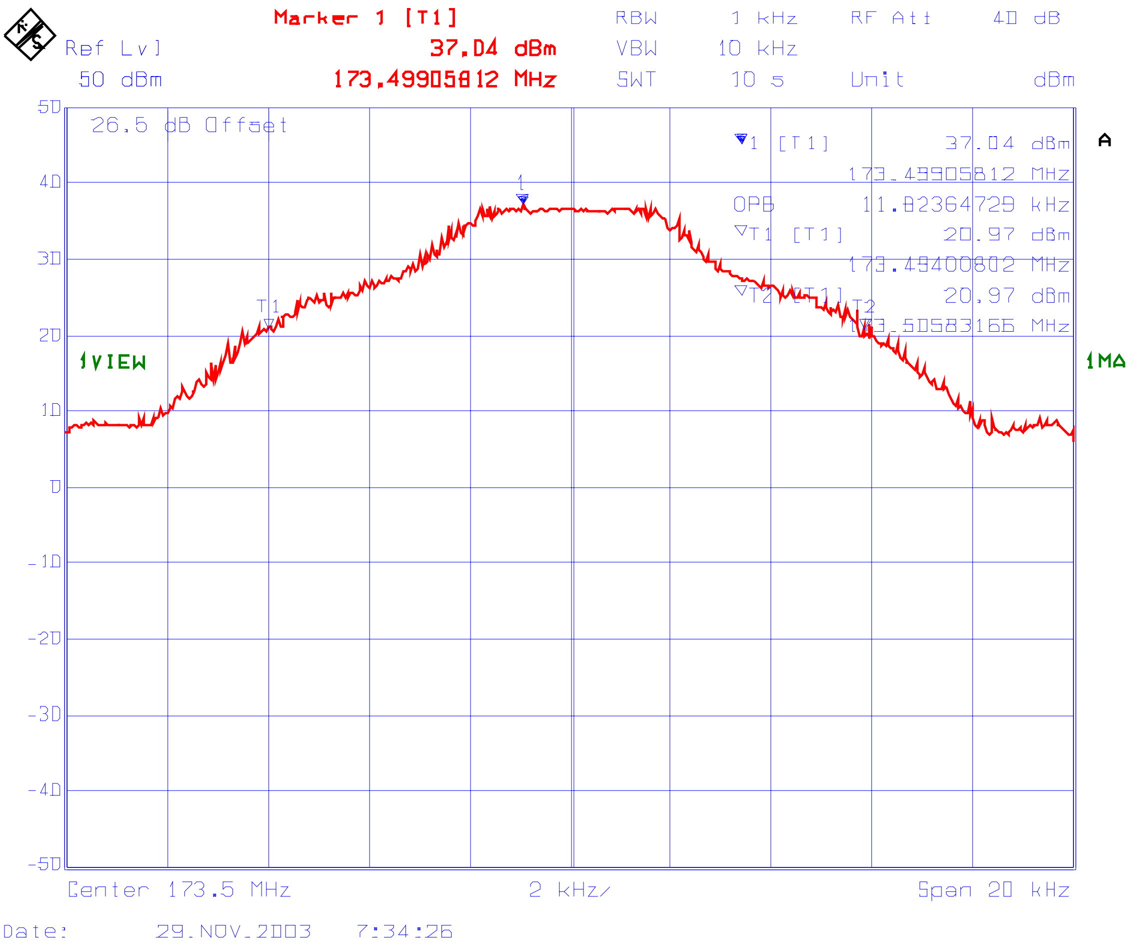
PLOT #: 23 99% OBW, RF Output
Frequency: 136 MHz, 12.5 kHz Channel Spacing
Modulation: FM modulation with an external 9600 b/s random data source



PLOT #: 24 99% OBW, RF Output
Frequency: 160 MHz, 12.5 kHz Channel Spacing
Modulation: FM modulation with an external 9600 b/s random data source



PLOT #: 25 99% OBW, RF Output
Frequency: 173.5 MHz, 12.5 kHz Channel Spacing
Modulation: FM modulation with an external 9600 b/s random data source

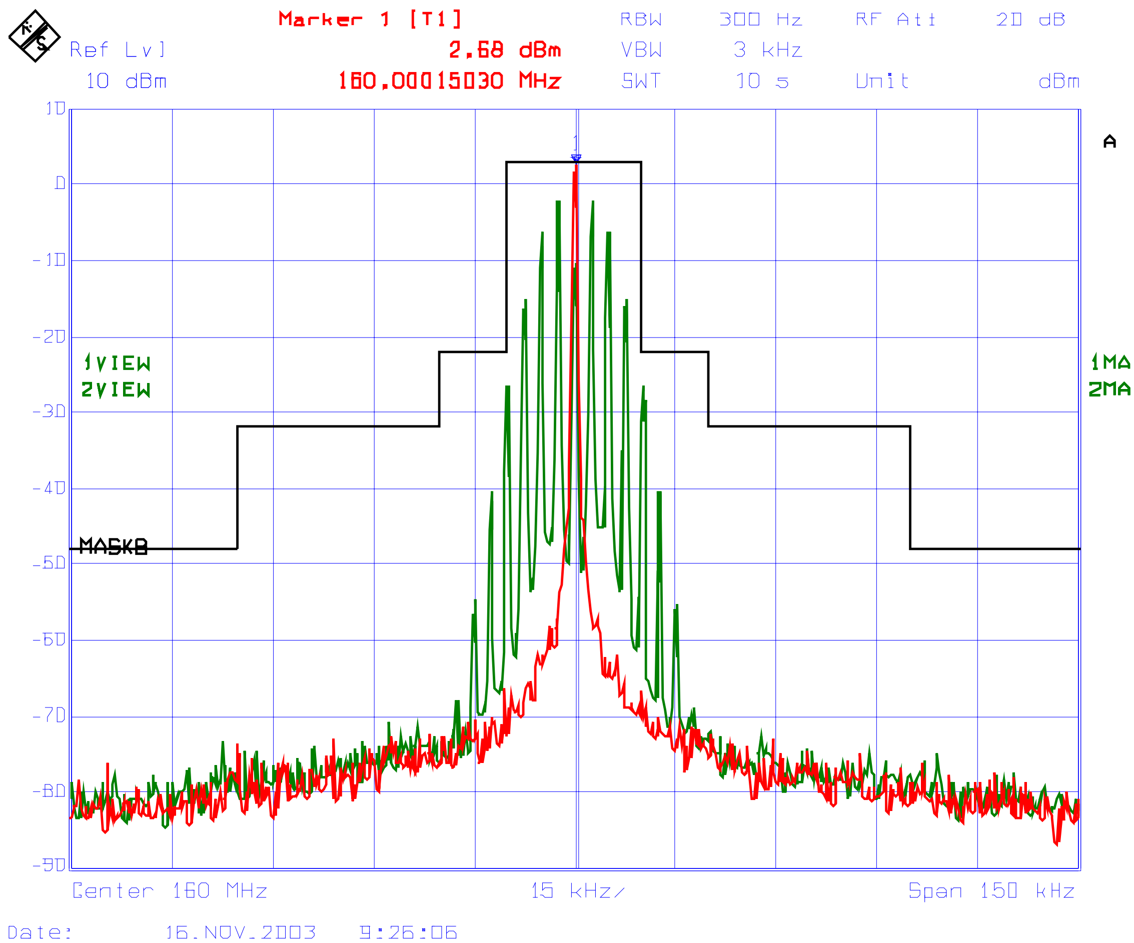


6.8.5.3. Emission Masks

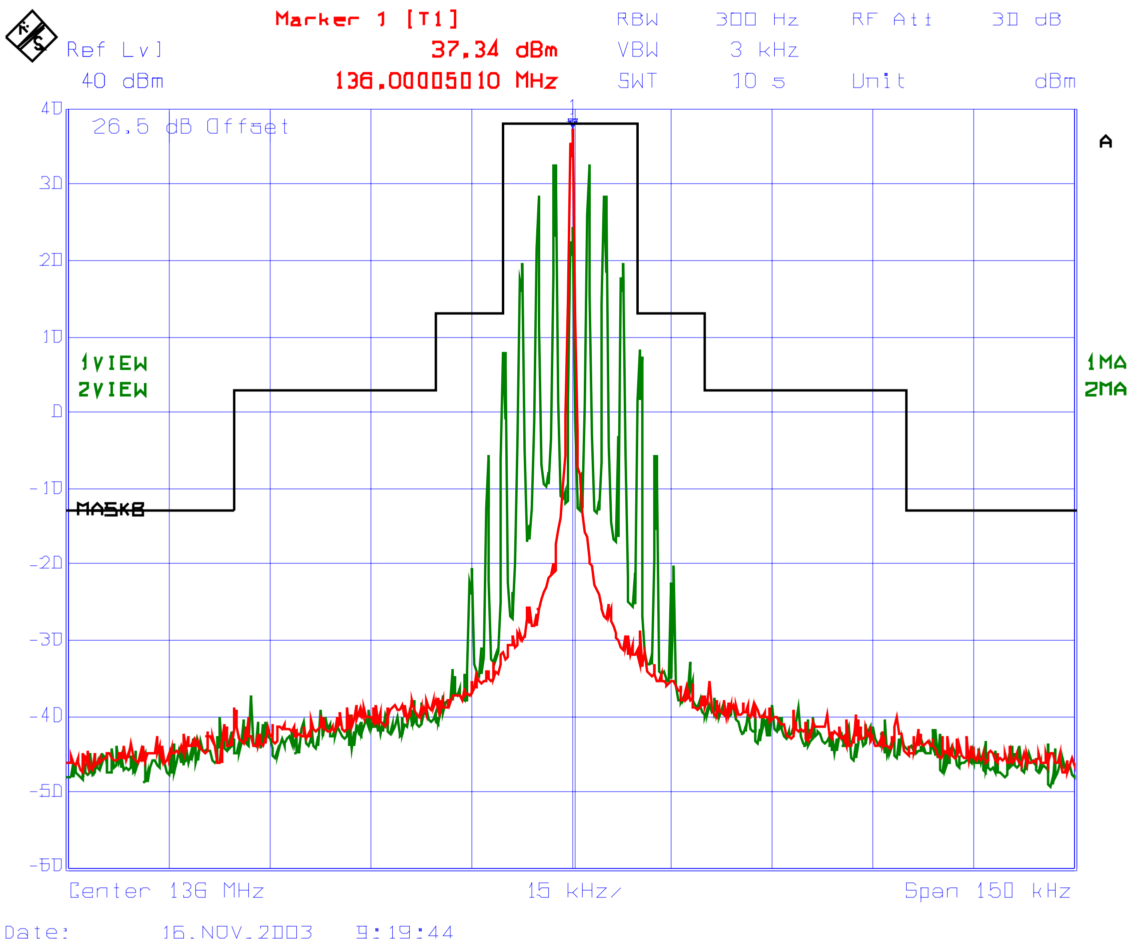
Conform.

- Emission Mask B for FM Voice Modulation with 2.5 kHz Sine Wave Signal, Permitted Band 136-174 MHz, 25 kHz Channel Spacing: refer to Plots # 26 to 29.
- Emission Mask C for FM Data Modulation with an external 9600 b/s random data source, Permitted Band 136-174 MHz, 25 kHz Channel Spacing: refer to Plots # 30-33.
- Emission Mask D for FM Voice Modulation with 2.5 kHz Sine Wave Signal, Permitted Band 136-174 MHz, 12.5 kHz Channel Spacing: refer to Plots # 34 to 37.
- Emission Mask D for FM Data Modulation with an external 9600 b/s random data source, Permitted Band 136-174 MHz, 12.5 kHz Channel Spacing: refer to Plots # 38-41.

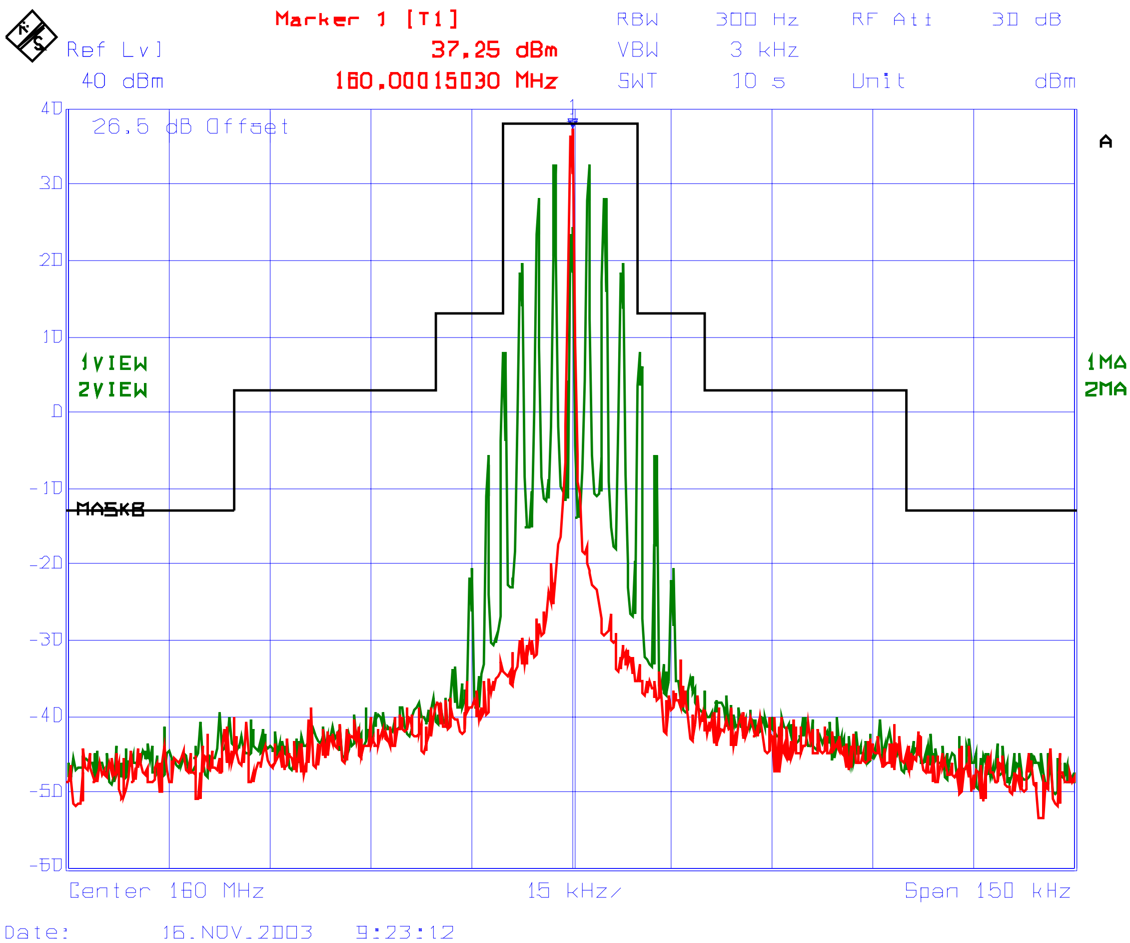
PLOT #: 26 Emission Mask B, RF Input
Frequency: 160 MHz, 25 kHz Channel Spacing
Modulation: FM modulation with 2.5 kHz Sine wave signal



