Test Report

Report Number: 30748871
Project Number: 3074887
Report Date: April 29, 2005

Testing performed on the
HiPer XT with UHF, GSM and Bluetooth modules
Model Number: 01-860801-03
FCC ID: LCB-860801
to

FCC Part 90

for
Topcon Positioning Systems, Inc.

A2LA Certificate Number: 1755-01

Test Performed by:	**Test Authorized by:**
Intertek Testing Services NA, Inc	Topcon Positioning Systems, Inc.
1365 Adams Court	7400 National Drive
Menlo Park, CA 94025	Livermore, CA 94551 USA

Prepared by: **Date:** April 29, 2005

David Chernomordik, EMC Technical Manager

Reviewed by: **Date:** April 29, 2005

Ollie Moyrong, EMC Department Manager

Report No. 30748871

Equipment Under Test:	Hiper XT with UHF, GSM and Bluetooth modules
Trade Name:	Topcon Positioning Systems
Model No.:	01-860801-03
Serial No.:	Not Labeled
FCC ID:	LCB-860801
Applicant:	Topcon Positioning Systems, Inc.
Contact:	Mr. Kent Mizuide
Address:	7400 National Drive Livermore, CA 94551
Country	USA
Tel. number:	925-245-8376
Fax number:	925-245-8594
Tel. number:	925-245-8300
Fax number:	925-245-8594
Applicable Regulation:	FCC Part 90
Test Site Location:	ITS - Site 1 1365 Adams Drive Menlo Park, CA 94025
Date of Test:	April 4 - 15, 2005

We attest to the accuracy of this report:

David Chernomordik
EMC Technical Manager

Ollie Moyrong
EMC Department Manager

TABLE OF CONTENTS

1.0 Introduction

1.1 Product Description

The Equipment under Test (EUT), model: 01-860801-03 is a dual-frequency GPS+ receiver with UHF modem, GSM module, and Bluetooth module.

The GSM module is FCC certified, FCC ID: IHDT56DB1 (modular approval).

For more information about the radios, refer to the attached product description.

Use of Product	surveying, construction, commercial mapping etc.			
Whether quantity (>1) production is planned	yes			
Specification of the radio modules installed into the product				
Type	UHF radio	GSM radio		Bluetooth radio
Rated RF Output Power	2 W	0.631W	0.809W	1 mW
Frequency Ranges, MHz	450 – 470	824.2-848.8	1850.2-1909.8	2402 – 2480
Type of emissions	F1D	GXW	GXW	FHSS
Type of modulation	GMSK, FM-4	-	-	GFSK
Channel bandwidth and maximum data rate	25kHz at 19200 (FM-4) 12.5kHz at 9600 (FM-4)	250kHz	250kHz	782 kHz
Antenna & Gain	Whip, 3 dBi	Whip, 3 dBi	Whip, 3 dBi	Omnidirectional, 0.5 dBi, internal
Detachable antenna?	yes	yes		no
External input	data	data		data
Operating temperature	From -30^0C to $+50^0$C			
FCC approval status	In the process of being certified	Certified module, FCC ID: IHDT56DB1		Certified with the Hiper Plus product, FCC ID: LCB-40801

Note: According to the user's manual, UHF and GSM transmitters do not transmit simultaneously.

EUT receive date: April 1, 2005
EUT receive condition: The prototype version of the EUT was received in good condition with no apparent damage. As declared by the Applicant it is identical to the production units.
Test start date: April 4, 2005
Test completion date: April 14, 2005

1.2 Summary of Test Results

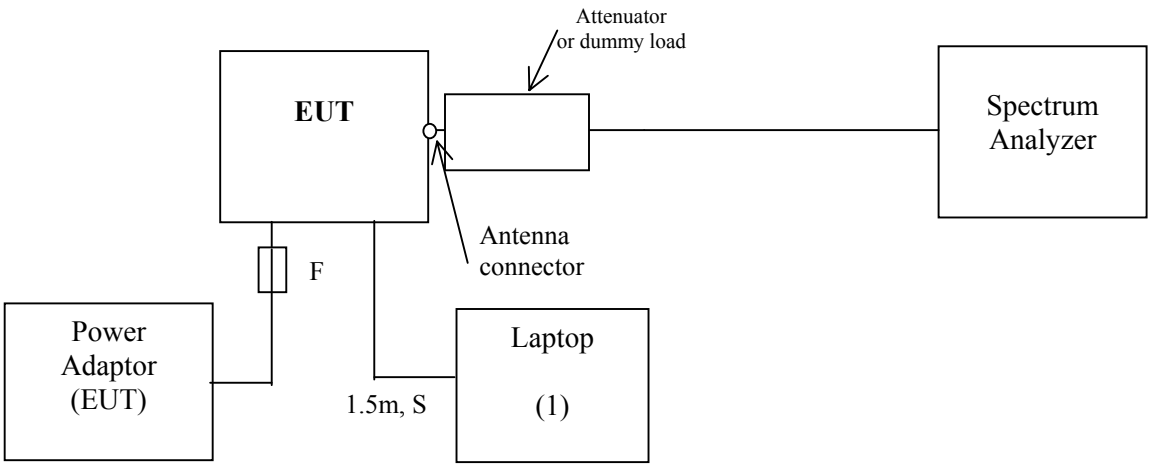
FCC Rule	Description of Test	Result	Page
2.1046	RF Power Output	Complies	8
90.205(h)	ERP	Complies	15
2.1047	Modulation characteristics	Not Applicable	-
2.1049, 90.209	Occupied Bandwidth	Complies	16
90.210	Emission masks	Complies	21
2.1051, 90.210	Out of Band Emissions at Antenna Terminals	Complies	26
2.1053, 90.210	Spurious Radiation	Complies	43
2.1055, 90.213	Frequency Stability vs. Temperature and Voltage	Complies	50
90.214	Transient frequency behavior	Complies	45
2.1091	RF Exposure evaluation	Complies	52

1.3 Test Configuration

1.3.1 Support Equipment

Item #	Description	Model No.	S/N
1	Compaq Laptop	Armada 7400	7933CY570119

1.3.2 Block diagram of Test Setup



S = Shielded **U** = Unshielded	**F** = With Ferrite **m** = Length in Meters

1.4 Related Submittal(s) Grants

None

2.0 RF Power Output
FCC 2.1046

2.1 Test Procedure

The EUT RF output was connected as shown on the diagram in sec.1.3.2. The EUT was setup to transmit continuously the maximum power.

The spectrum analyzed was setup to measure a peak power.. The attenuation and cable loss were added to the spectrum analyzed reading by using OFFSET function.

Measurements were performed at three frequencies (low, middle, and high channels) for both type of modulation