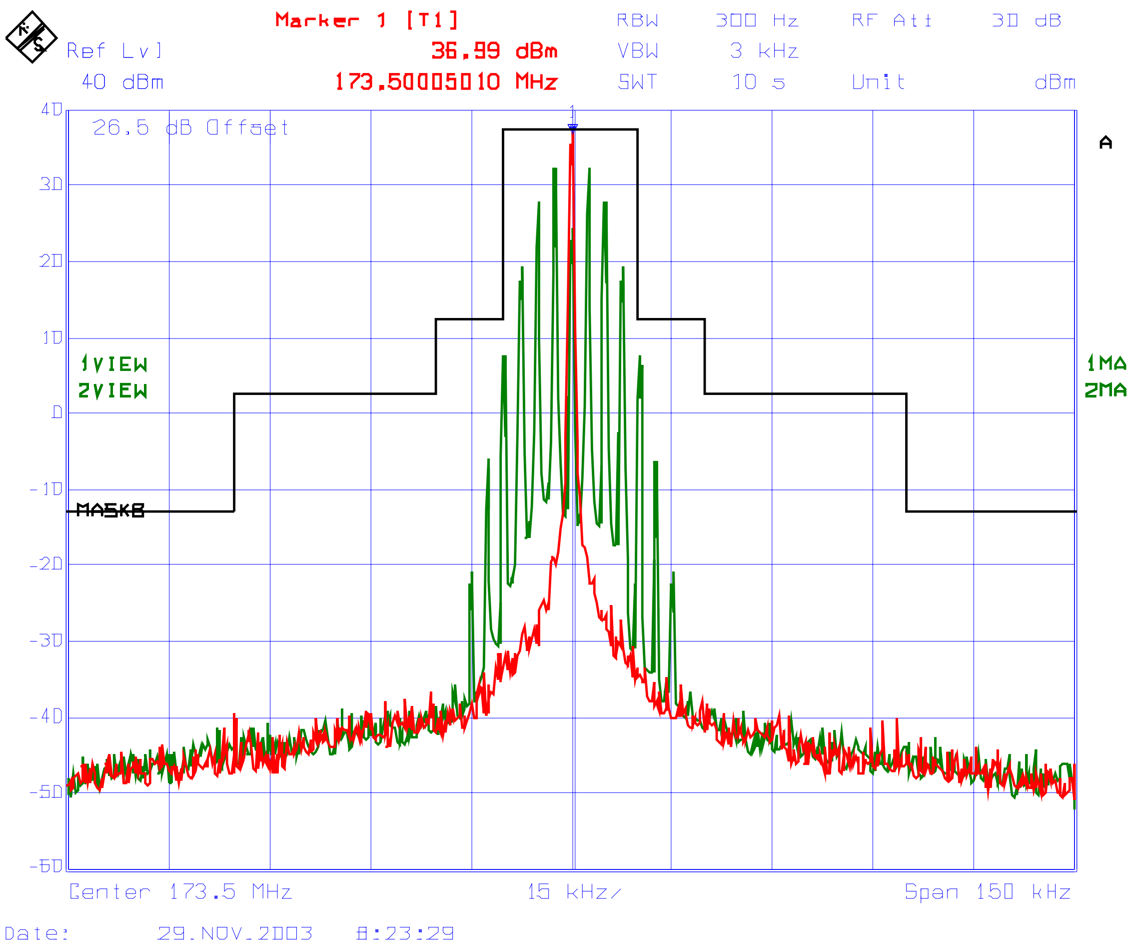
PLOT #: 27 Emission Mask B, RF Output
Frequency: 136 MHz, 25 kHz Channel Spacing
Modulation: FM modulation with 2.5 kHz Sine wave signal



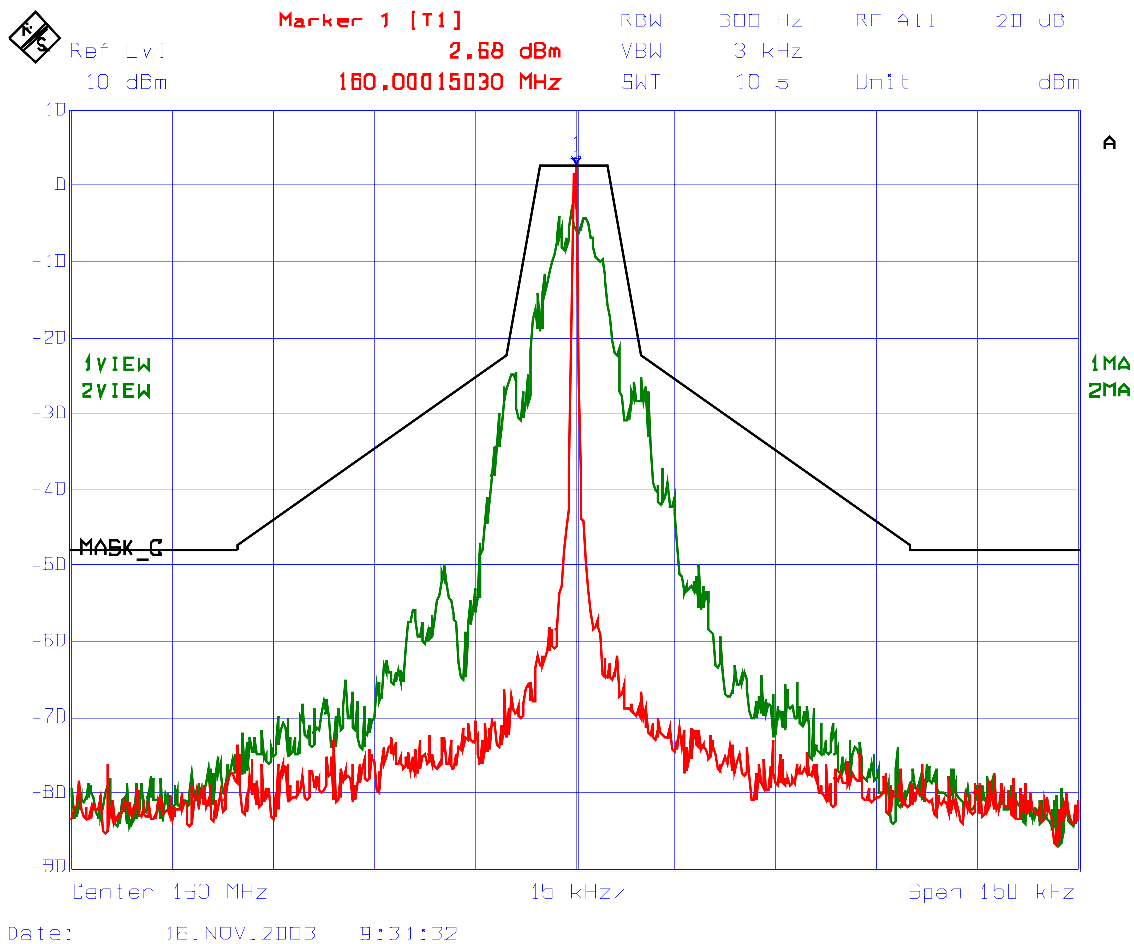
PLOT #: 28 Emission Mask B, RF Output
Frequency: 160 MHz, 25 kHz Channel Spacing
Modulation: FM modulation with 2.5 kHz Sine wave signal



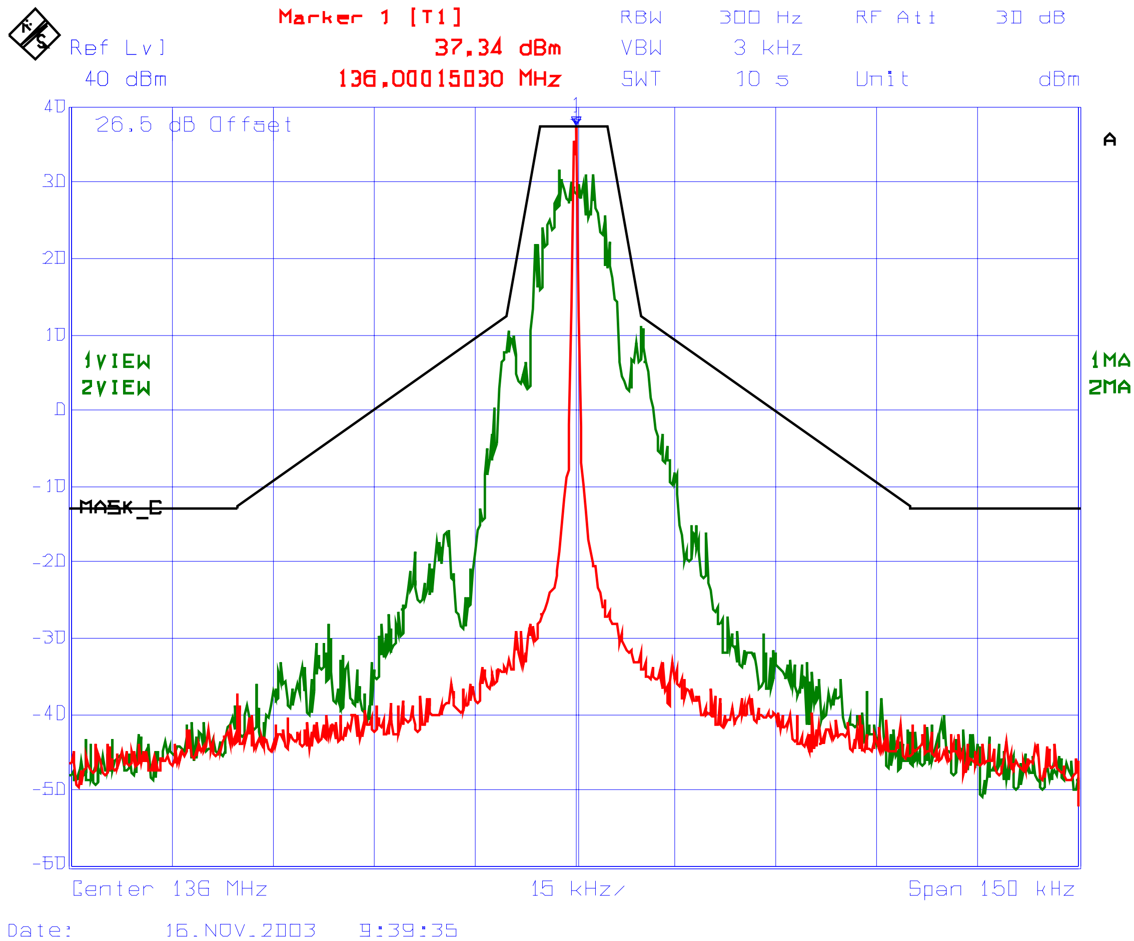
PLOT #: 29 Emission Mask B, RF Output
Frequency: 173.5 MHz, 25 kHz Channel Spacing
Modulation: FM modulation with 2.5 kHz Sine wave signal



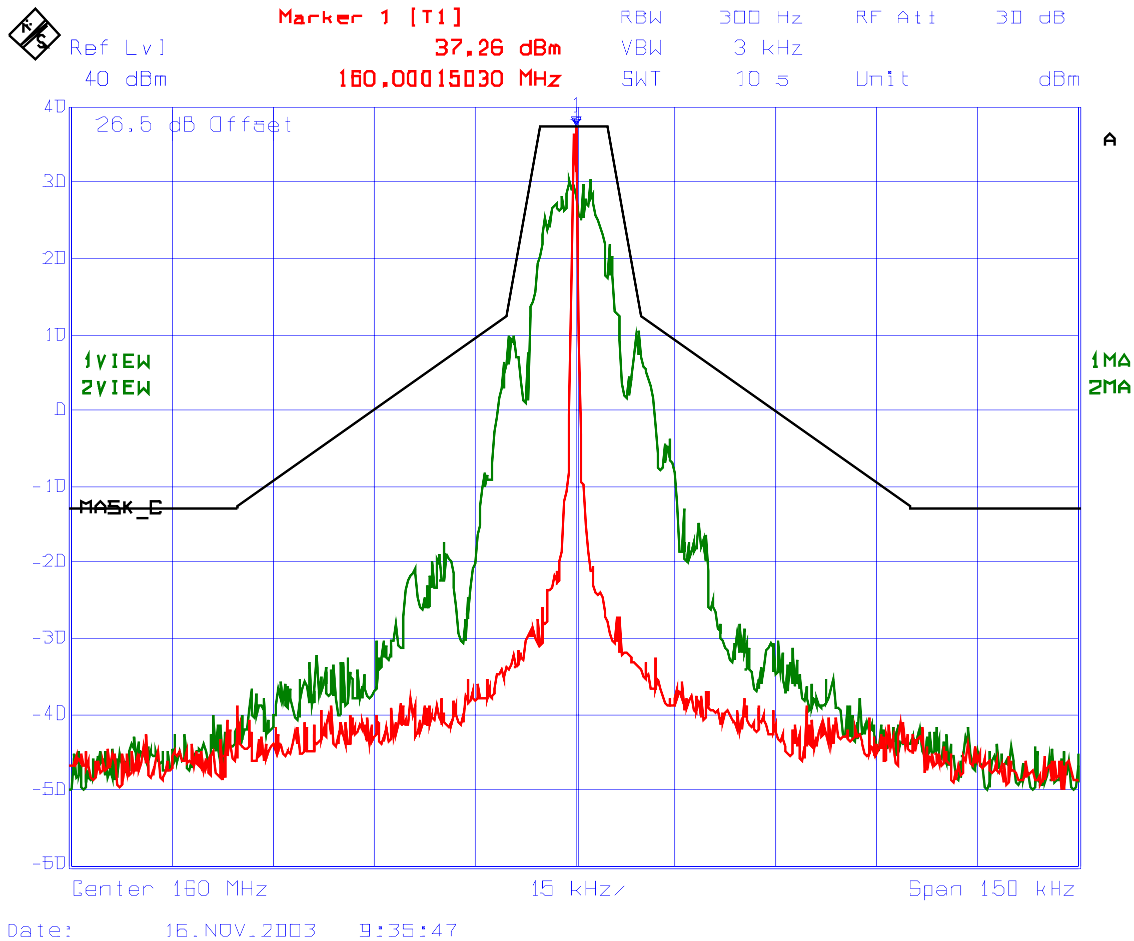
PLOT #: 30 Emission Mask C, RF Input
Frequency: 160 MHz, 25 kHz Channel Spacing
Modulation: FM modulation with an external 9600 b/s random data source



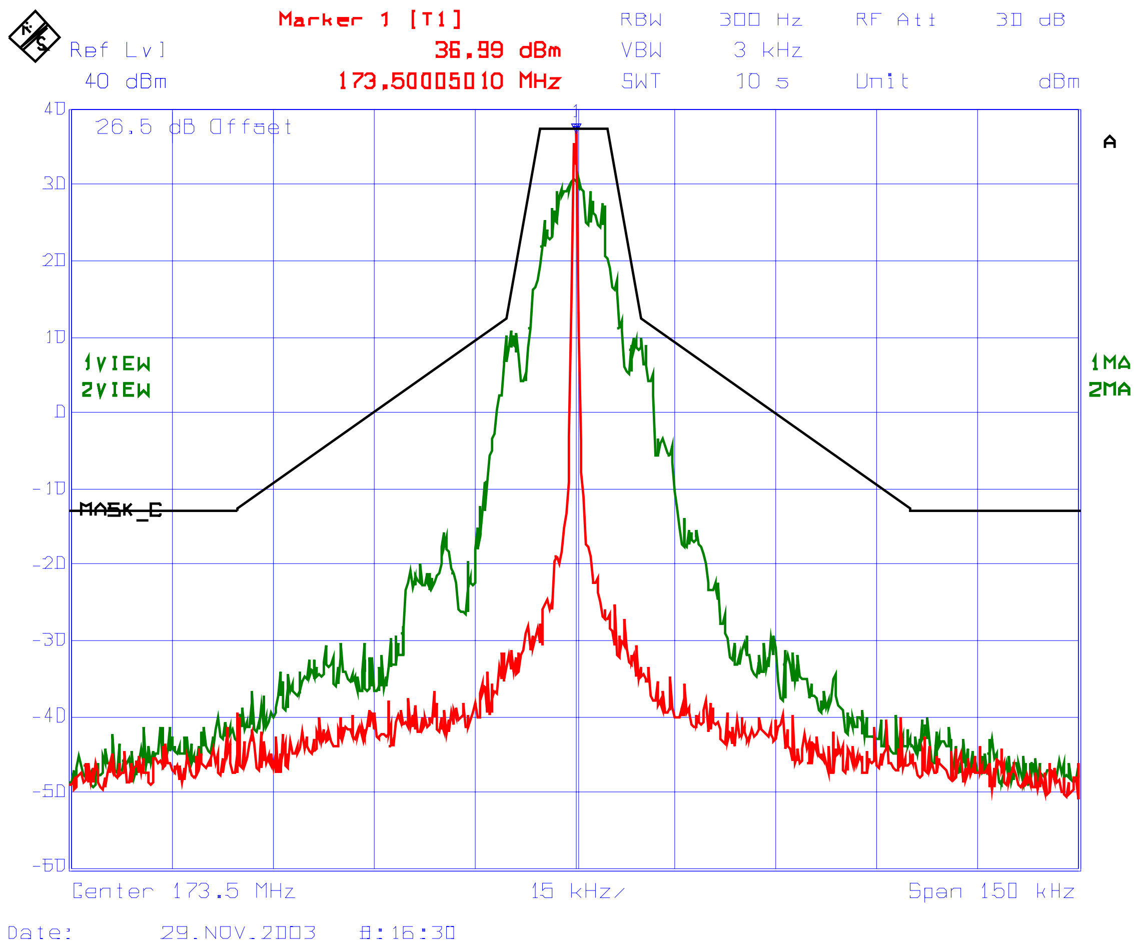
PLOT #: 31 Emission Mask C, RF Output
Frequency: 136 MHz, 25 kHz Channel Spacing
Modulation: FM modulation with an external 9600 b/s random data source