2.2 Test Equipment

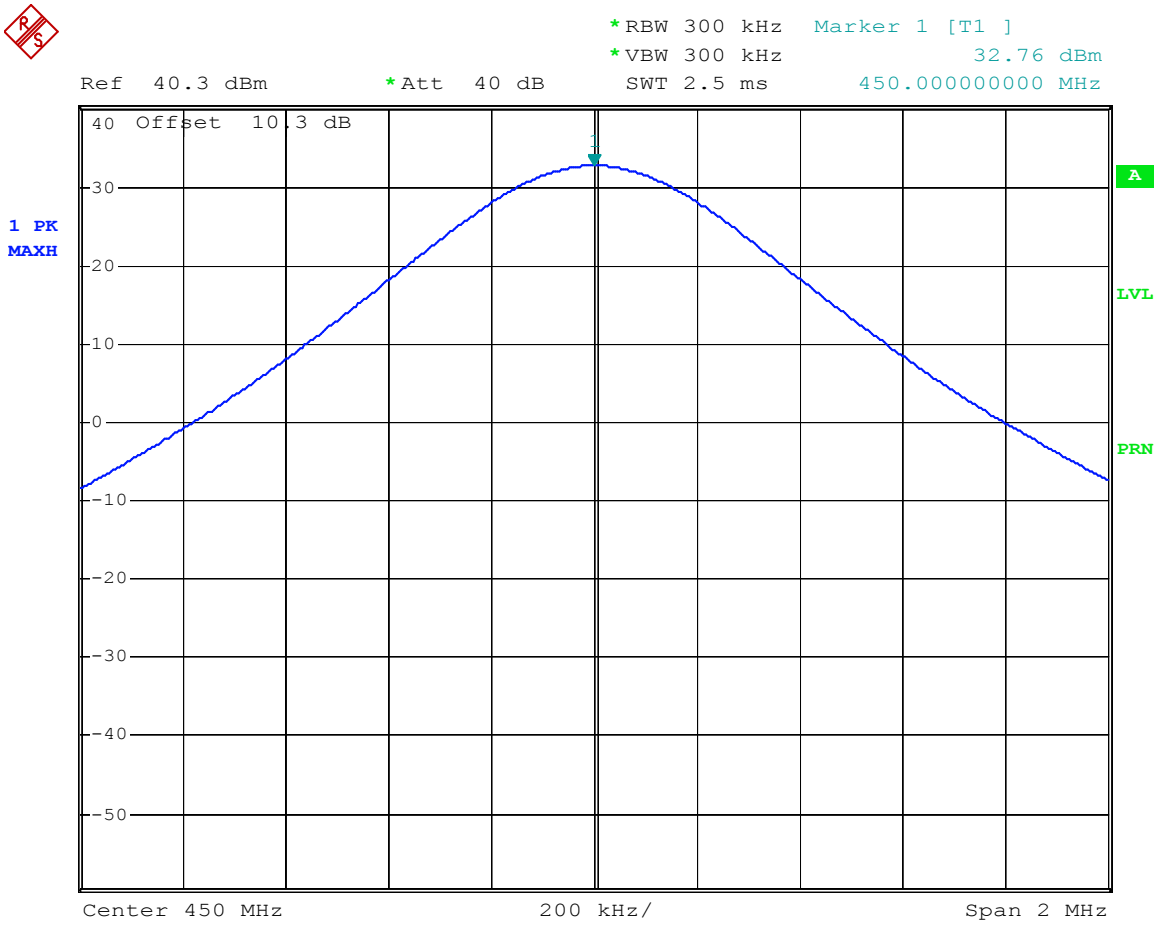
Rohde & Schwarz FSP40 Spectrum Analyzer

2.3 Test Results

Frequency (MHz)	Modulation/data rate	Measured Output Power (dBm)	Measured Output Power (Watt)	Plot
450	FM-4/19200	32.8	1.91	2.1
450	GMSK/9600	32.8	1.91	2.2
460	FM-4/19200	32.5	1.78	2.3
460	GMSK/9600	32.5	1.78	2.4
470	FM-4/19200	32.3	1.70	2.5
470	GMSK/9600	32.3	1.70	2.6

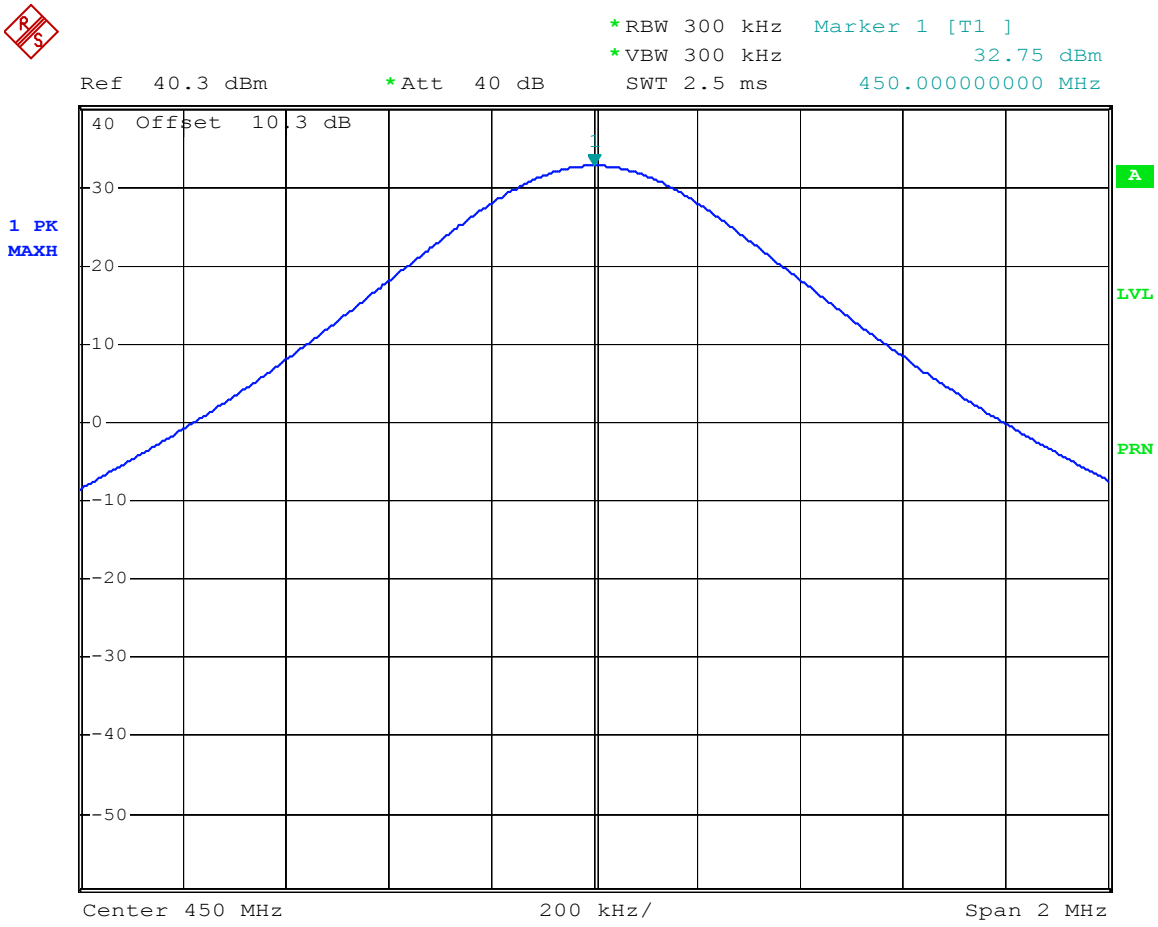
For more details refer to the attached plots.

Plot 2.1



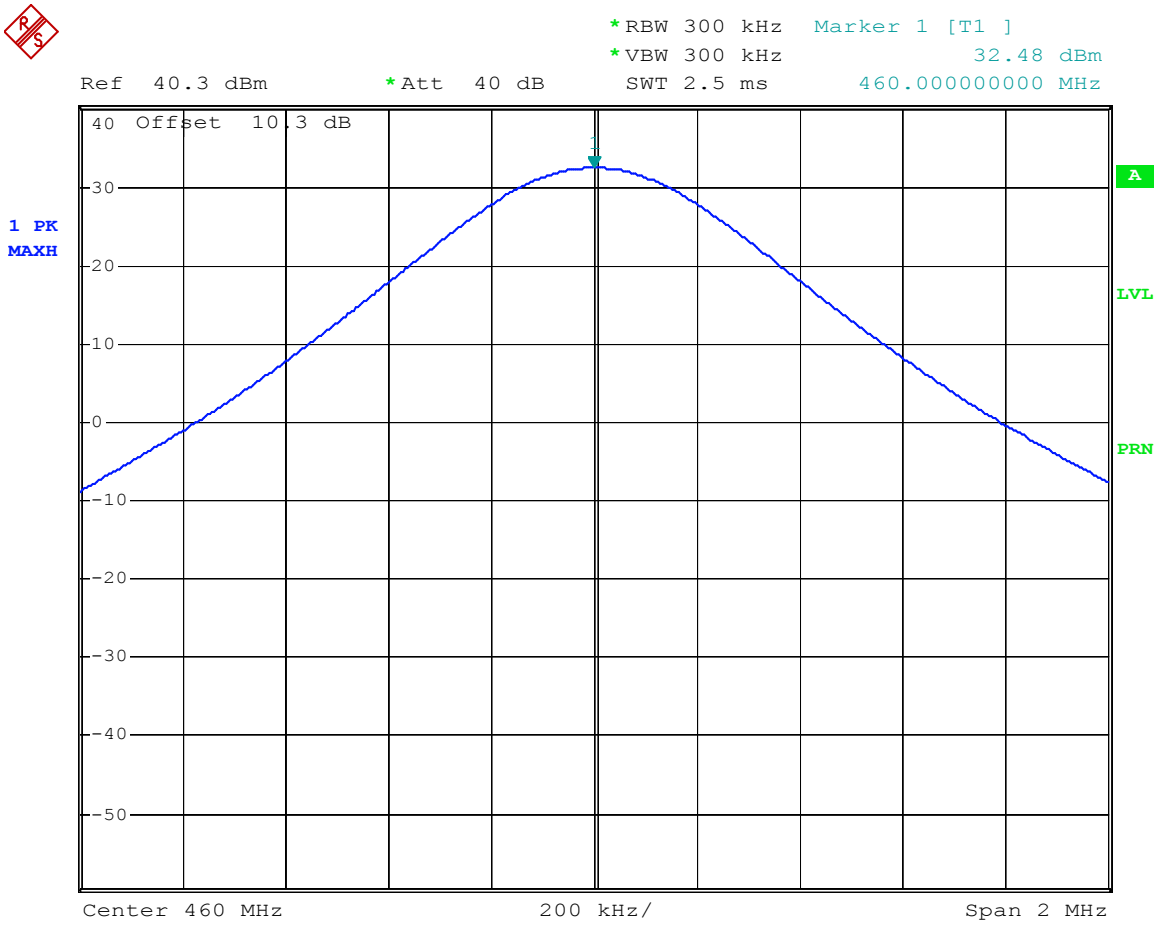
Comment: Output Power, low channel, mod FM-4, rate 19200
Date: 4.APR.2005 16:53:07