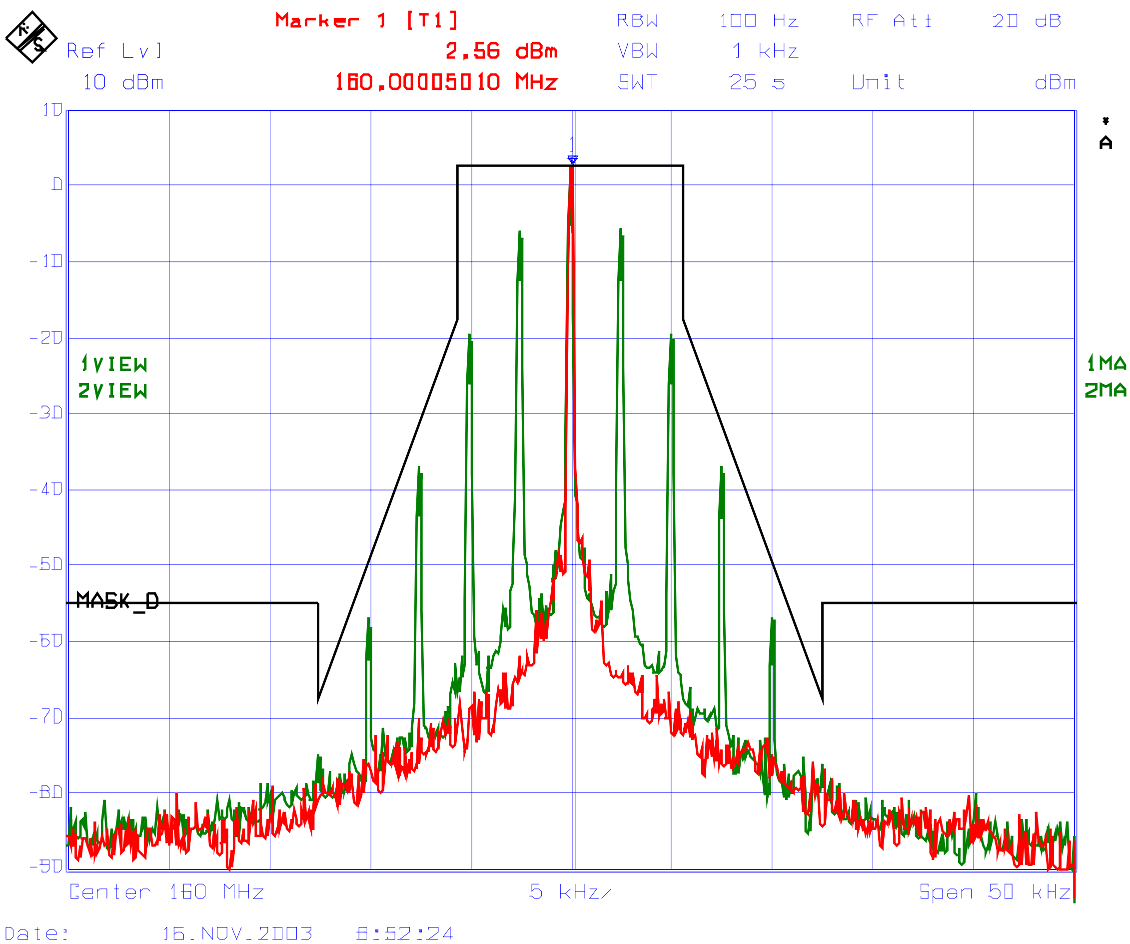
PLOT #: 32 Emission Mask C, RF Output
Frequency: 160 MHz, 25 kHz Channel Spacing
Modulation: FM modulation with an external 9600 b/s random data source



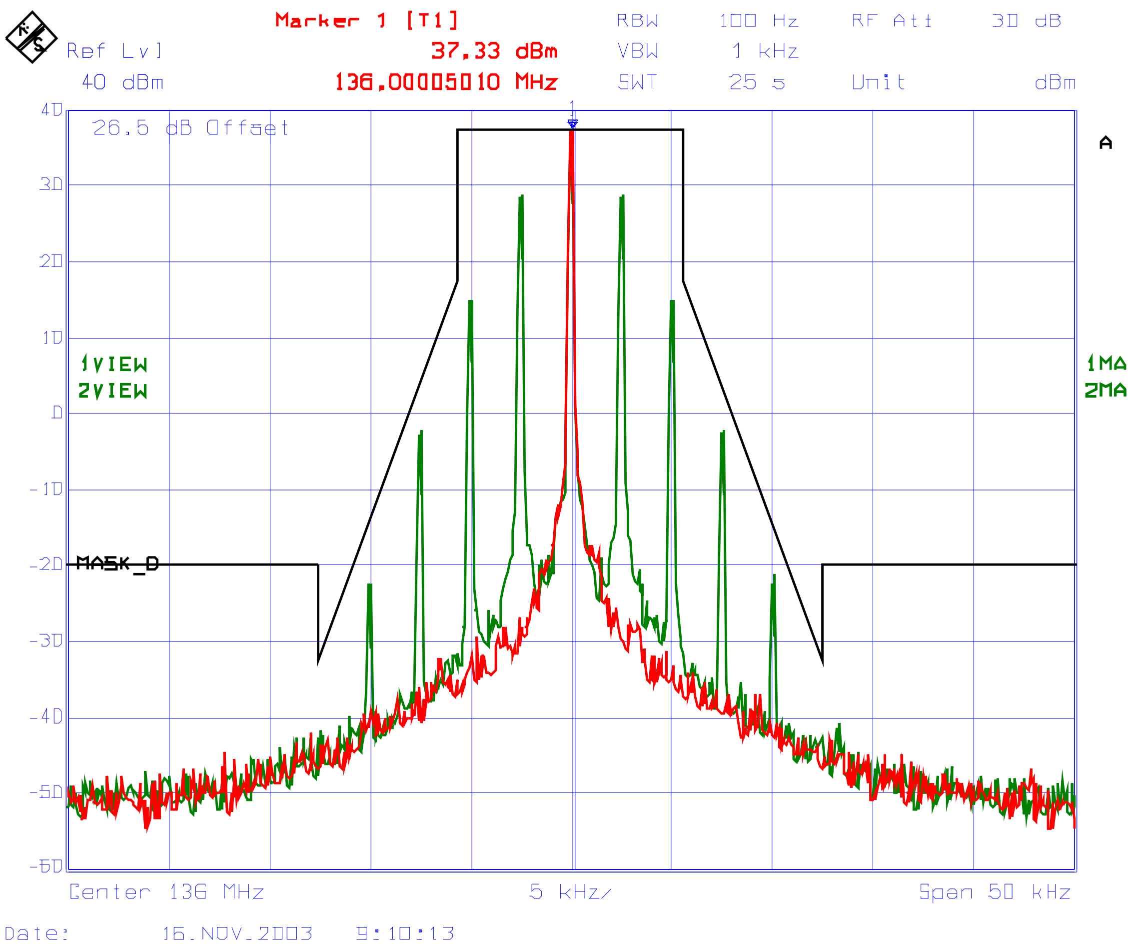
PLOT #: 33 Emission Mask C, RF Output
Frequency: 173.5 MHz, 25 kHz Channel Spacing
Modulation: FM modulation with an external 9600 b/s random data source



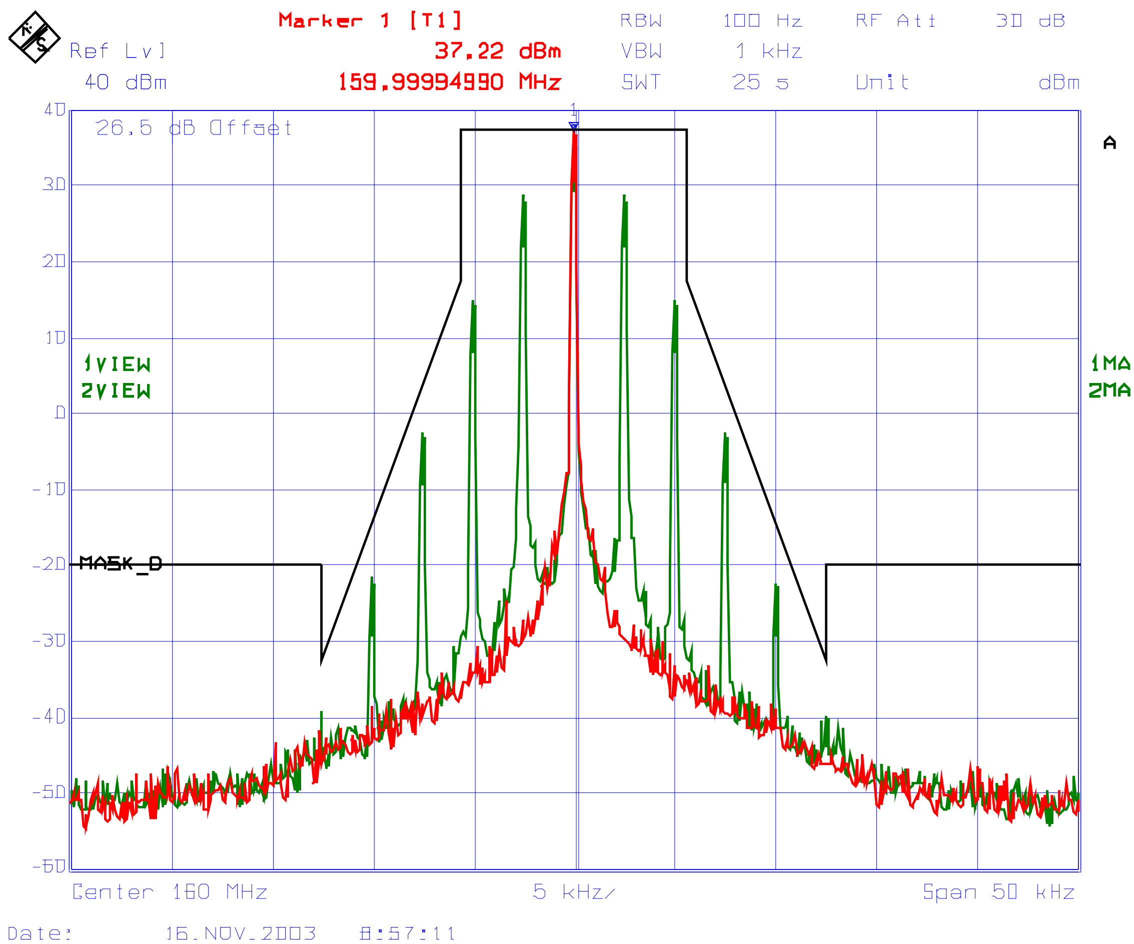
PLOT #: 34 Emission Mask D, RF Input
Frequency: 160 MHz, 12.5 kHz Channel Spacing
Modulation: FM modulation with 2.5 kHz Sine wave signal



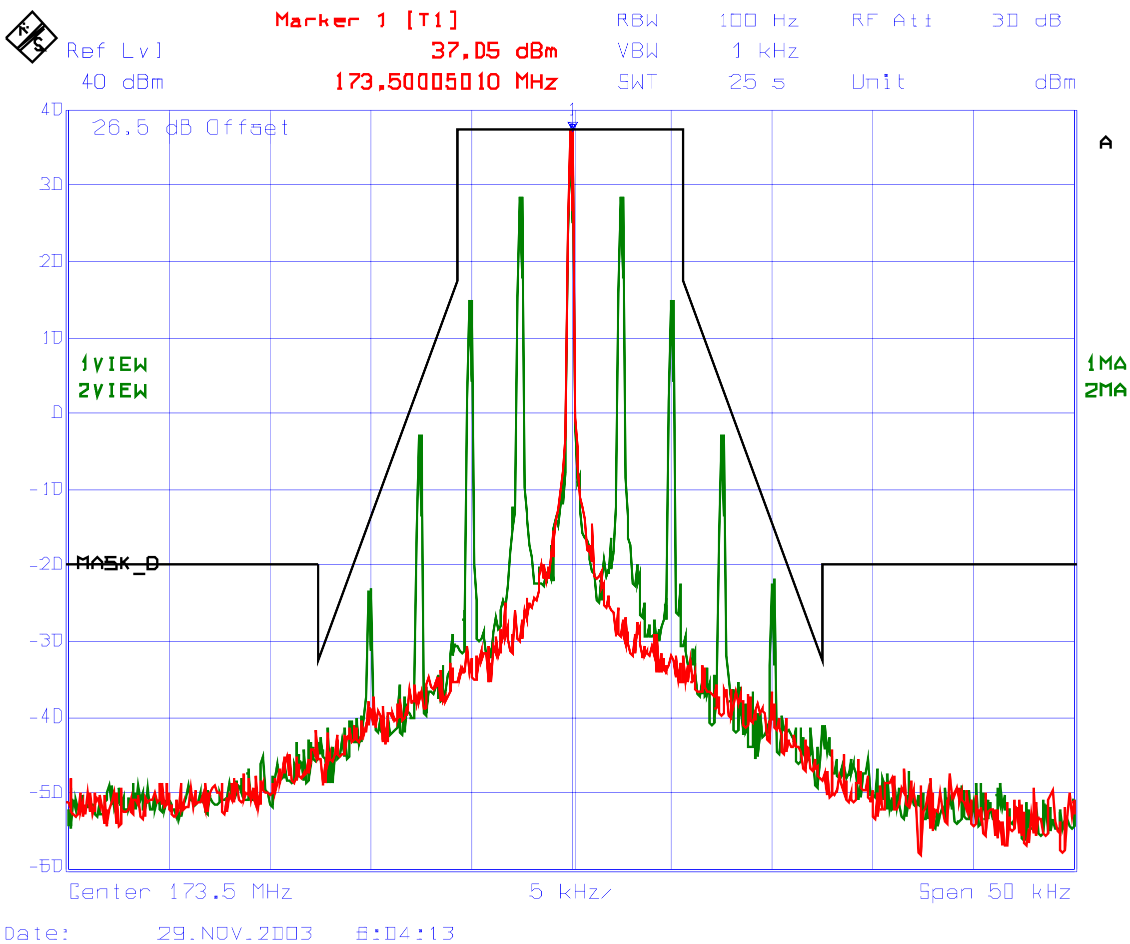
PLOT #: 35 Emission Mask D, RF Output
Frequency: 136 MHz, 12.5 kHz Channel Spacing
Modulation: FM modulation with 2.5 kHz Sine wave signal



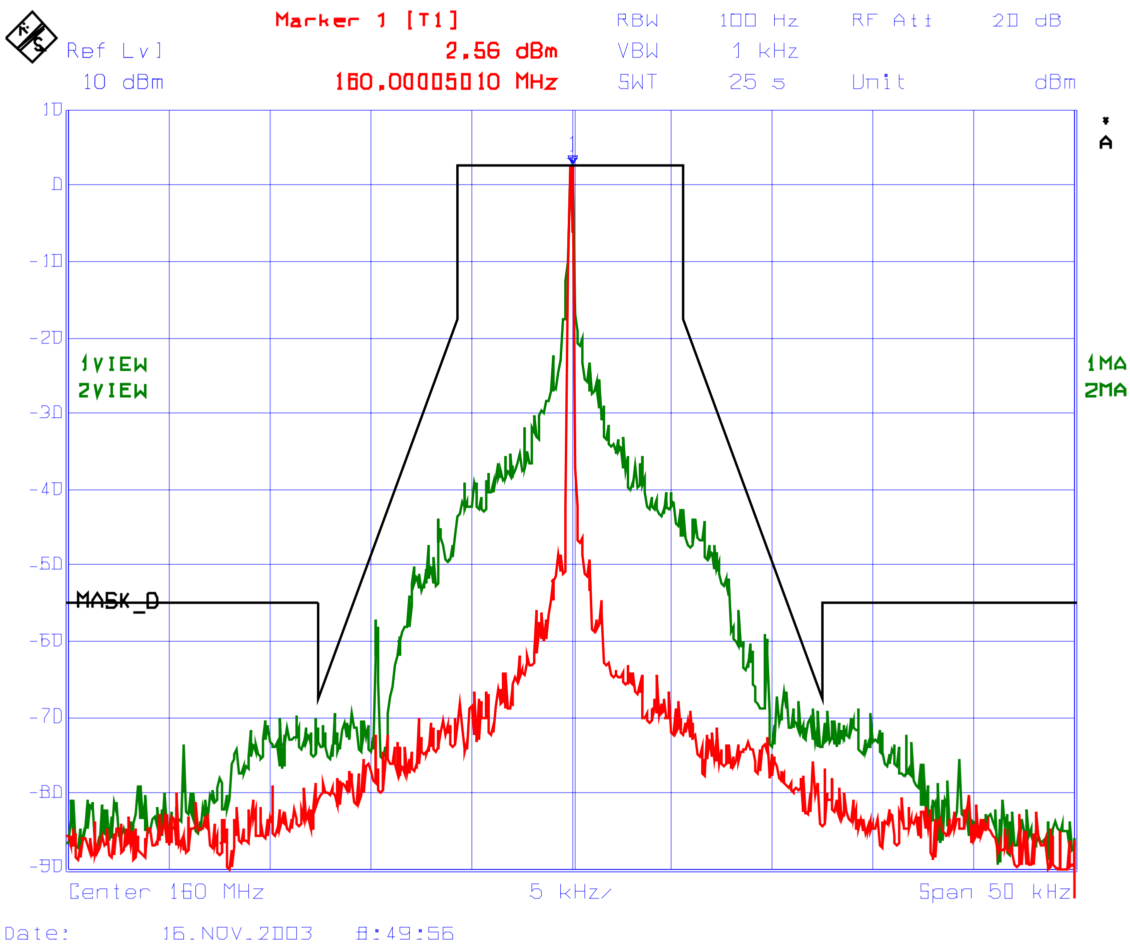
PLOT #: 36 Emission Mask D, RF Output
Frequency: 160 MHz, 12.5 kHz Channel Spacing
Modulation: FM modulation with 2.5 kHz Sine wave signal