Plot 2.2



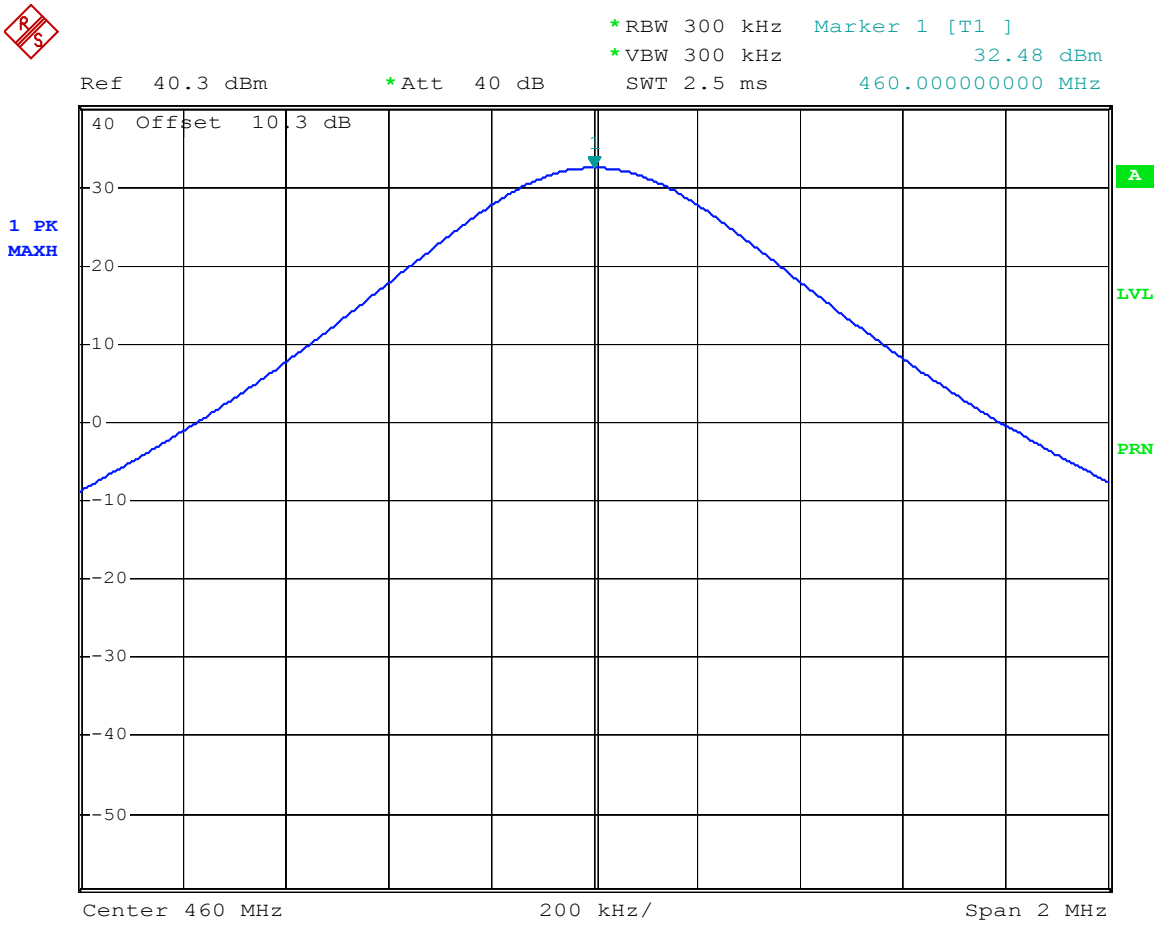
Comment: Output Power, low channel, mod GMSK, rate 9600
Date: 4.APR.2005 17:03:16

Plot 2.3



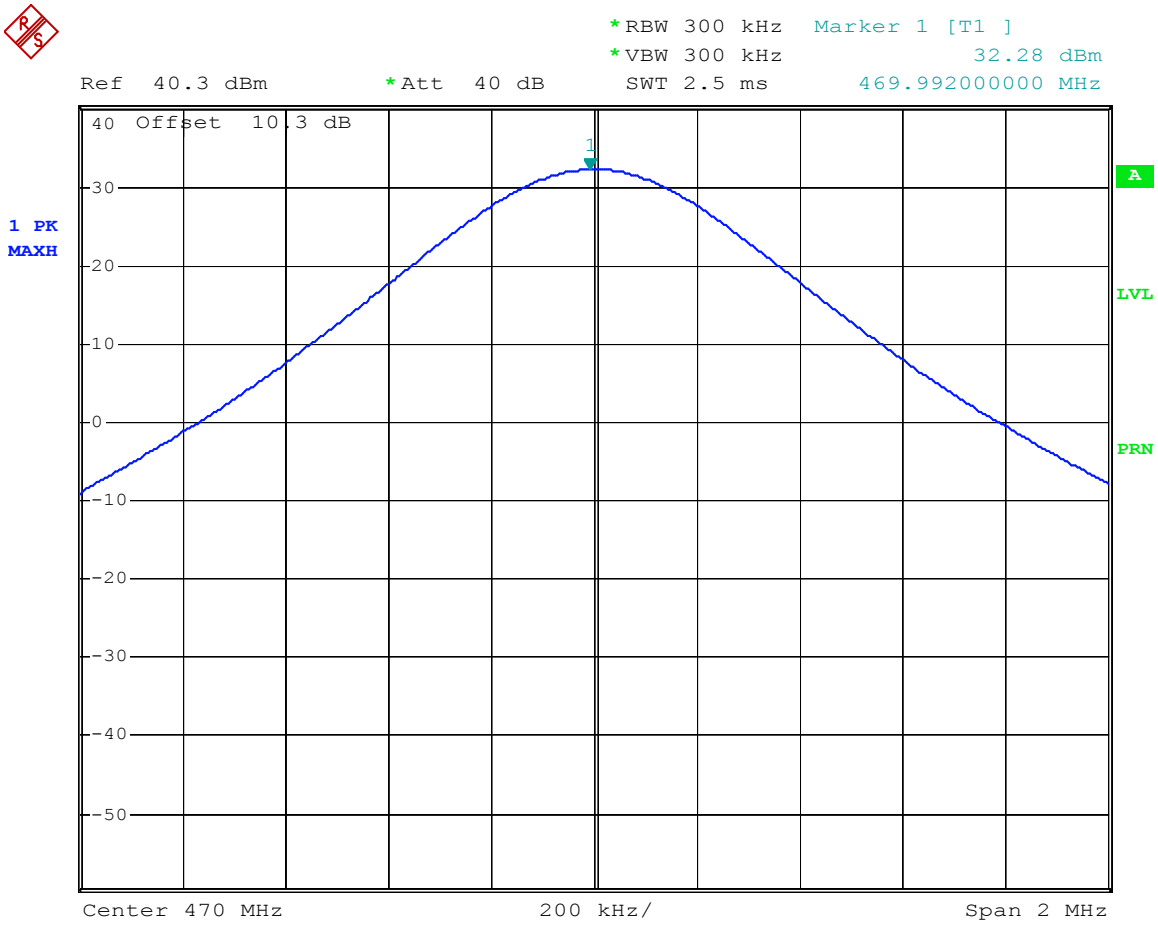
Comment: Output Power, middle channel, mod FM-4, rate 19200
Date: 4.APR.2005 16:55:23