PLOT #: 37 Emission Mask D, RF Output
Frequency: 173.5 MHz, 12.5 kHz Channel Spacing
Modulation: FM modulation with 2.5 kHz Sine wave signal

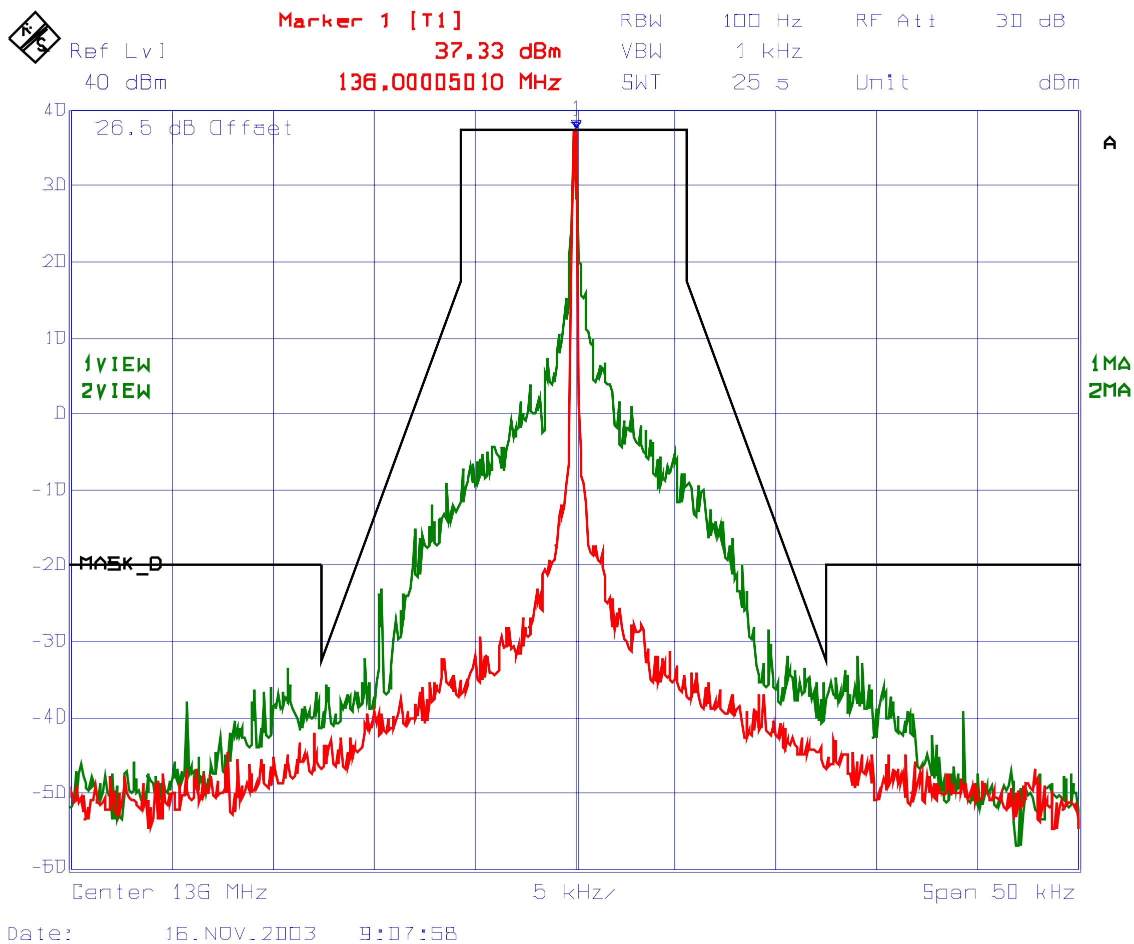


PLOT #: 38 Emission Mask D, RF Input
Frequency: 160 MHz, 12.5 kHz Channel Spacing
Modulation: FM modulation with an external 9600 b/s random data source

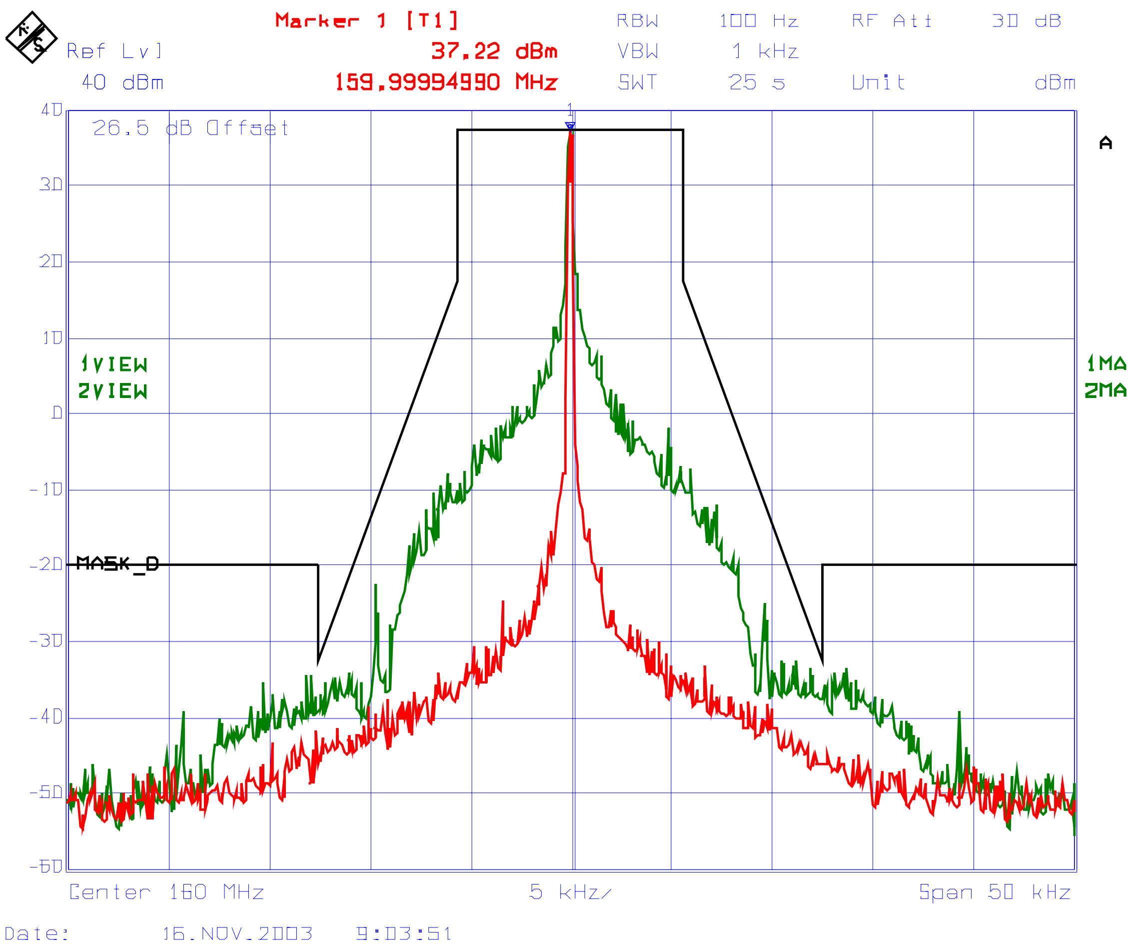


- *All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)*

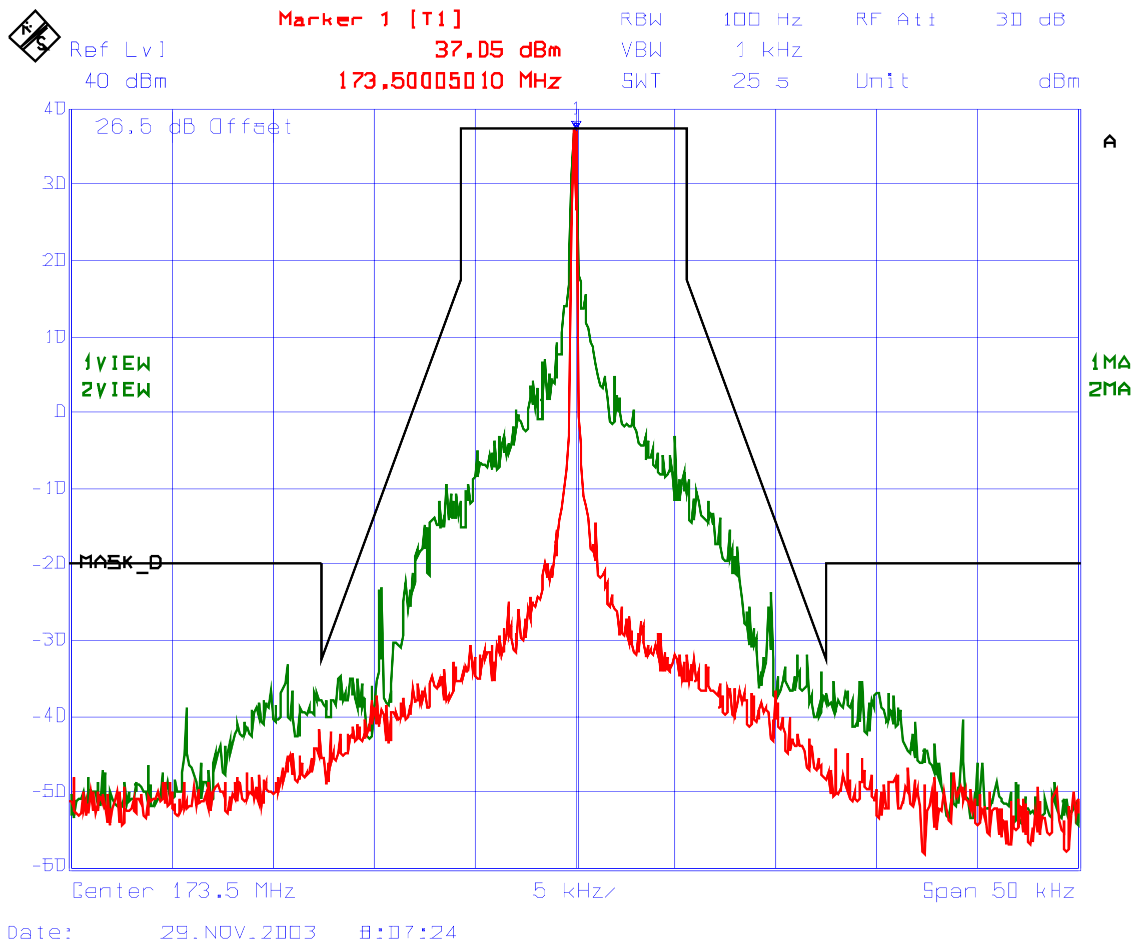
PLOT #: 39 Emission Mask D, RF Output
Frequency: 136 MHz, 12.5 kHz Channel Spacing
Modulation: FM modulation with an external 9600 b/s random data source



PLOT #: 40 Emission Mask D, RF Output
Frequency: 160 MHz, 12.5 kHz Channel Spacing
Modulation: FM modulation with an external 9600 b/s random data source



PLOT #: 41 Emission Mask D, RF Output
Frequency: 173.5 MHz, 12.5 kHz Channel Spacing
Modulation: FM modulation with an external 9600 b/s random data source



6.9. TRANSMITTER ANTENNA POWER SPURIOUS/HARMONIC CONDUCTED EMISSIONS @ FCC 90.210

6.9.1. Limits @ 90.210

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

FCC Rules	Frequency Range	Attenuation Limit (dBc)
90.210(b)&(c) – Voice & data	10 MHz to Lowest frequency of the radio to 10th harmonic of the highest frequency of the radio	43+10*log(P)
90.210(d) – Voice & data	10 MHz to Lowest frequency of the radio to 10th harmonic of the highest frequency of the radio	50+10*log(P) or -20 dBm or 70 dBc whichever is less
90.210(e) – Voice & data	10 MHz to Lowest frequency of the radio to 10th harmonic of the highest frequency of the radio	55+10*log(P) or -25 dBm or 65 dBc whichever is less

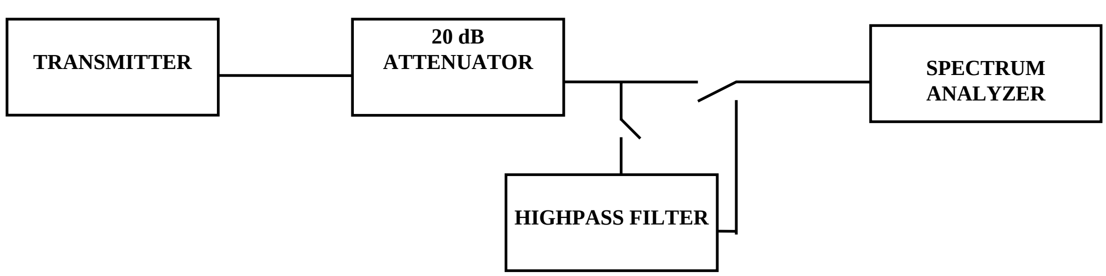
6.9.2. Method of Measurements

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

6.9.3. Test Equipment List

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

6.9.4. Test Arrangement



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

6.9.5. Test Data

6.9.5.1. Near Lowest Frequency (136 MHz)

Fundamental Frequency: 136 MHz (1 RF Signal input/output)
RF Output Power: 37.8 dBm (conducted)
Modulation: Unmodulated

FREQUENCY	TRANSMITTER CONDUCTED ANTENNA EMISSIONS		LIMIT	MARGIN	PASS/
(MHz)	(dBm)	(dBc)	(dBc)	(dB)	FAIL
The emissions were scanned from 10 MHz to 2 GHz and no significant rf spurious/harmonic emissions were found to be less than 20 dB below the Limits. Refer to Plots # 42-43 for Spurious emissions outside the Permitted Band 136-174 MHz					

Fundamental Frequency: 136, 136.0125 MHz (2 channel inputs/outputs)
RF Output Power: 36.0 dBm (conducted)
Modulation: Unmodulatedl

FREQUENCY	TRANSMITTER CONDUCTED ANTENNA EMISSIONS		LIMIT	MARGIN	PASS/
(MHz)	(dBm)	(dBc)	(dBc)	(dB)	FAIL
The emissions were scanned from 10 MHz to 2 GHz and no significant rf spurious/harmonic emissions were found to be less than 20 dB below the Limits. Refer to Plots # 44-45 for Spurious emissions outside the Permitted Band 136-174 MHz					

Fundamental Frequency: 136, 136.0125, 136.0250 (3 channel inputs/outputs)
RF Output Power: 36.3 dBm (conducted)
Modulation: Unmodulated

FREQUENCY	TRANSMITTER CONDUCTED ANTENNA EMISSIONS		LIMIT	MARGIN	PASS/
(MHz)	(dBm)	(dBc)	(dBc)	(dB)	FAIL
The emissions were scanned from 10 MHz to 2 GHz and no significant rf spurious/harmonic emissions were found to be less than 20 dB below the Limits. Refer to Plots # 46-47 for Spurious emissions outside the Permitted Band 136-174 MHz					

6.9.5.2. Near Middle Frequency (160 MHz)

Fundamental Frequency: 160 MHz (1 RF Signal input/output)
RF Output Power: 38.0 dBm (conducted)
Modulation: Unmodulated

FREQUENCY (MHz)	TRANSMITTER CONDUCTED ANTENNA EMISSIONS		LIMIT (dBc)	MARGIN (dB)	PASS/ FAIL
	(dBm)	(dBc)			
The emissions were scanned from 10 MHz to 2 GHz and no significant rf spurious/harmonic emissions were found to be less than 20 dB below the Limits.					

Refer to Plots # 48-49 for Spurious emissions outside the Permitted Band 136-174 MHz

Fundamental Frequency: 160 & 160.0125 MHz (2 channel inputs/outputs)
RF Output Power: 37.1 dBm (conducted)
Modulation: Unmodulatedl

FREQUENCY (MHz)	TRANSMITTER CONDUCTED ANTENNA EMISSIONS		LIMIT (dBc)	MARGIN (dB)	PASS/ FAIL
	(dBm)	(dBc)			
The emissions were scanned from 10 MHz to 2 GHz and no significant rf spurious/harmonic emissions were found to be less than 20 dB below the Limits.					

Refer to Plots # 50-51 for Spurious emissions outside the Permitted Band 136-174 MHz

Fundamental Frequency: 160, 160.0125, 159.9875 (3 channel inputs/outputs)
RF Output Power: 35.9 dBm (conducted)
Modulation: Unmodulated

FREQUENCY (MHz)	TRANSMITTER CONDUCTED ANTENNA EMISSIONS		LIMIT (dBc)	MARGIN (dB)	PASS/ FAIL
	(dBm)	(dBc)			
The emissions were scanned from 10 MHz to 2 GHz and no significant rf spurious/harmonic emissions were found to be less than 20 dB below the Limits.					

Refer to Plots # 52-53 for Spurious emissions outside the Permitted Band 136-174 MHz

6.9.5.3. *Near Highest Frequency (highest-173.5 MHz)*

Fundamental Frequency: 173.5 MHz (1 RF Signal input/output)
RF Output Power: 37.7 dBm (conducted)
Modulation: Unmodulated

FREQUENCY (MHz)	TRANSMITTER CONDUCTED ANTENNA EMISSIONS (dBm)	(dBc)	LIMIT (dBc)	MARGIN (dB)	PASS/ FAIL
344.3	-37.8	-75.5	-57.7	-17.8	PASS

The emissions were scanned from 10 MHz to 2 GHz and all emissions within 20 dB below the limits were recorded.
Refer to Plots # 54-55 for Spurious emissions outside the Permitted Band 136-174 MHz

Fundamental Frequency: 173.5 & 173.4875 MHz (2 channel inputs/outputs)
RF Output Power: 36.6 dBm (conducted)
Modulation: Unmodulatedl

FREQUENCY (MHz)	TRANSMITTER CONDUCTED ANTENNA EMISSIONS (dBm)	(dBc)	LIMIT (dBc)	MARGIN (dB)	PASS/ FAIL
344.3	-39.2	-75.8	-56.6	-19.2	PASS

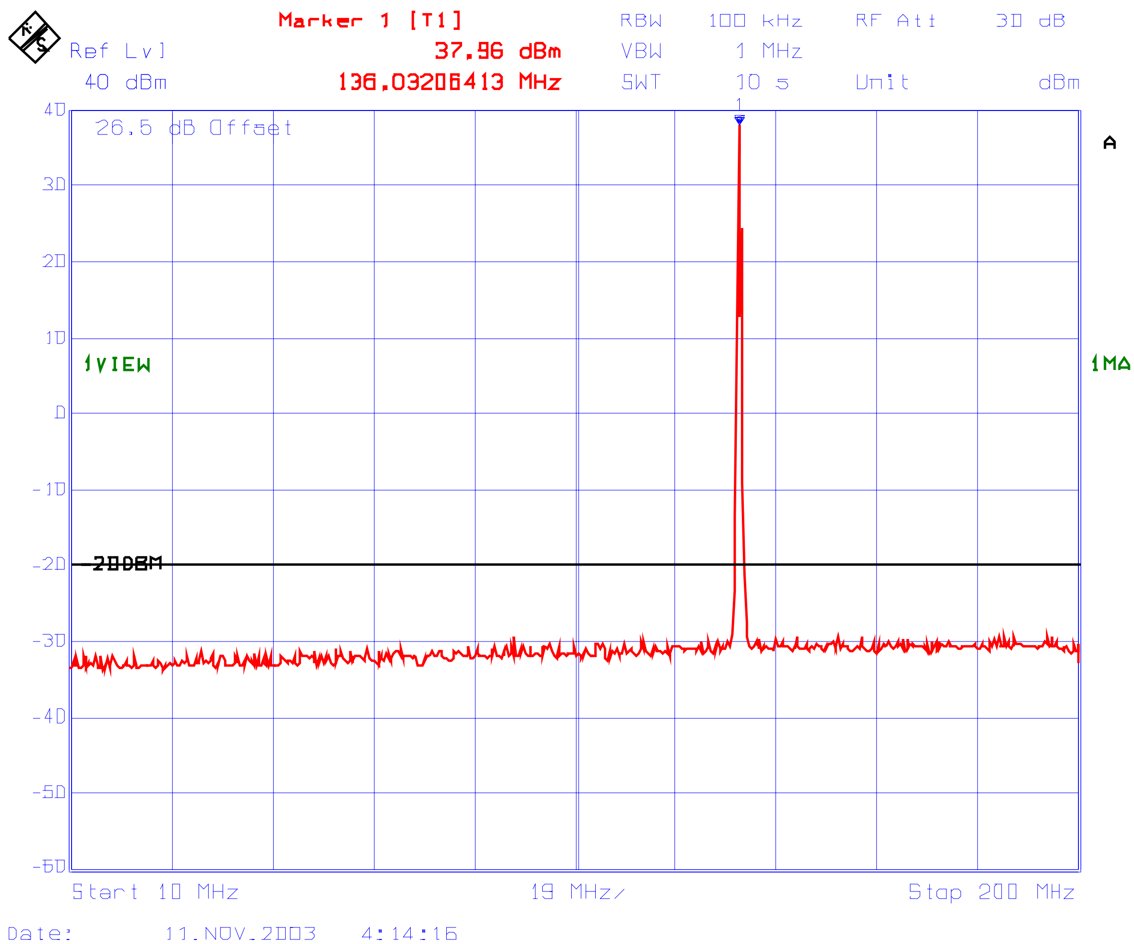
The emissions were scanned from 10 MHz to 2 GHz and all emissions within 20 dB below the limits were recorded.
Refer to Plots # 56-57 for Spurious emissions outside the Permitted Band 136-174 MHz

Fundamental Frequency: 173.5, 173.4875 and 173.4750 (3 channel inputs/outputs)
RF Output Power: 37.0 dBm (conducted)
Modulation: Unmodulated

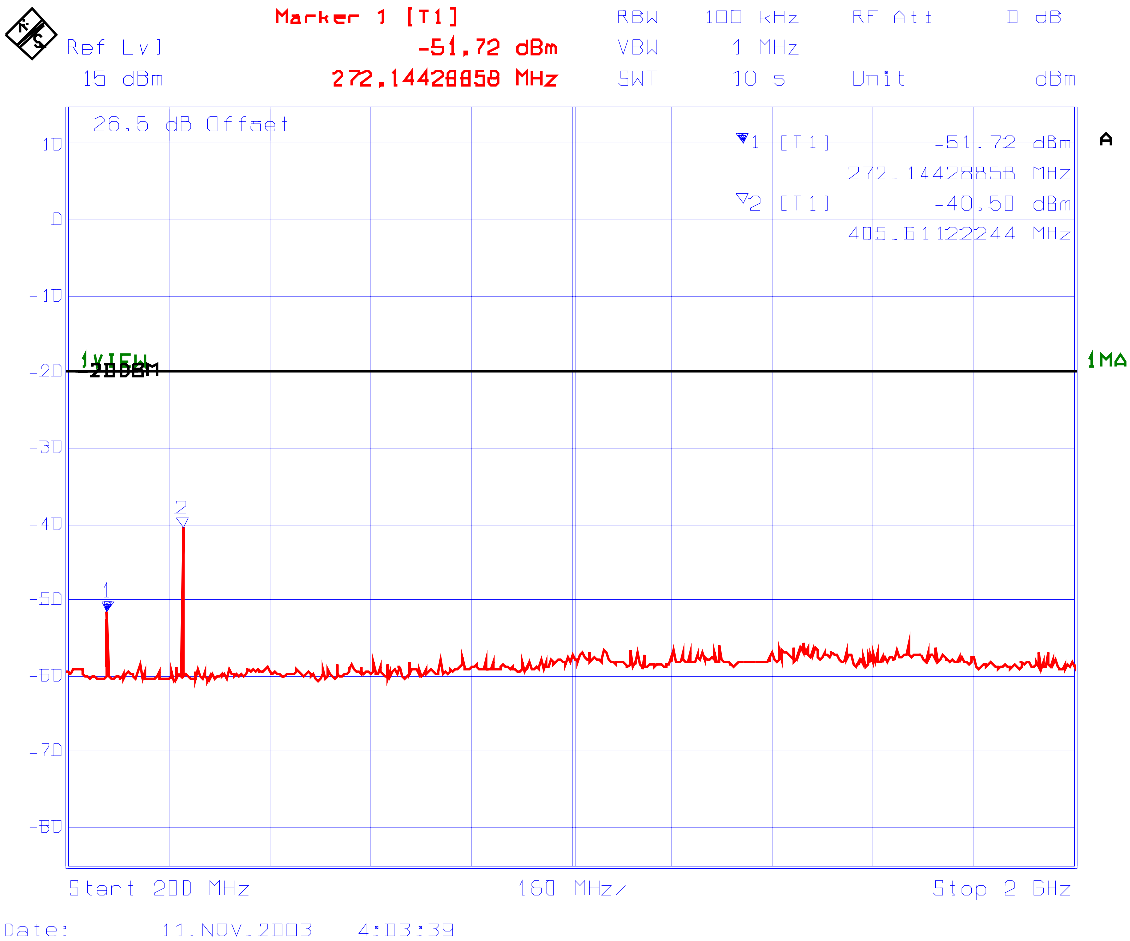
FREQUENCY (MHz)	TRANSMITTER CONDUCTED ANTENNA EMISSIONS (dBm)	(dBc)	LIMIT (dBc)	MARGIN (dB)	PASS/ FAIL
344.3	-38.8	-75.8	-57.0	-18.8	PASS

The emissions were scanned from 10 MHz to 2GHz and all emissions within 20 dB below the limits were recorded.
Refer to Plots # 58-59 for Spurious emissions outside the Permitted Band 136-174 MHz

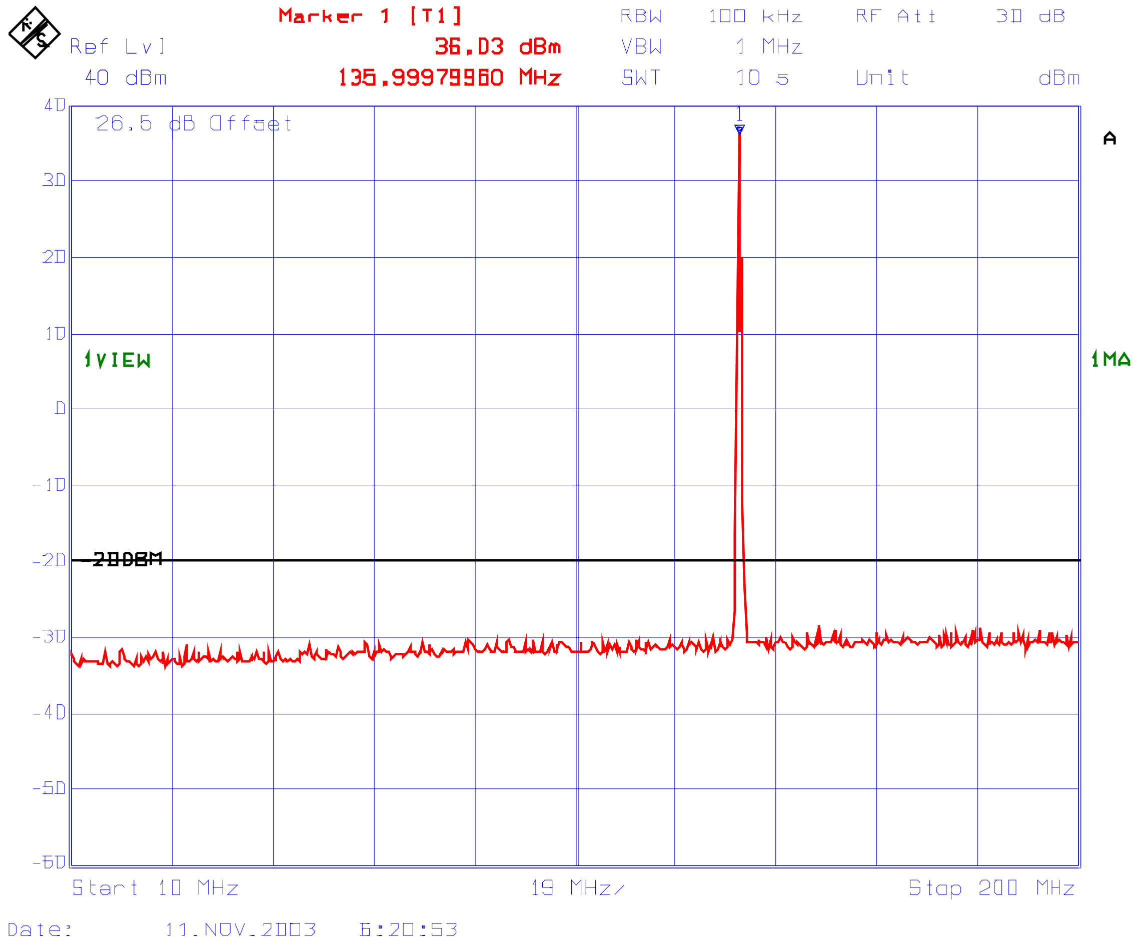
PLOT #: 42 Transmitter Spurious Emissions Conducted with 1 RF signal input
Fc: 136 MHz



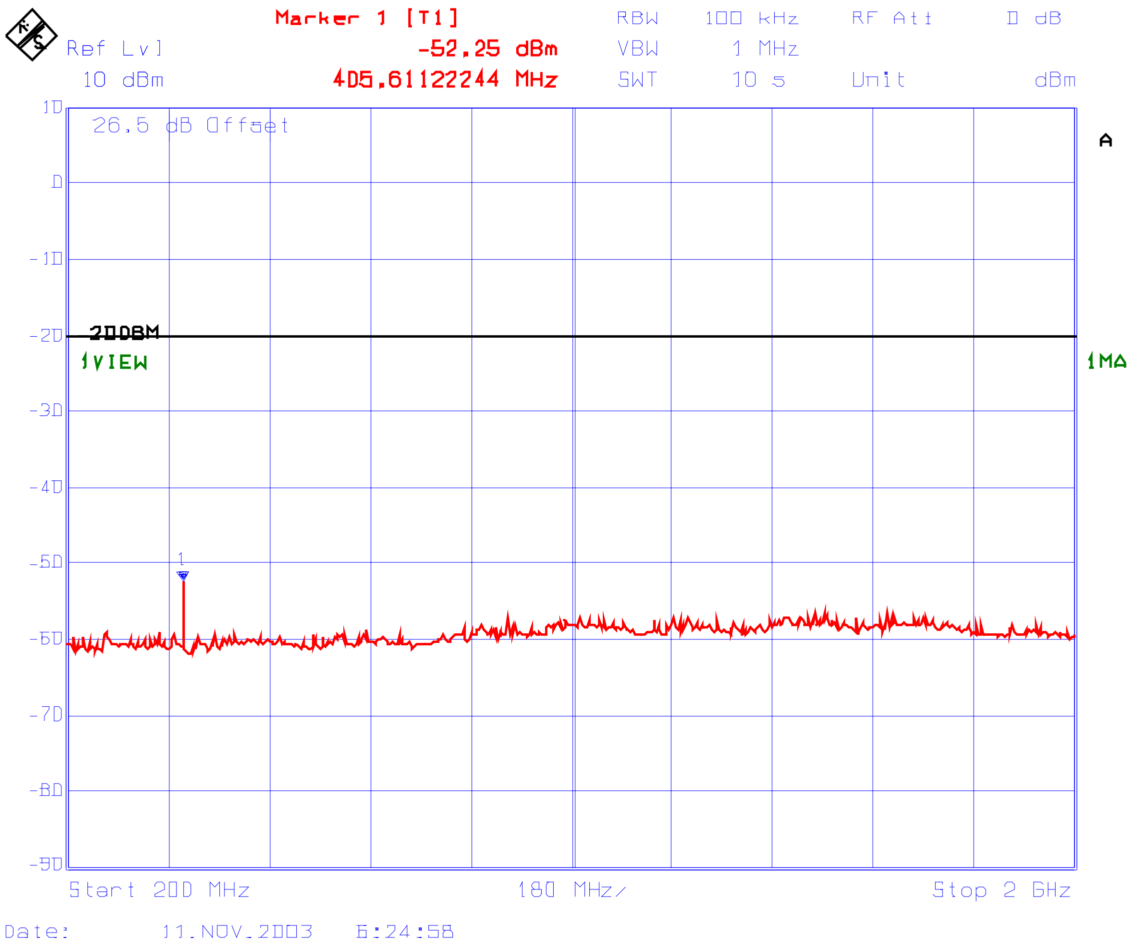
PLOT #: 43 Transmitter Spurious Emissions Conducted with 1 RF signal input
Fc: 136 MHz