Plot 2.4



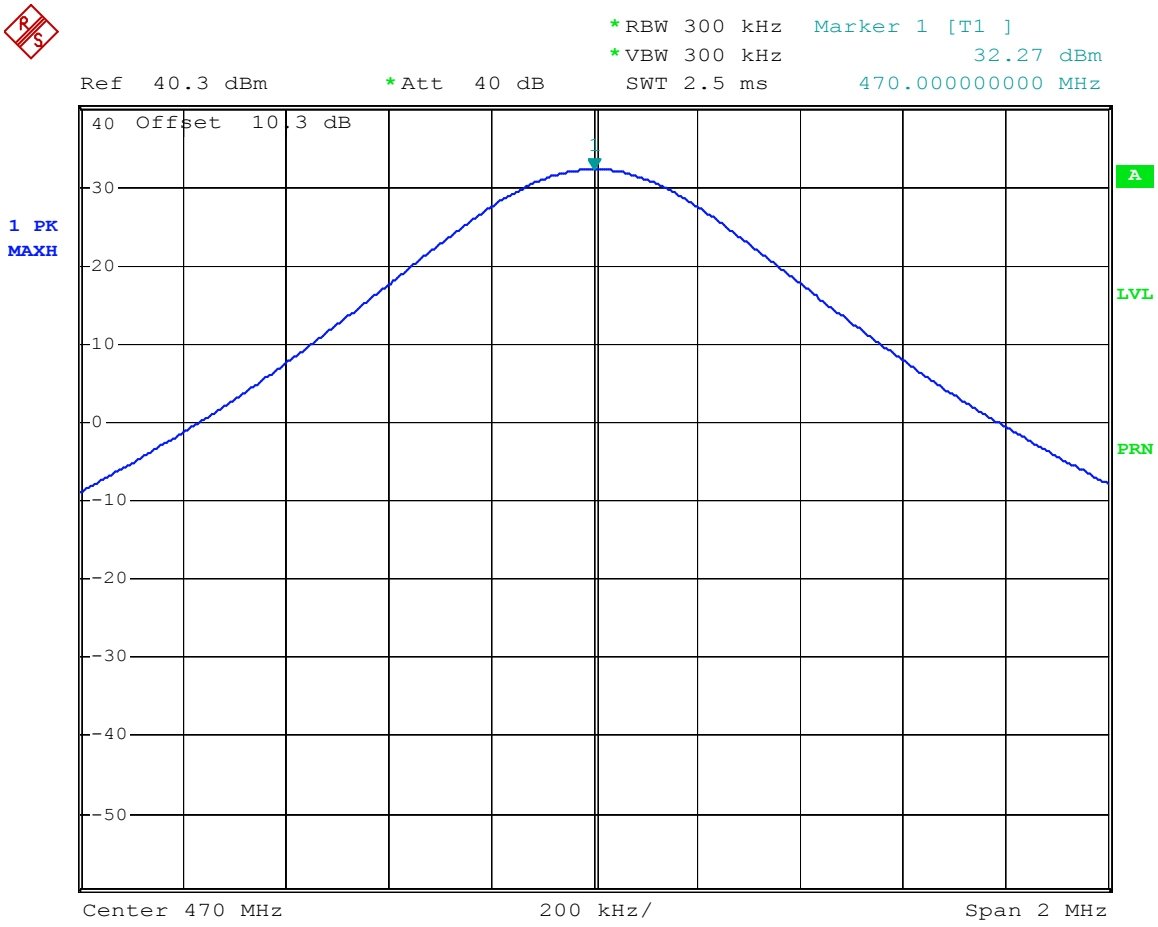
Comment: Output Power, middle channel, mod GMSK, rate 9600
Date: 4.APR.2005 16:57:03

Plot 2.5



Comment: Output Power, high channel, mod FM-4, rate 19200
Date: 4.APR.2005 16:59:15

Plot 2.6



Comment: Output Power, high channel, mod GMSK, rate 9600
Date: 4.APR.2005 17:01:33

3.0 Radiated Power

3.1 Requirement

FCC 90.205(h)

The maximum Effective Radiated Power (ERP) is 500 Watts.

3.2 Test Procedure

The ERP was calculated by adding the antenna gain to the output power in dBm.

$ERP = P_{max} + G_{dBd}$

3.3 Test Equipment

None

3.4 Test Results

According to the Installation Guide, a typical 3 dBi (0.9 dBd) gain antenna is used with the EUT. Therefore, the calculated peak radiated power is:

ERP = 32.8 + 0.9 = 33.7 dBm (or 2.3 W);
EIRP= 32.8 + 3.0 = 35.8 dBm (or 3.8 W).

Result	**Complies**

4.0 Occupied Bandwidth

FCC 2.1049, 90.209(b)(5)

4.1 Test Procedure

The EUT RF output was connected as shown on the diagram in sec.1.3.2. The EUT was setup to transmit the maximum power.

The spectrum analyzed was setup to measure the Occupied Bandwidth (defined as the 99% Power Bandwidth). The Occupied Bandwidth was measured at middle channel for both types of modulation.

4.2 Test Equipment

Rohde & Schwarz FSP40 Spectrum Analyzer

4.3 Test Results

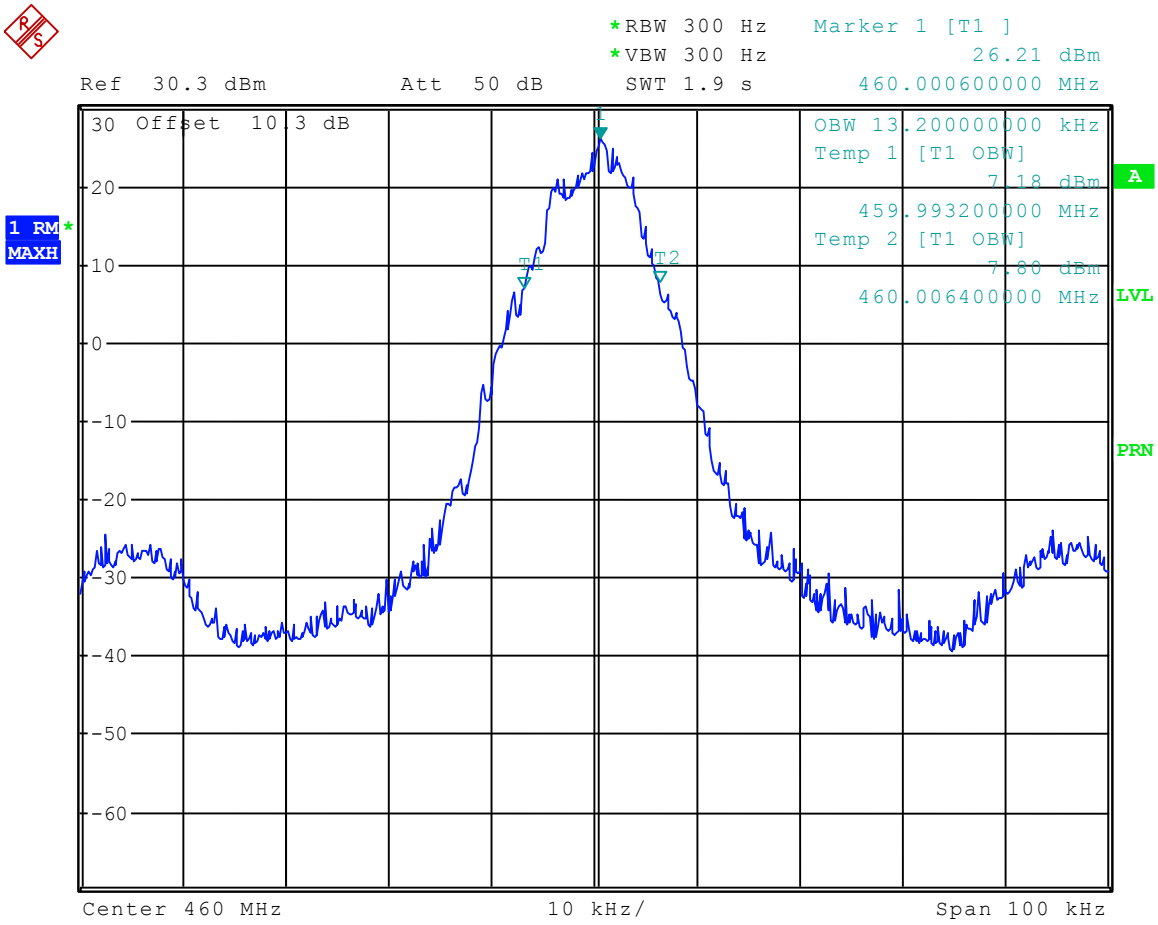
Frequency (MHz)	Modulation/data rate	Measured Occupied Bandwidth (kHz)	Emission Designator	Plot
460	FM-4/19200 *	13.2	13K2F1D	4.1
460	GMSK/9600 *	10.4	10K0F1D	4.2
460	FM-4/9600 **	6.3	6K30F1D	4.3
460	GMSK/4800 **	5.1	5K10F1D	4.4

* May be authorized at 20 kHz bandwidth

** May be authorized at 11.25 kHz bandwidth

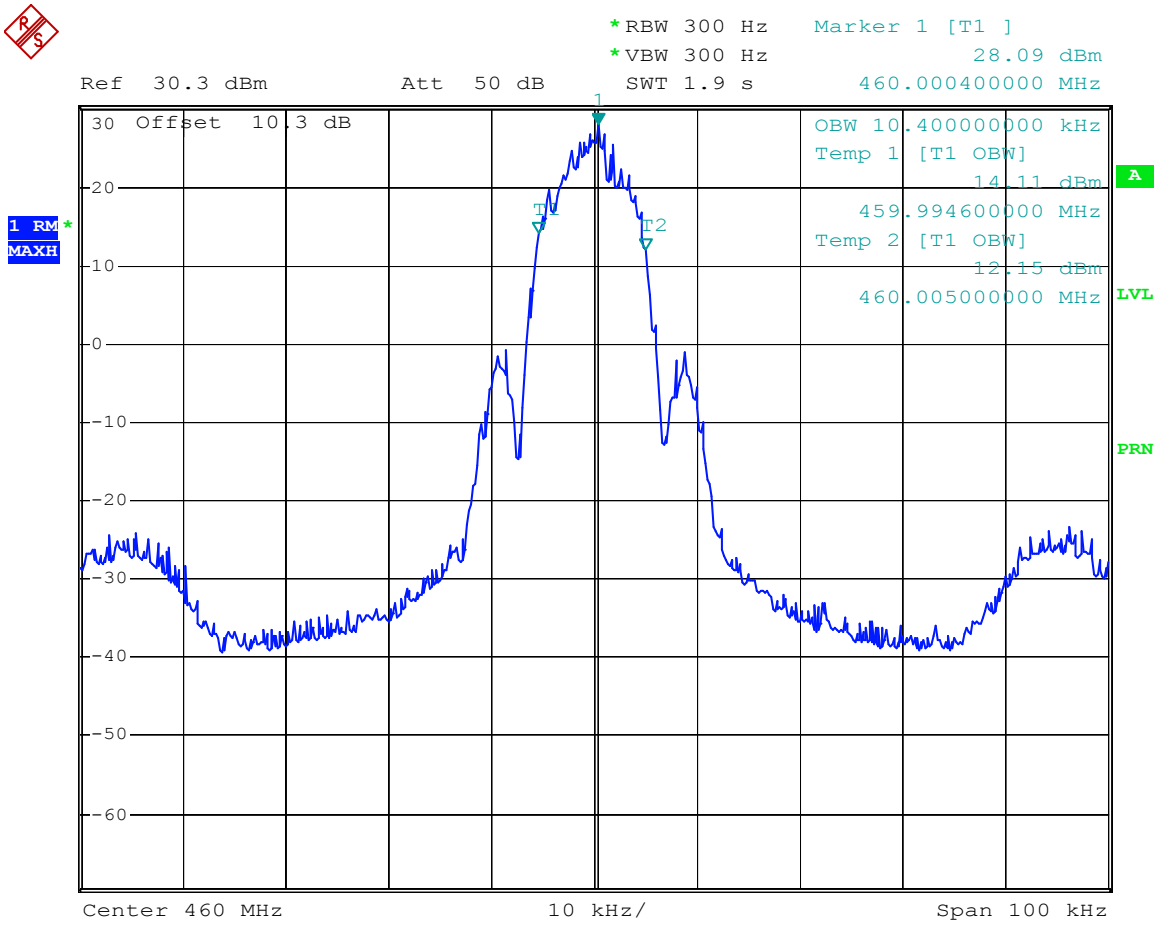
For more details refer to the attached plots.

Plot 4.1



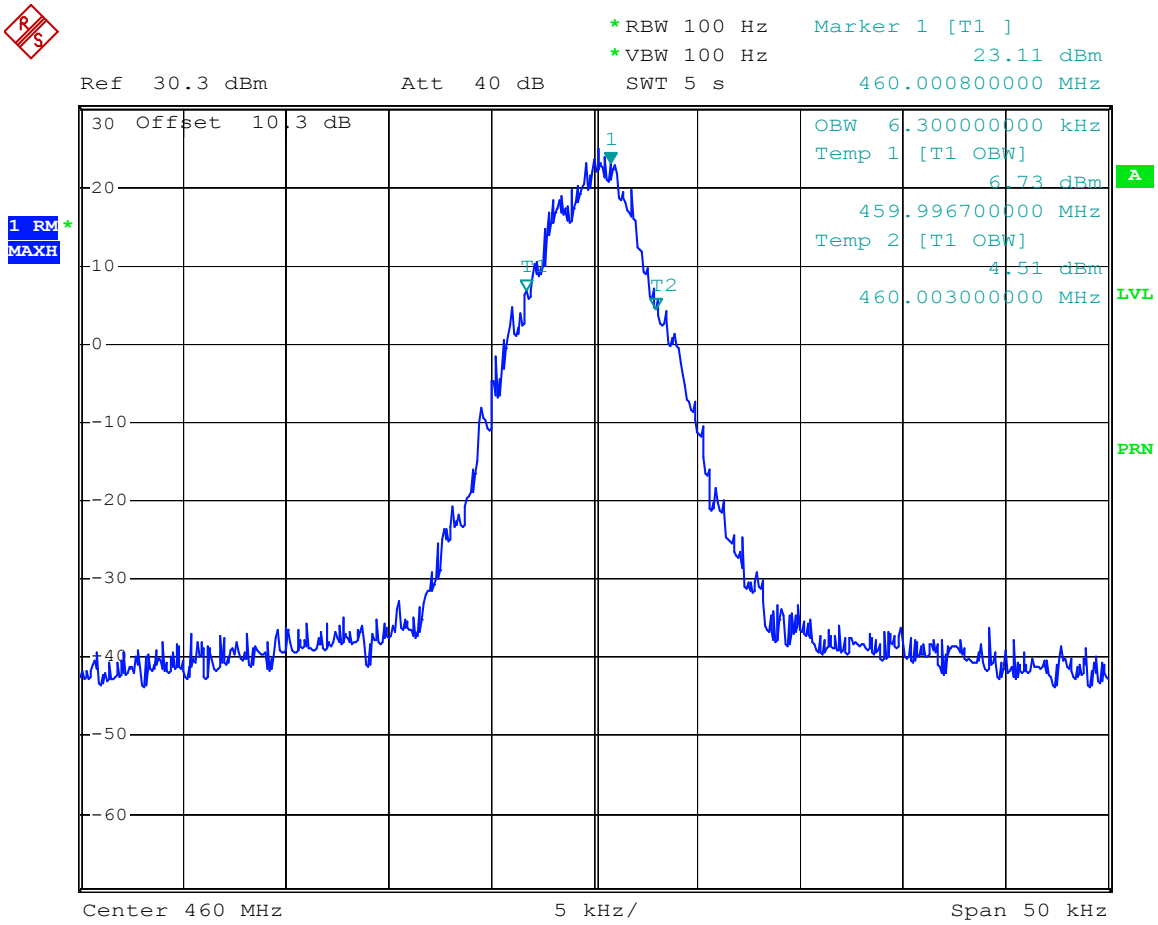
Comment: Occupied bandwidth, middle channel, mod FM-4, rate 19200, 20
Comment: kHz authorized bandwidth
Date: 7.APR.2005 14:30:46

Plot 4.2



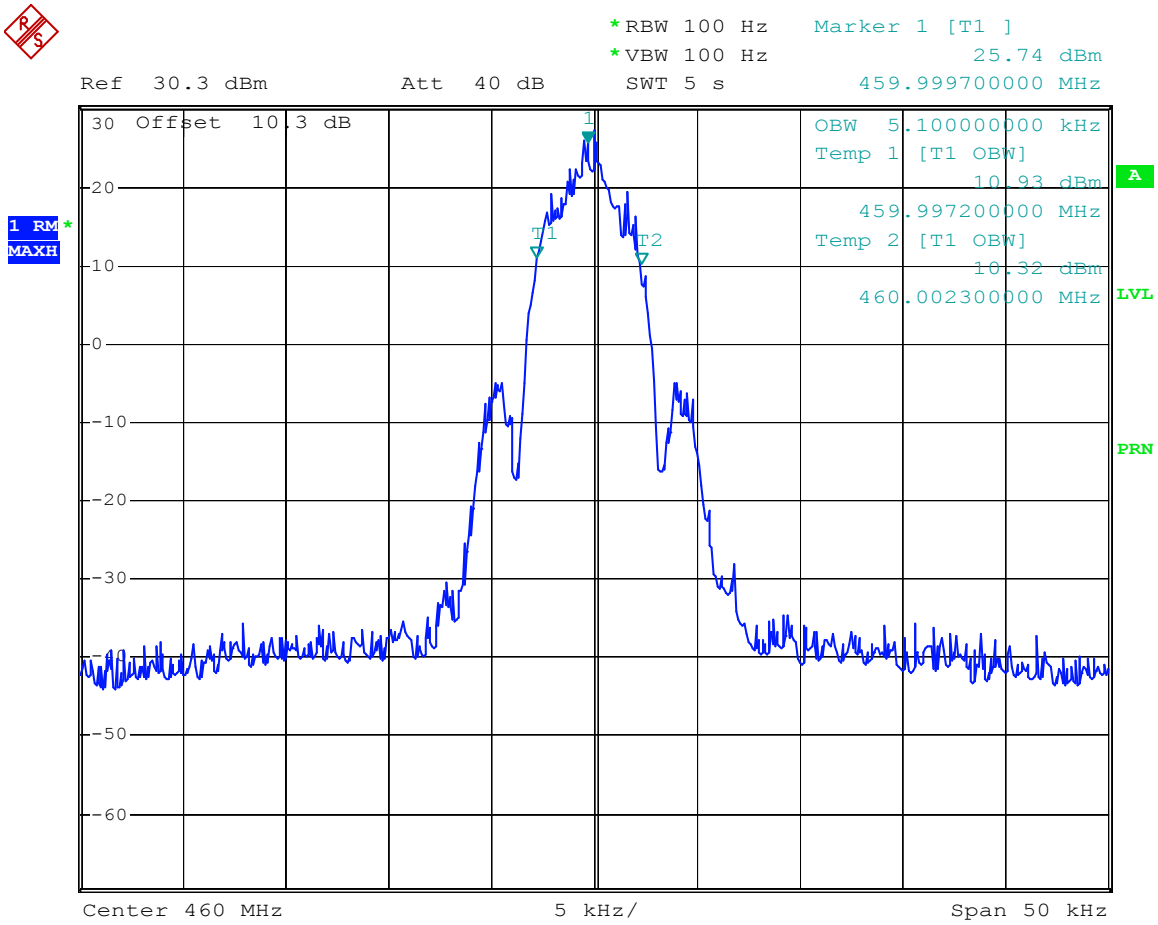
Comment: Occupied bandwidth, middle channel, mod GMSK, rate 9600, 20
Comment: kHz authorized bandwidth
Date: 7.APR.2005 14:28:03