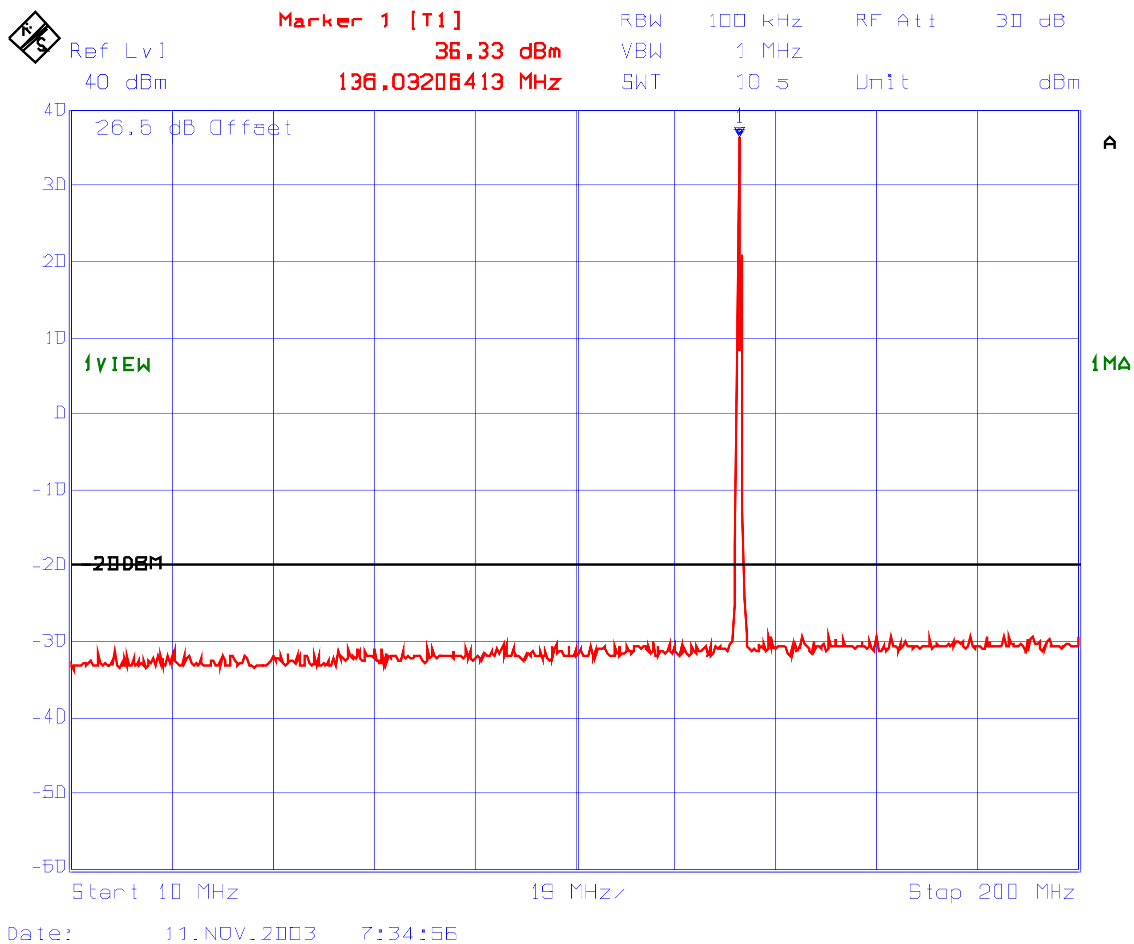
PLOT #: 44 Transmitter Spurious Emissions Conducted with 2 RF signal input
Fc: 136 MHz, Fc + 12.5 kHz



PLOT #: 45 Transmitter Spurious Emissions Conducted with 2 RF signal input
Fc: 136 MHz, Fc + 12.5 kHz

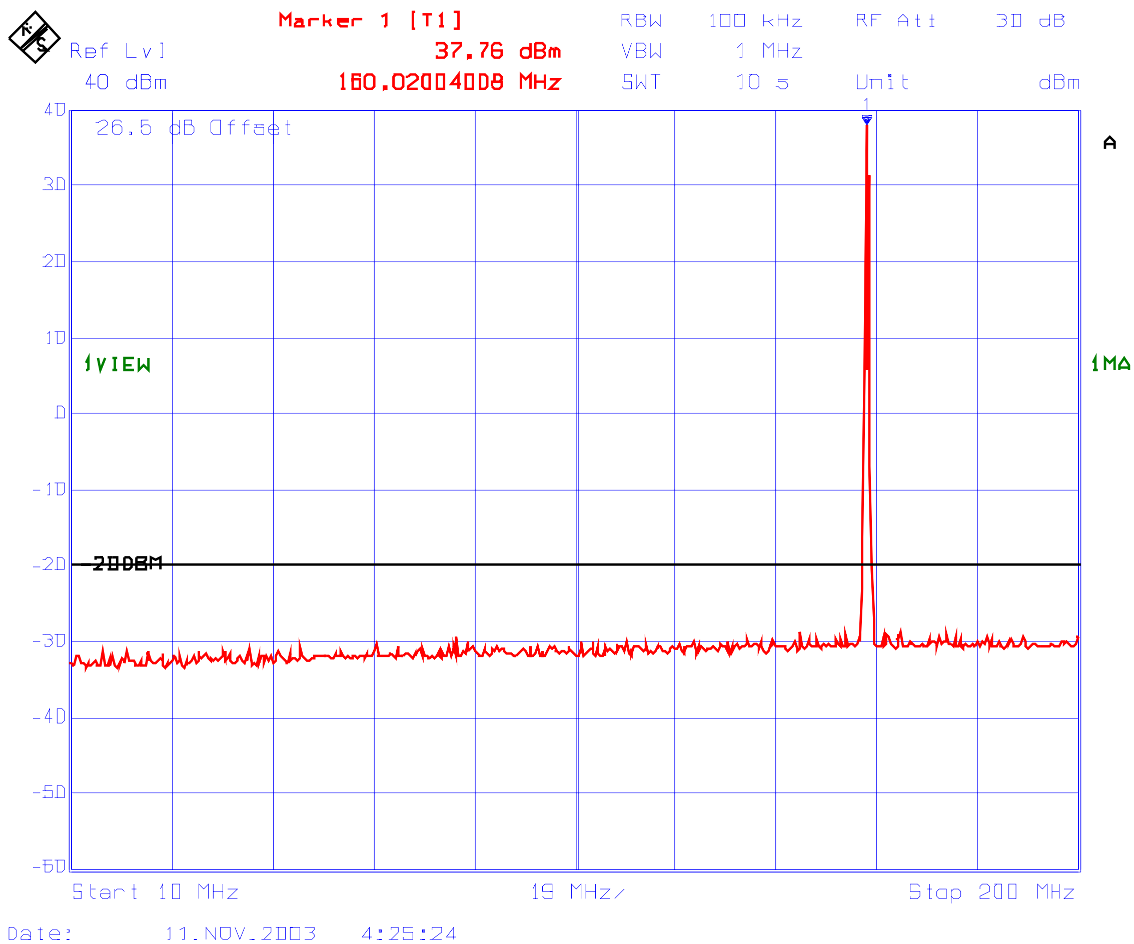


PLOT #: 46 Transmitter Spurious Emissions Conducted with 3 RF signal input
Fc: 136 MHz, Fc + 12.5 kHz, Fc + 25 kHz



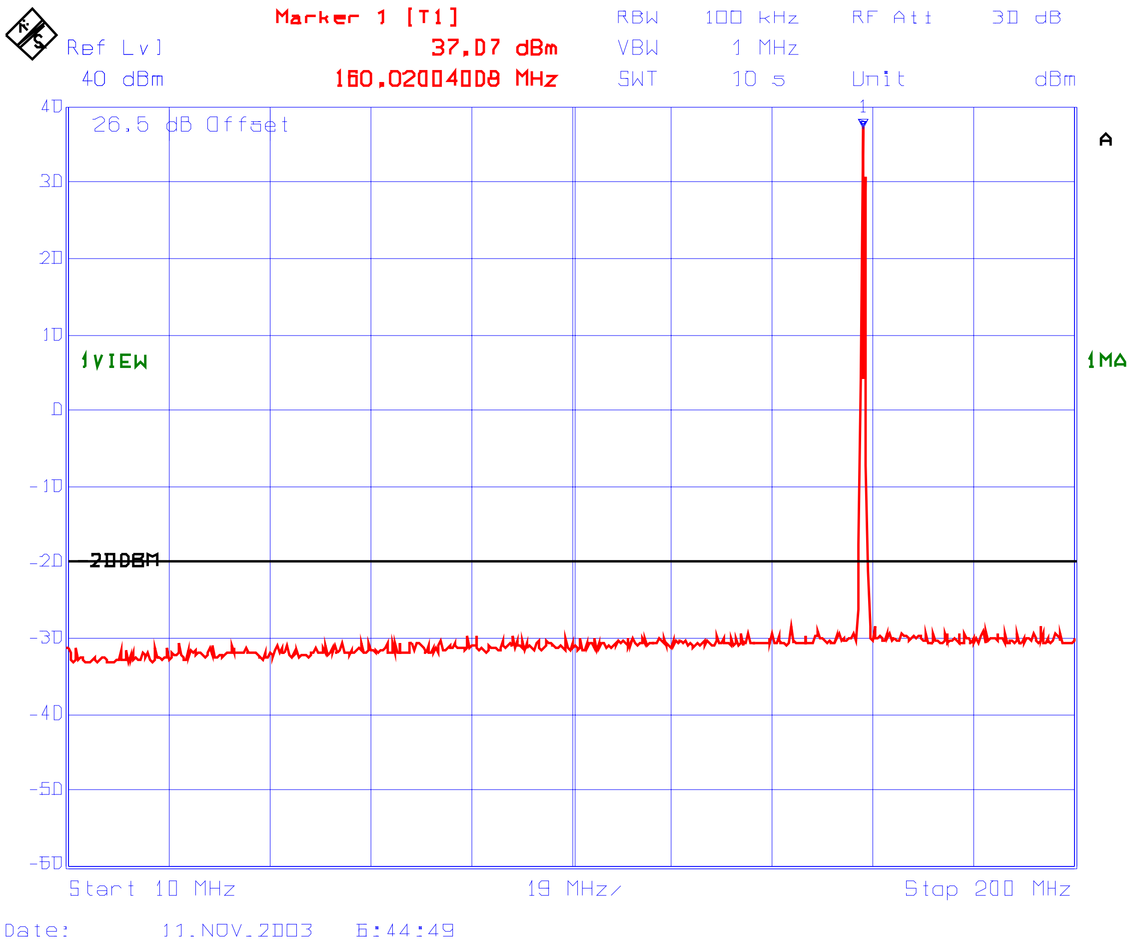
PLOT #: 47 Transmitter Spurious Emissions Conducted with 3 RF signal input
Fc: 136 MHz, Fc + 12.5 kHz, Fc + 25 kHz

PLOT #: 48 Transmitter Spurious Emissions Conducted with 1 RF signal input
Fc: 160 MHz



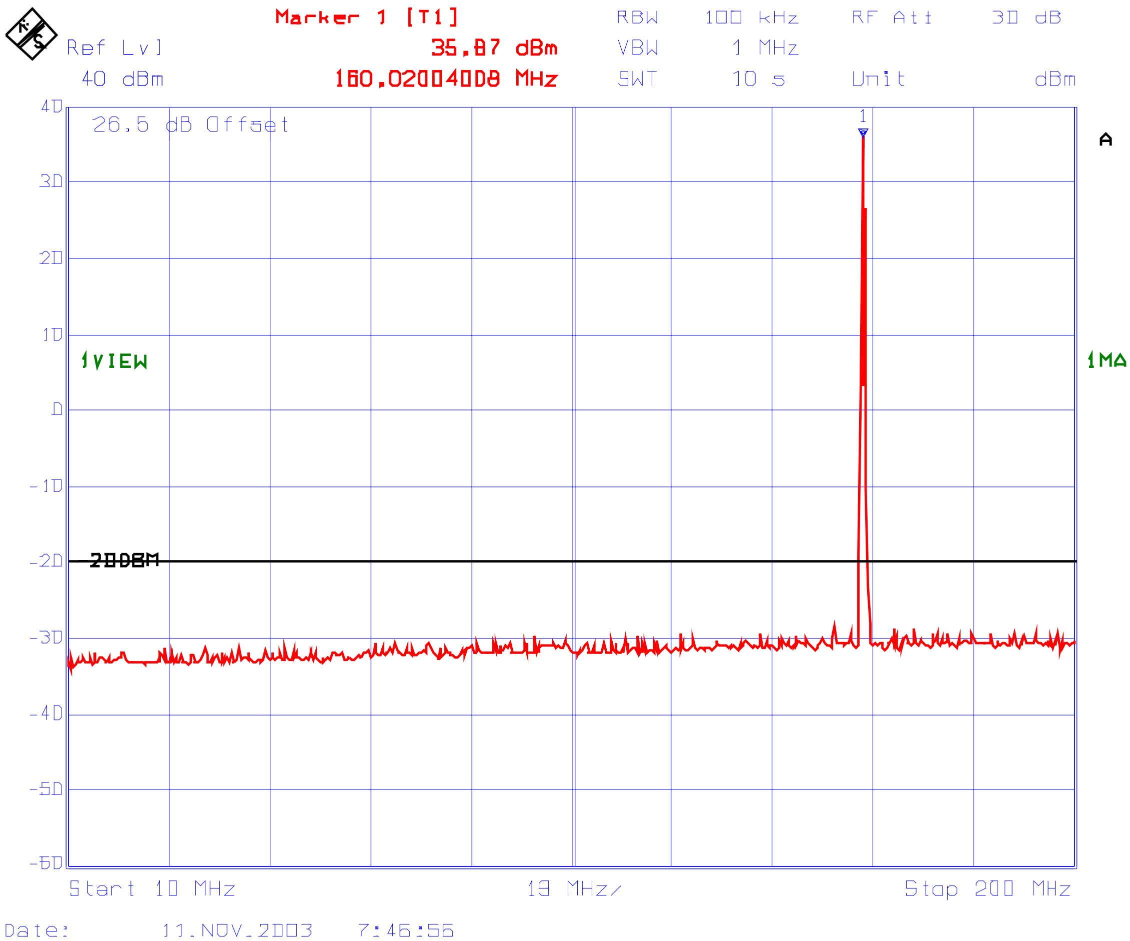
PLOT #: 49 Transmitter Spurious Emissions Conducted with 1 RF signal input
Fc: 160 MHz

PLOT #: 50 Transmitter Spurious Emissions Conducted with 2 RF signal input
Fc: 160 MHz, Fc + 12.5 kHz

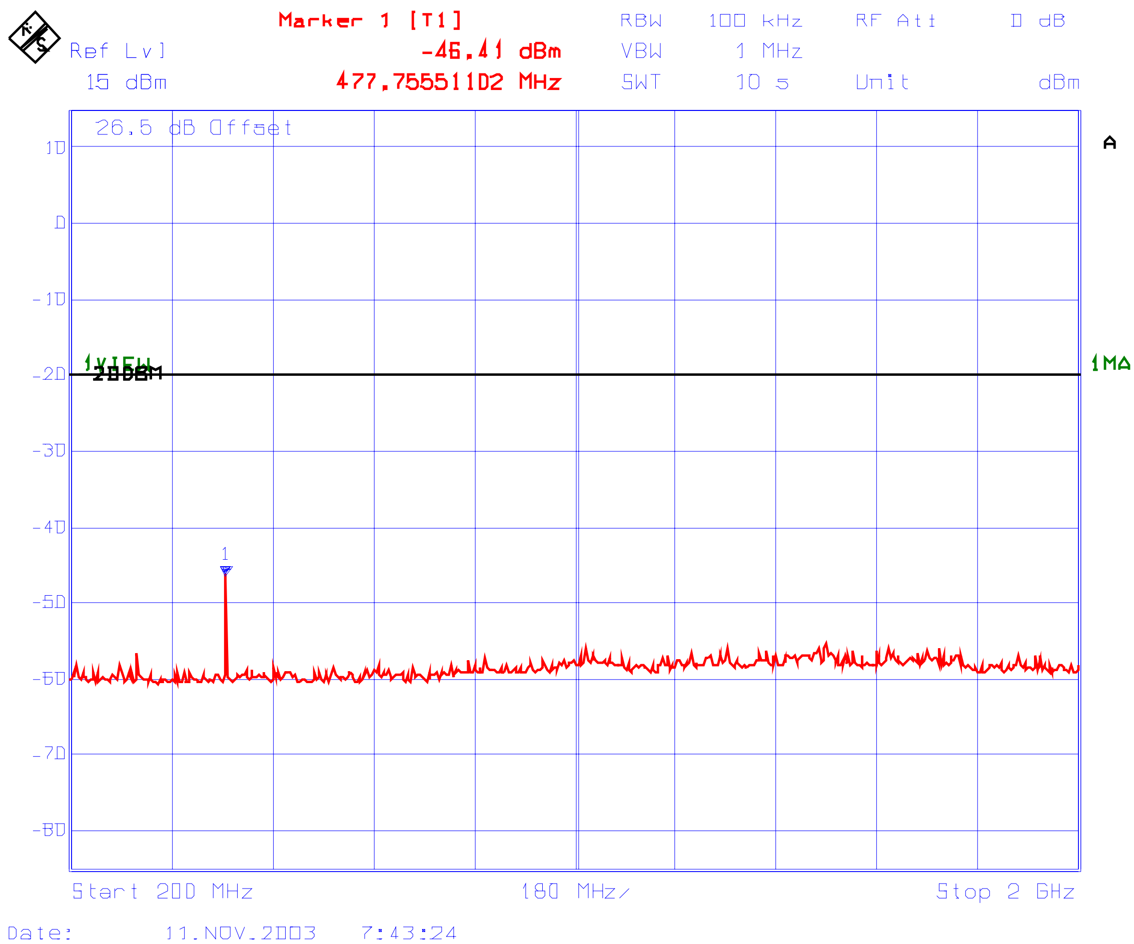


PLOT #: 51 Transmitter Spurious Emissions Conducted with 2 RF signal input
Fc: 160 MHz, Fc + 12.5 kHz