Plot 4.3



Comment: Occupied bandwidth, middle channel, mod FM-4, rate 9600, 11.
Comment: 25 kHz authorized bandwidth
Date: 7.APR.2005 14:35:57

Plot 4.4



Comment: Occupied bandwidth, middle channel, mod GMSK, rate 4800, 11.
Comment: 25 kHz authorized bandwidth
Date: 7.APR.2005 14:38:30

5.0 Emission Mask

FCC 90.210

5.1 Requirement

Equipment designed to operate with a 25 kHz channel bandwidth must meet the requirements of Emission Mask C (for equipment without audio low pass filter).

Equipment designed to operate with a 12.5 kHz channel bandwidth must meet the requirements of Emission Mask D.

5.2 Test Procedure

The EUT RF output was connected as shown on the diagram in sec.1.3.2. The EUT was setup to transmit the maximum power.

The spectrum analyzed was setup to measure the Emission Mask at frequencies ± 50 kHz from the fundamental frequency. The Emission Mask was measured at middle channel for both types of modulation.

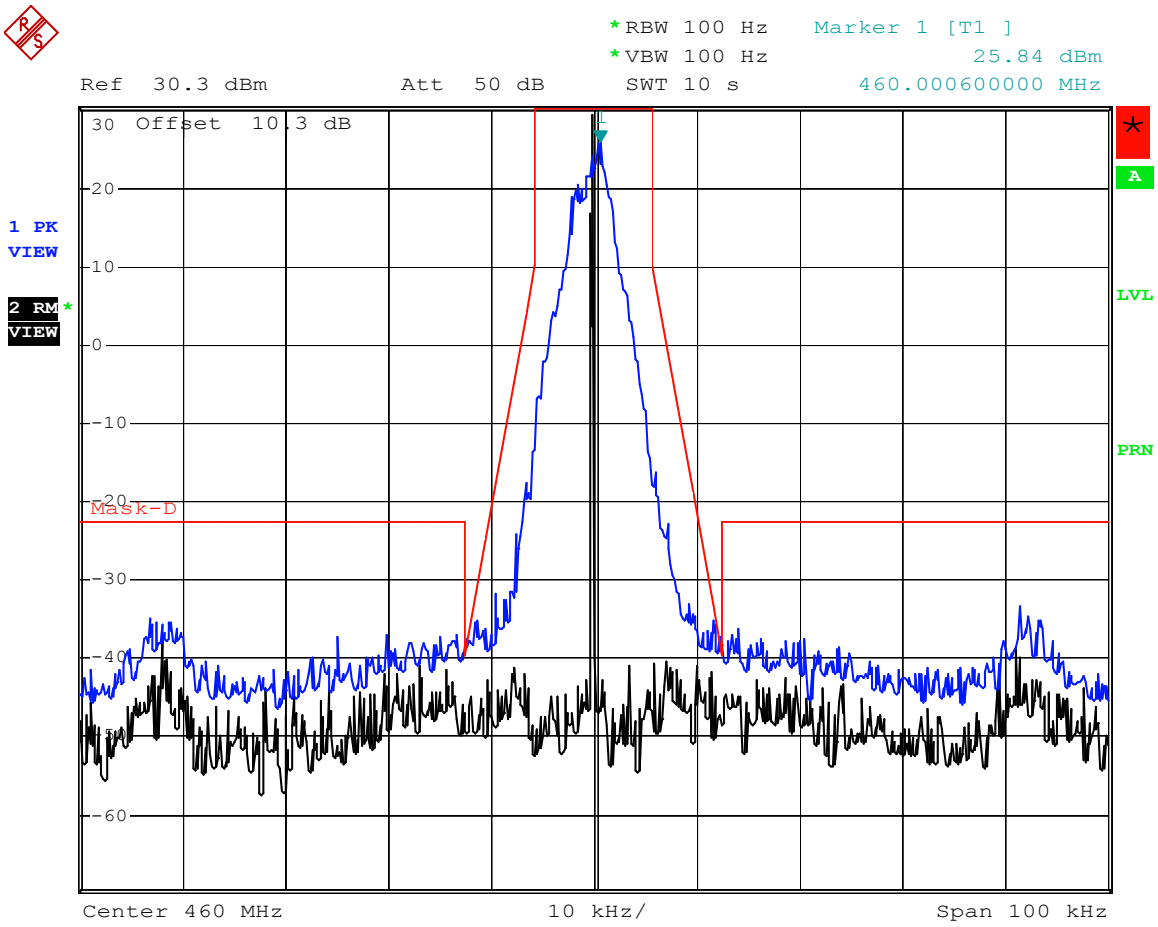
5.3 Test Equipment

Rohde & Schwarz FSP40 Spectrum Analyzer

5.4 Test Results

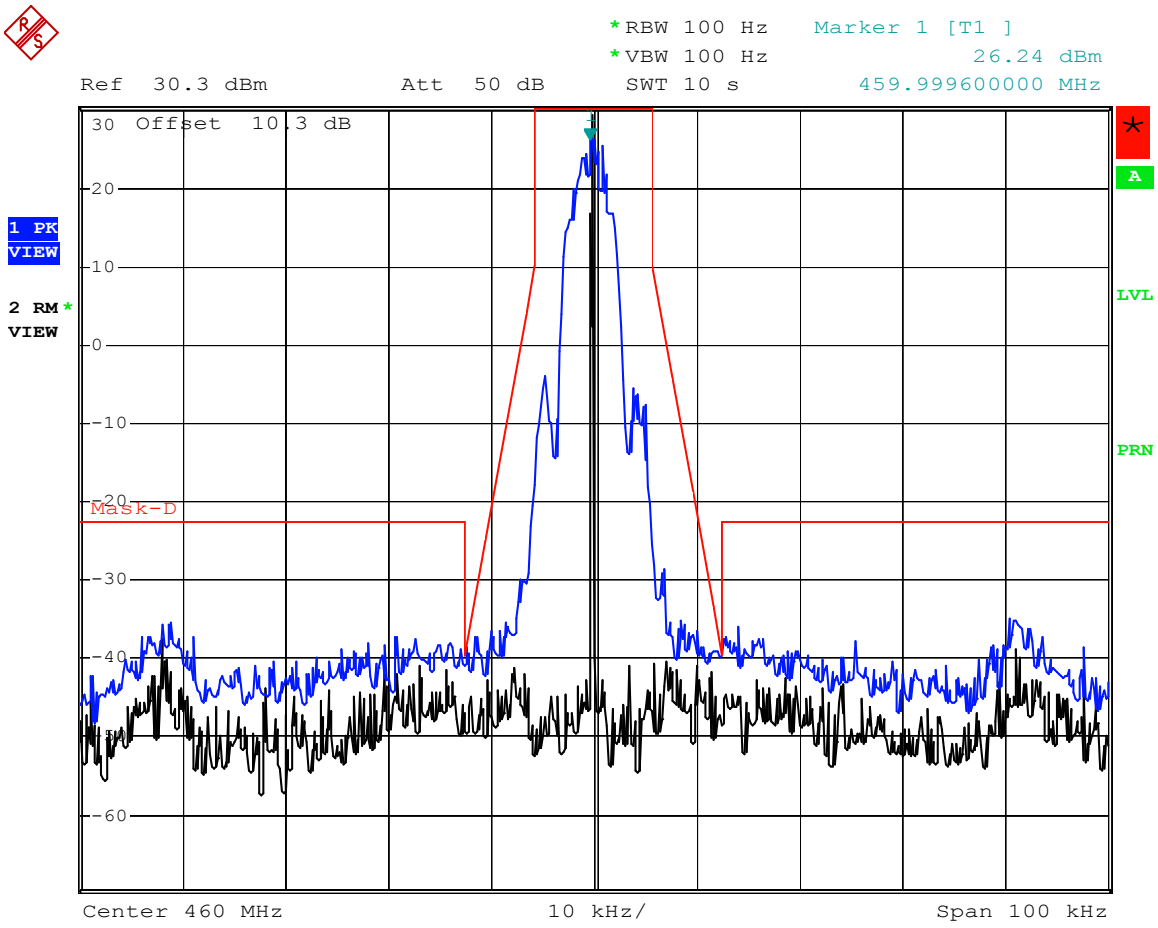
Complies with Emission Mask Requirements. For more details refer to the attached plots: 5.1 – 5.4.