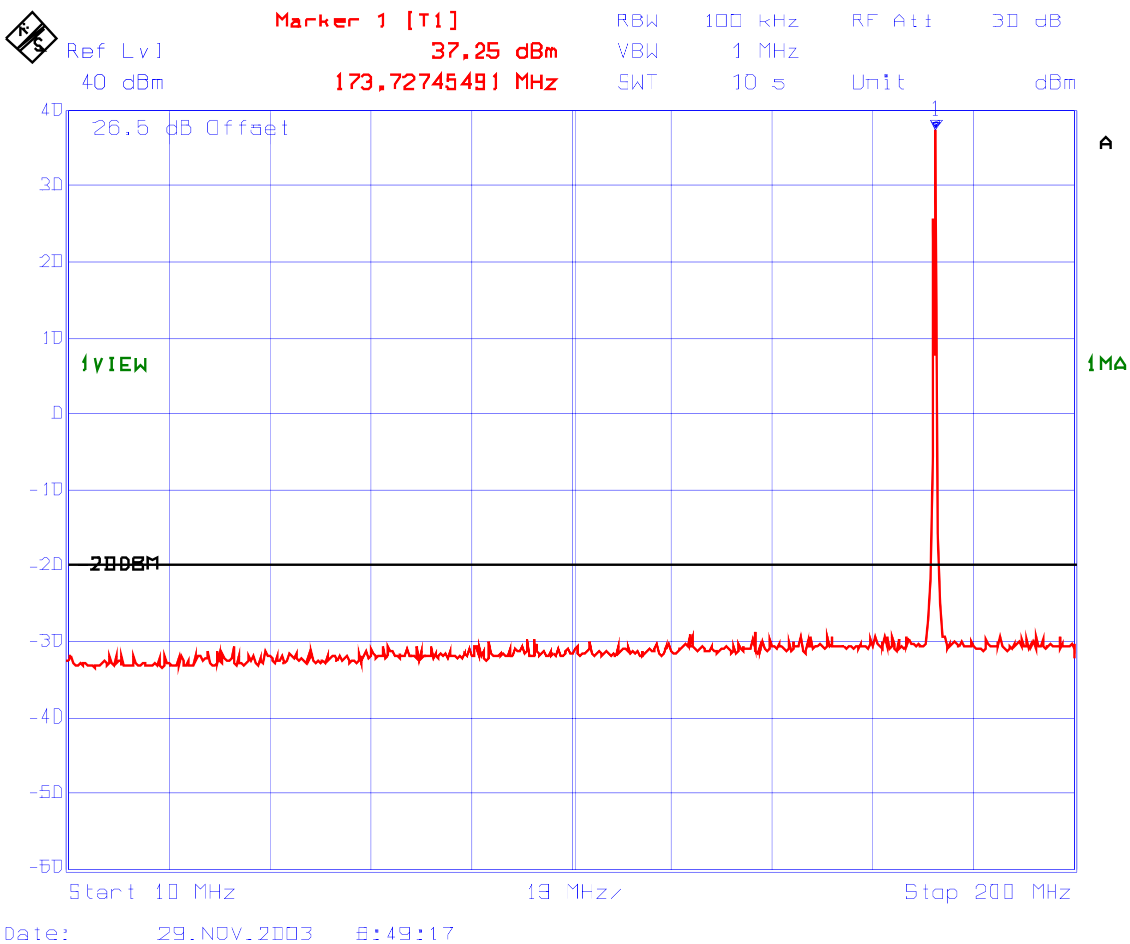
PLOT #: 52 Transmitter Spurious Emissions Conducted with 3 RF signal input
Fc: 160 MHz, Fc + 12.5 kHz, Fc – 12.5 kHz



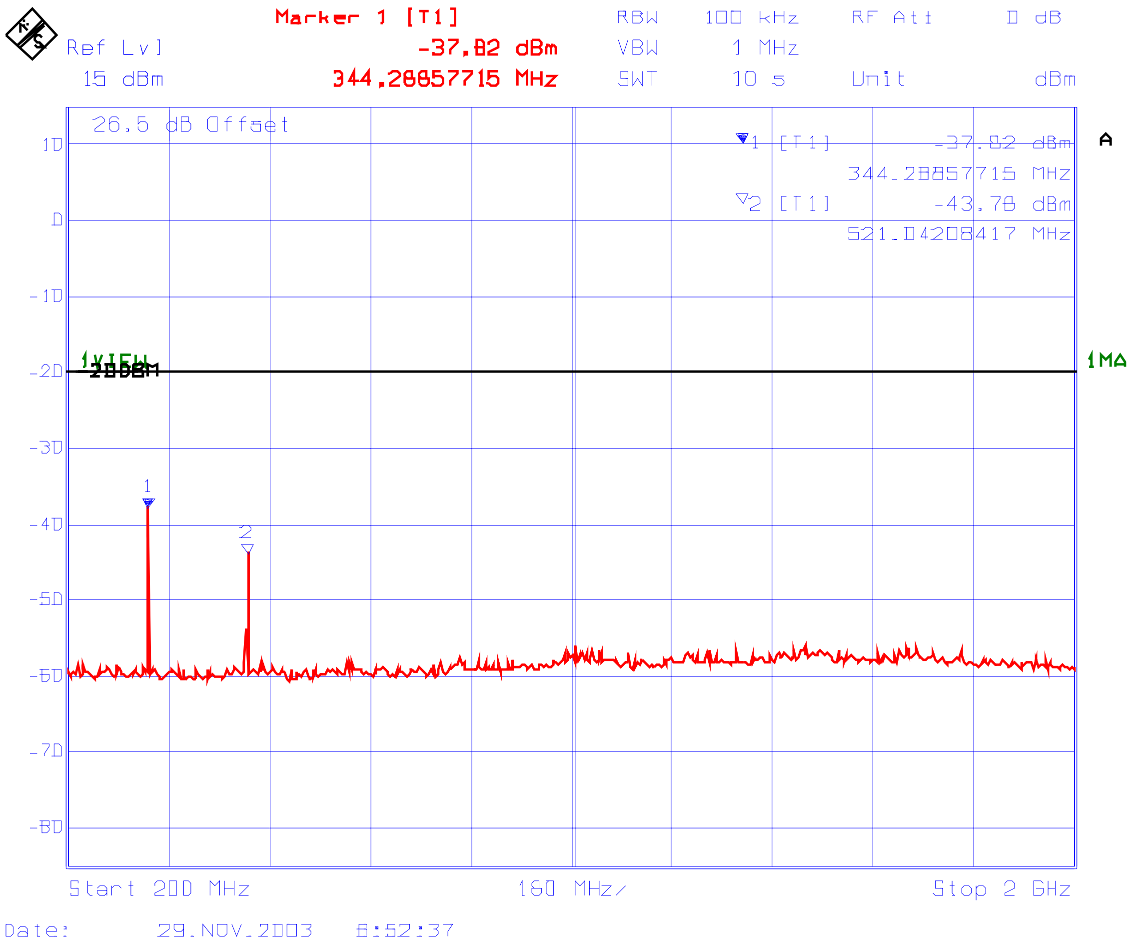
PLOT #: 53 Transmitter Spurious Emissions Conducted with 3 RF signal input
Fc: 160 MHz, Fc + 12.5 kHz, Fc – 12.5 kHz



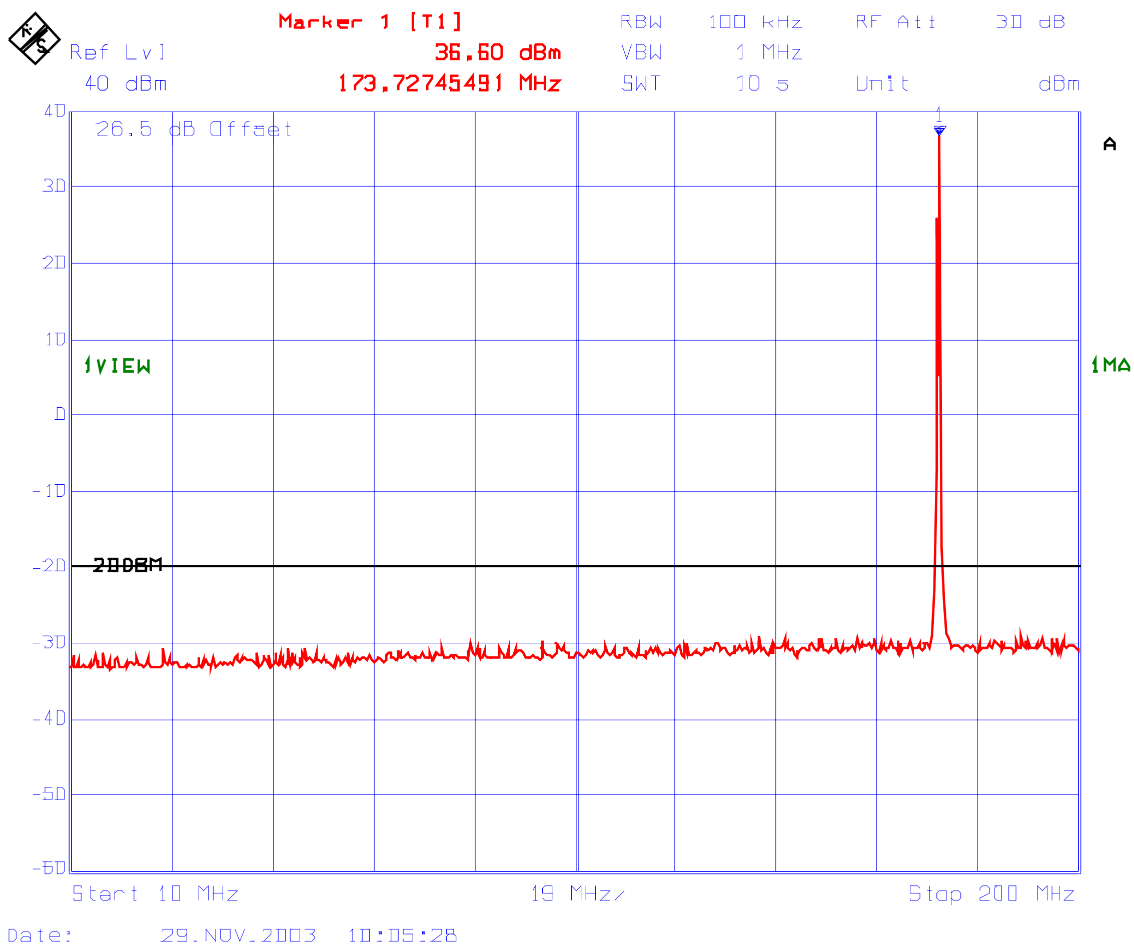
PLOT #: 54 Transmitter Spurious Emissions Conducted with 1 RF signal input
Fc: 173.5 MHz



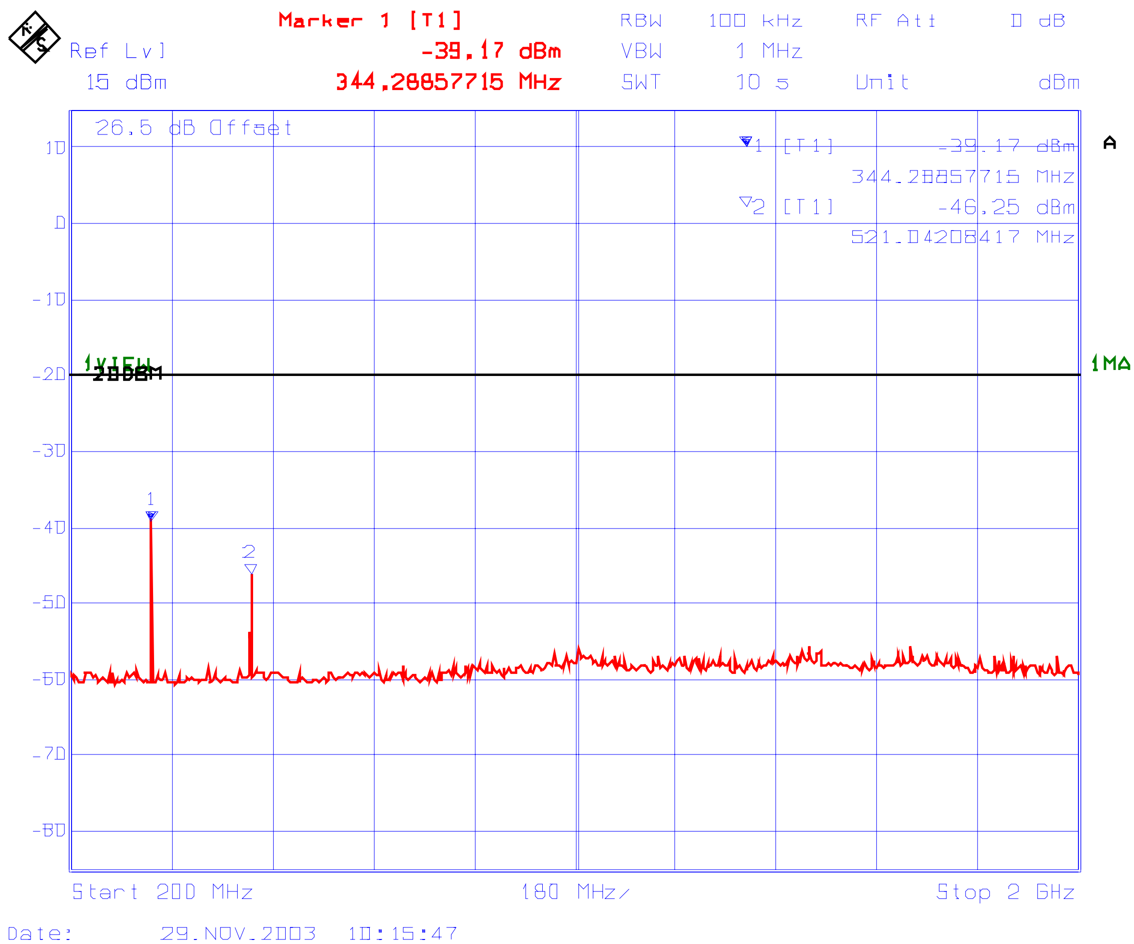
PLOT #: 55 Transmitter Spurious Emissions Conducted with 1 RF signal input
Fc: 173.5 MHz



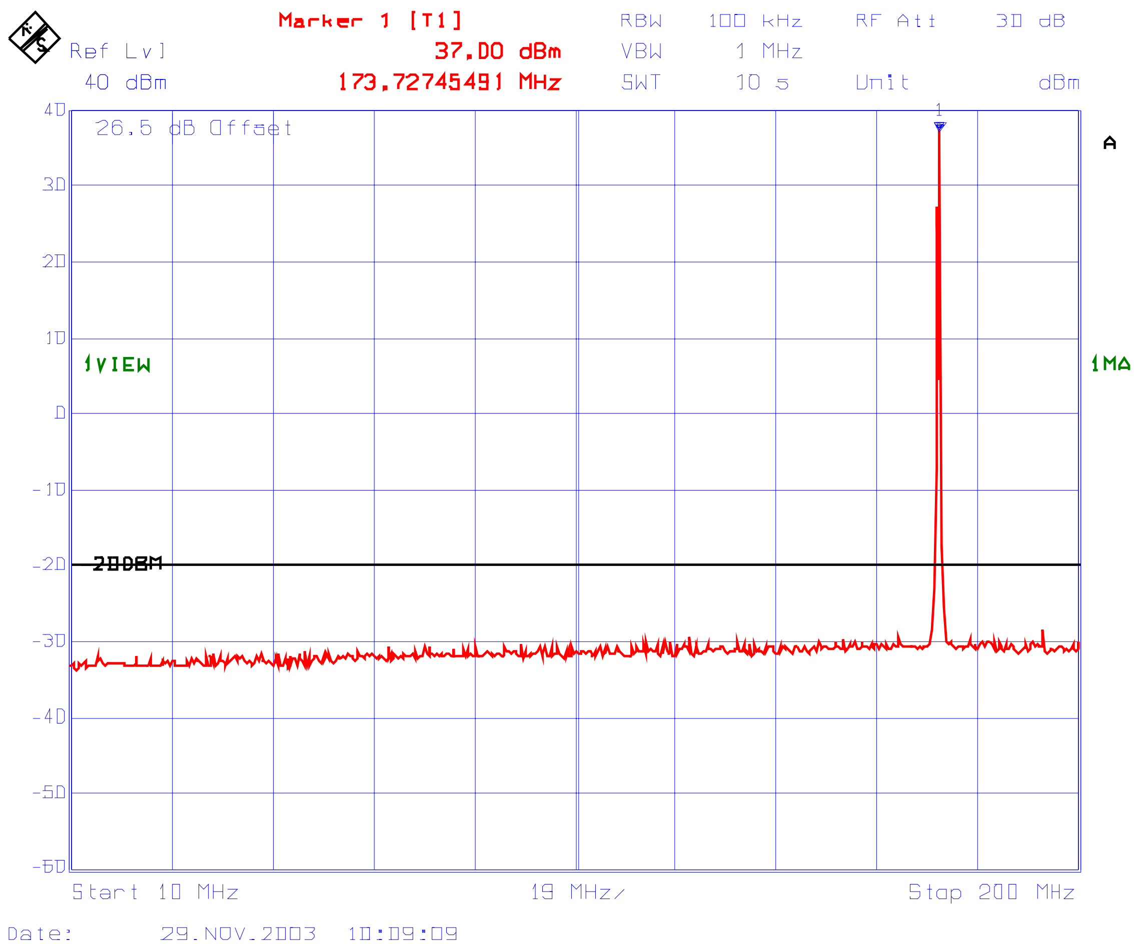
PLOT #: 56 Transmitter Spurious Emissions Conducted with 2 RF signal input
Fc: 173.5 MHz, Fc - 12.5 kHz



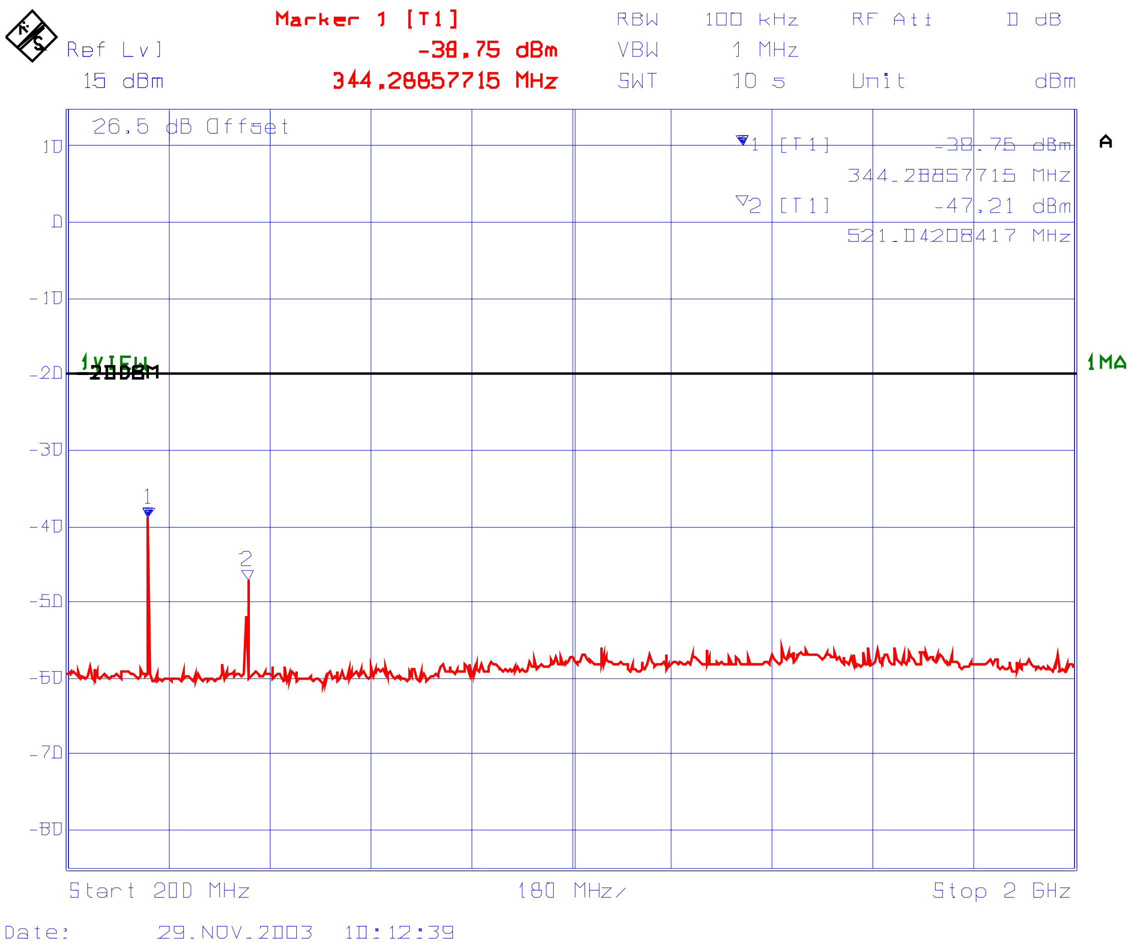
PLOT #: 57 Transmitter Spurious Emissions Conducted with 2 RF signal input
Fc: 173.5 MHz, Fc - 12.5 kHz



PLOT #: 58 Transmitter Spurious Emissions Conducted with 3 RF signal input
Fc: 173.5 MHz, Fc - 12.5 kHz, Fc –25 kHz



PLOT #: 59 Transmitter Spurious Emissions Conducted with 3 RF signal input
Fc: 173.5 MHz, Fc - 12.5 kHz, Fc –25 kHz



6.10. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS @ FCC 90.210

6.10.1. Limits @ FCC 90.210

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

Frequency Range (MHz)	Maximum Authorized BW (KHz)	Channel Spacing (KHz)	Recommended Frequency Deviation (KHz)	FCC Applicable Mask
136-174	20.0	25.0	5.0	• 90.210(b): Mask B – Voice • 90.210(c): Mask C – Data
136-174	11.25	12.5	2.5	• 90.210(d): Mask D – Voice & Data
136-174	6.0	6.25	1.25	• 90.210(b): Mask E – Voice & Data

6.10.2. Method of Measurements

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

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

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

6.10.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Advantest	R3271	15050203	100 Hz to 32 GHz with external mixer for frequency above 32 GHz
Microwave Amplifier	Hewlett Packard	HP 83017A	3116A00661	1 GHz to 26.5 GHz
Active Loop Antenna	EMCO	6507	8906-1167	1 kHz – 30 MHz
Biconilog Antenna	EMCO	3143	1029	20 MHz to 2 GHz
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz
Horn Antenna with Mixer	EMCO	3160-09	1007	18 GHz – 26.5 GHz
Horn Antenna with Mixer	EMCO	3160-10	1001	26.5 GHz – 40 GHz

6.10.4. Test Setup

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

6.10.5. Test Data

Remarks:

- The rf spurious/harmonic emission characteristics between 2 different channel spacing operations are identical. Therefore, the following radiated emissions were performed on the radio set with 12.5 kHz Channel Spacing operation, and the results were compared with the lowest limit of –20 dBm for the worst case.
- The Radiated emissions were performed at 3 meters distance.

6.10.5.1. Near Lowest Frequency (136 MHz)

FREQUENCY (MHz)	E-FIELD Level @3m (dBuV/m)	ERP Substitution measured by Method (dBm)	(dBc)	EMI Receiver Detector (Peak/QP)	ANTENNA PLANE (H/V)	LIMIT (dBc)	MARGIN (dB)	PASS/ FAIL
30 – 2000	**	**	**	PEAK	V & H	-55.5	**	PASS
• The emissions were scanned from 30 MHz to 2 GHz and no significant rf spurious/harmonic emissions were found to be less than 20 dB below the Limits.								

6.10.5.2. Near Middle Frequency (160 MHz)

FREQUENCY (MHz)	E-FIELD Level @3m (dBuV/m)	ERP Substitution measured by Method (dBm)	(dBc)	EMI Receiver Detector (Peak/QP)	ANTENNA PLANE (H/V)	LIMIT (dBc)	MARGIN (dB)	PASS/ FAIL
30 – 2000	**	**	**	PEAK	V & H	-55.5	**	PASS
• The emissions were scanned from 30 MHz to 2 GHz and no significant rf spurious/harmonic emissions were found to be less than 20 dB below the Limits.								

6.10.5.3. Near Highest Frequency (174 MHz)

FREQUENCY (MHz)	E-FIELD Level @3m (dBuV/m)	ERP Substitution measured by Method (dBm)	(dBc)	EMI Receiver Detector (Peak/QP)	ANTENNA PLANE (H/V)	LIMIT (dBc)	MARGIN (dB)	PASS/ FAIL
30 – 2000	**	**	**	PEAK	V & H	-55.5	**	PASS
• The emissions were scanned from 30 MHz to 2 GHz and no significant rf spurious/harmonic emissions were found to be less 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 (Radiated Emissions)	PROBABILITY DISTRIBUTION	UNCERTAINTY (± dB)	
		3 m	10 m
Antenna Factor Calibration	Normal (k=2)	±1.0	±1.0
Cable Loss Calibration	Normal (k=2)	±0.3	±0.5
EMI Receiver specification	Rectangular	±1.5	±1.5
Antenna Directivit	Rectangular	+0.5	+0.5
Antenna factor variation with height	Rectangular	±2.0	±0.5
Antenna phase center variation	Rectangular	0.0	±0.2
Antenna factor frequency interpolation	Rectangular	±0.25	±0.25
Measurement distance variation	Rectangular	±0.6	±0.4
Site imperfections	Rectangular	±2.0	±2.0
Mismatch: Receiver VRC Γ_1 = 0.2 Antenna VRC Γ_R = 0.67(Bi) 0.3 (Lp) Uncertainty limits 20Log(1±$\Gamma_1 \Gamma_R$)	U-Shaped	+1.1 -1.25	±0.5
System repeatability	Std. Deviation	±0.5	±0.5
Repeatability of EUT		-	-
Combined standard uncertainty	Normal	+2.19 / -2.21	+1.74 / -1.72
Expanded uncertainty U	Normal (k=2)	+4.38 / -4.42	+3.48 / -3.44

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

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

EXHIBIT 8. MEASUREMENT METHODS

8.1. CONDUCTED POWER MEASUREMENTS

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

Test procedure shall be as follows:

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

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

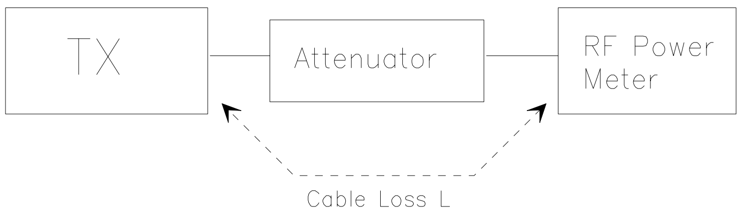
Step 2: Calculation of Average EIRP. See Figure 1

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

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

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

  Figure 1.



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

8.2.1. Maximizing RF Emission Level (E-Field)

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

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

(f) Set the EMI Receiver #1 and #2 as follows:

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

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

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

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

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

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

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

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

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

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

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

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

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

Figure 2

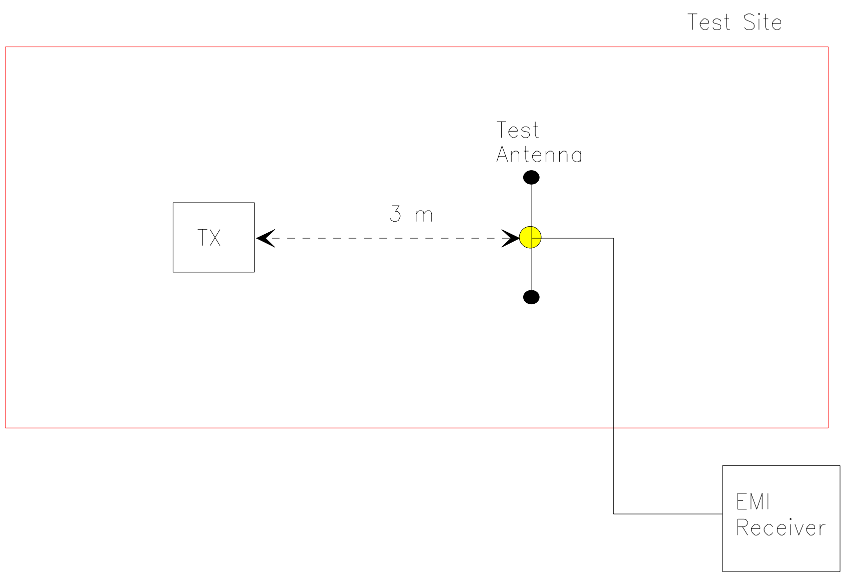
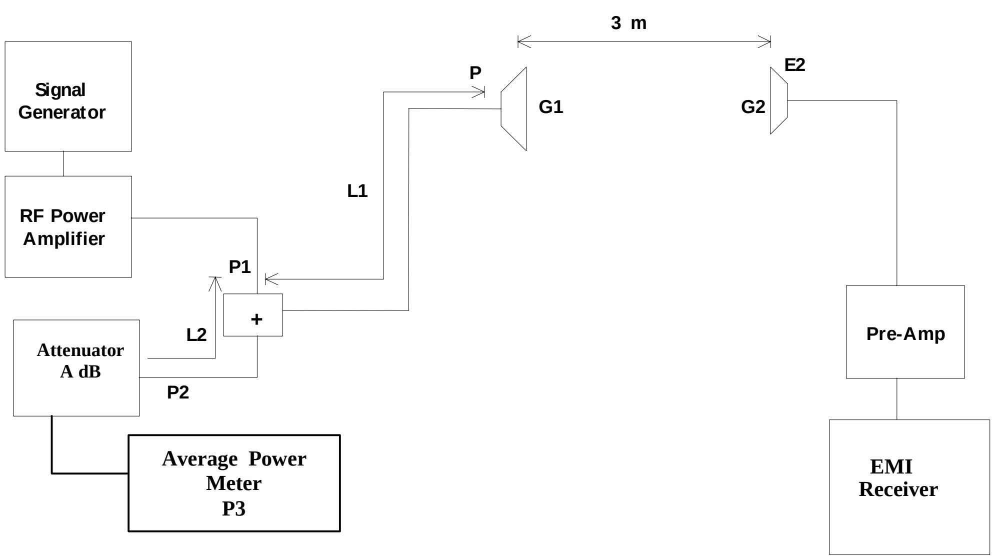


Figure 3



8.3. FREQUENCY STABILITY

Refer to FCC @ 2.1055.

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

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

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

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

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

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

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

8.4. EMISSION MASK

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

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

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

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

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

8.5. SPURIOUS EMISSIONS (CONDUCTED)

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

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

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

8.6. TRANSIENT FREQUENCY BEHAVIOR

1. Connect the transmitter under tests as shown in the above block diagram
2. Set the signal generator to the assigned frequency and modulate with a 1 kHz tone at ±12.5 kHz deviation and its output level to be 50 dB below the transmitter rf output at the test receiver end.
3. Set the horizontal sweep rate on the storage scope to 10 milliseconds per division and adjust the display to continuously view the 1000 Hz tone from the Demodulator Output Port (DOP) of the Test Receiver. Adjust the vertical scale amplitude control of the scope to display the 1000 Hz at ±4 divisions vertical Center at the display.
4. Adjust the scope so it will trigger on an increasing magnitude from the RF trigger signal of the transmitter under test when the transmitter was turned on. Set the controls to store the display.
5. The output at the DOP, due to the change in the ratio of the power between the signal generator input power and transmitter output power will, because of the capture effect of the test receiver, produce a change in display: For the first part of the sweep it will show the 1 kHz test signal. Then once the receiver's demodulator has been captured by the transmitter power, the display will show the frequency difference from the assigned frequency to the actual transmitter frequency versus time. The instant when the 1 kHz test signal is completely suppressed (including any capture time due to phasing) is considered to be t_{on}. The trace should be maintained within the allowed divisions during the period t_1 and t_2.
6. During the time from the end of t_2 to the beginning of t_3 the frequency difference should not exceed the limits set by the FCC in Part 90.214 and the outlined in the Carrier Frequency Stability sections. The allowed limit is equal to FCC frequency tolerance limits specified in FCC 90.213.
7. Repeat the above steps when the transmitter was turned off for measuring t_3.