Plot 5.1



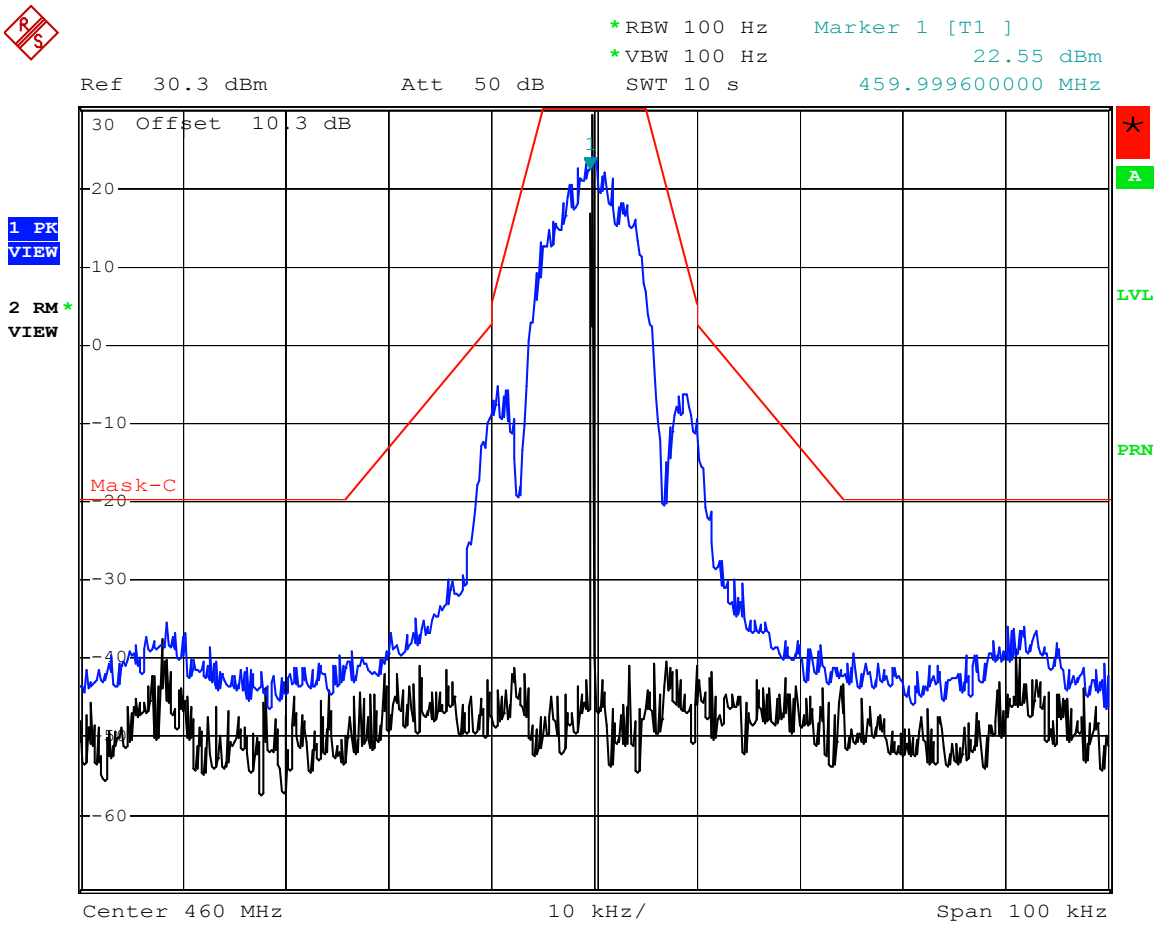
Comment: Emission mask, middle channel, mod FM-4, rate 9600, 11.25 kH
Comment: z authorized bandwidth
Date: 6.APR.2005 16:42:25

Plot 5.2



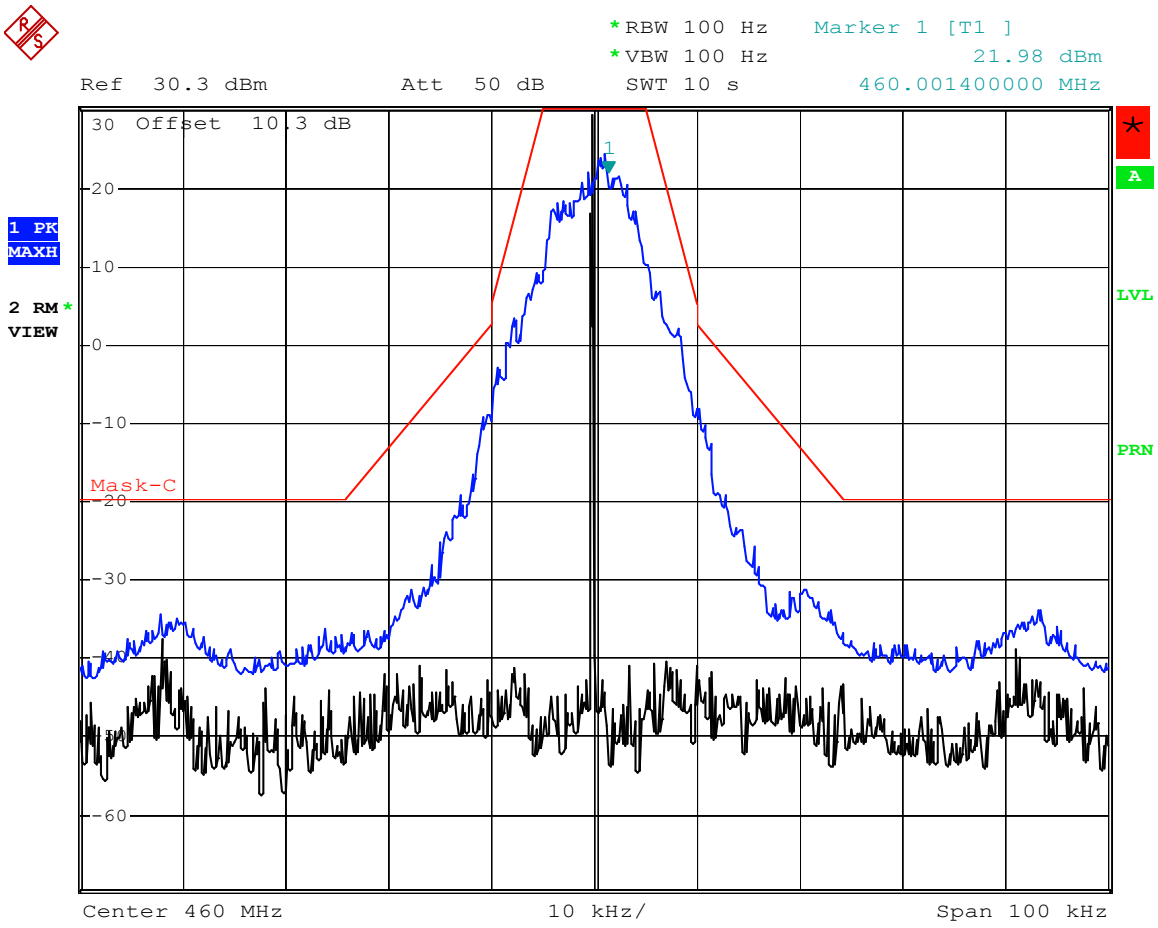
Comment: Emission mask, middle channel, mod GMSK, rate 4800, 11.25 kH
Comment: z authorized bandwidth
Date: 6.APR.2005 16:48:34

Plot 5.3



Comment: Emission mask, middle channel, mod GMSK, rate 9600, 20 kHz a
Comment: uthorized bandwidth
Date: 6.APR.2005 16:56:15

Plot 5.4



Comment: Emission mask, middle channel, mod FN-4, rate 19200, 20 kHz
Comment: authorized bandwidth
Date: 6.APR.2005 17:12:37

6.0 Out of Band Emissions at Antenna Terminals

FCC 2.1051, 90.210

6.1 Requirement

Emission Mask C

The power of any emissions must be attenuated below the unmodulated carrier output power (P) on any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: at least (43 + 10 log P) dB.

Note: That corresponds to the level of -13 dBm for any out-of-band and spurious emissions.

Emission Mask D

The power of any emissions must be attenuated below the unmodulated carrier output power (P) on any frequency removed from the center of the authorized bandwidth by more than 12.5 kHz:
at least (50 + 10 log P) dB or 70 dB, whichever is lesser attenuation.

Note: Attenuation of (50 + 10 log P) dB corresponds to the level of -20 dBm for any out-of-band and spurious emissions.

6.2 Test Procedure

The EUT RF output was connected as shown on the diagram in sec.1.3.2. The EUT was setup to transmit the maximum power.

For measurements at frequencies below 1 GHz, the spectrum analyzed resolution bandwidth was set to 10 kHz. For measurements at frequencies above 1 GHz, the spectrum analyzed resolution bandwidth was set to 1 MHz

Measurements were performed at three frequencies (low, middle, and high channels).

Sufficient scans were taken to show the out-of-band emissions up to 10th harmonic.

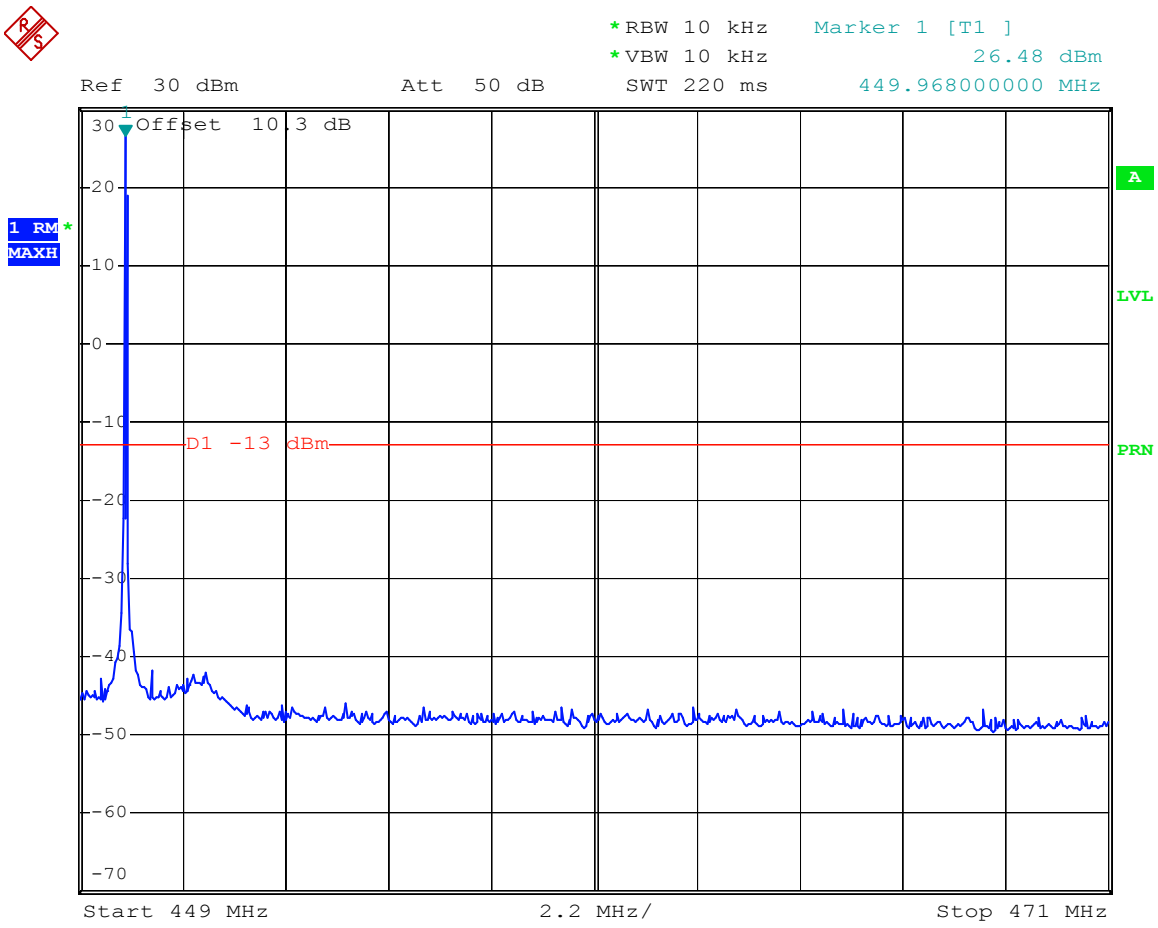
6.3 Test Equipment

Rohde & Schwarz FSP40 Spectrum Analyzer

6.4 Test Results

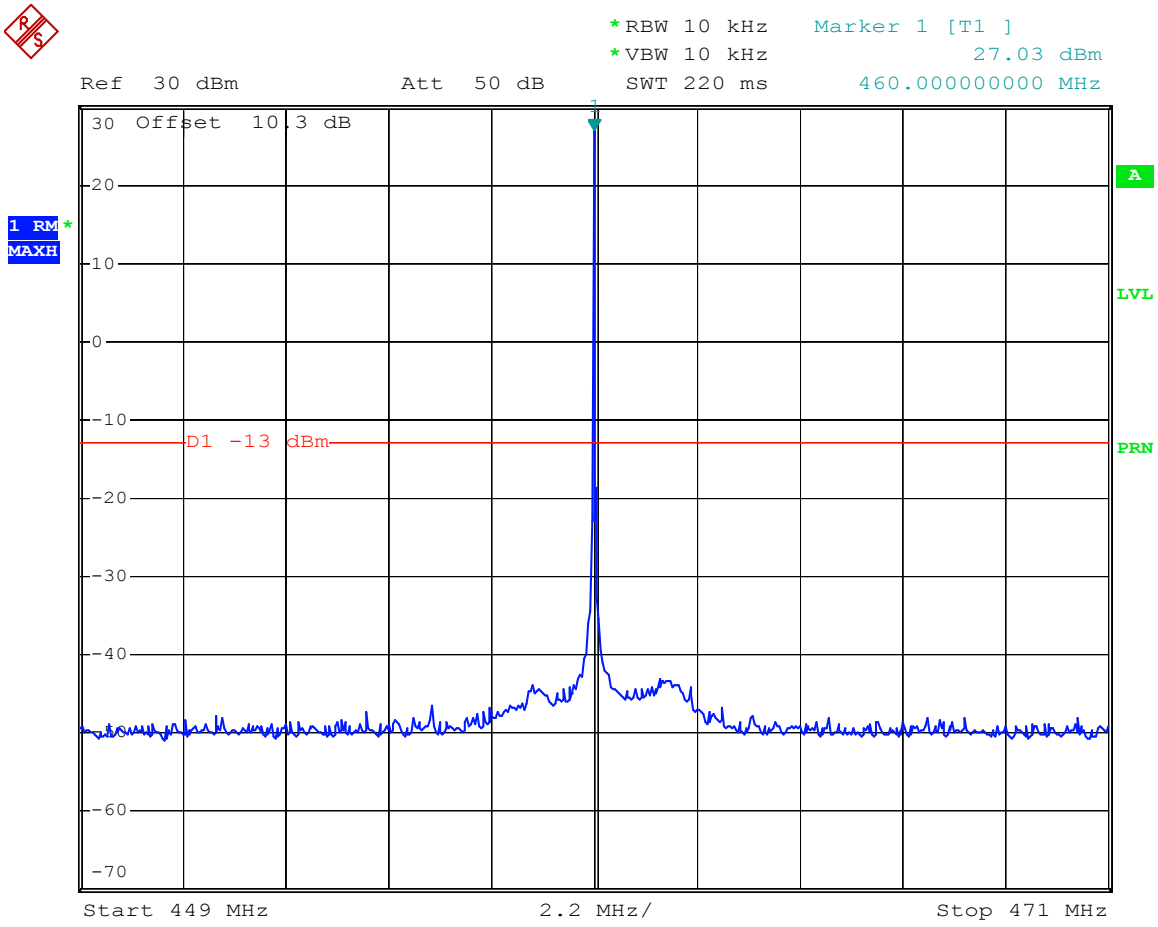
Complies	Refer to the following plots

Plot 6.1



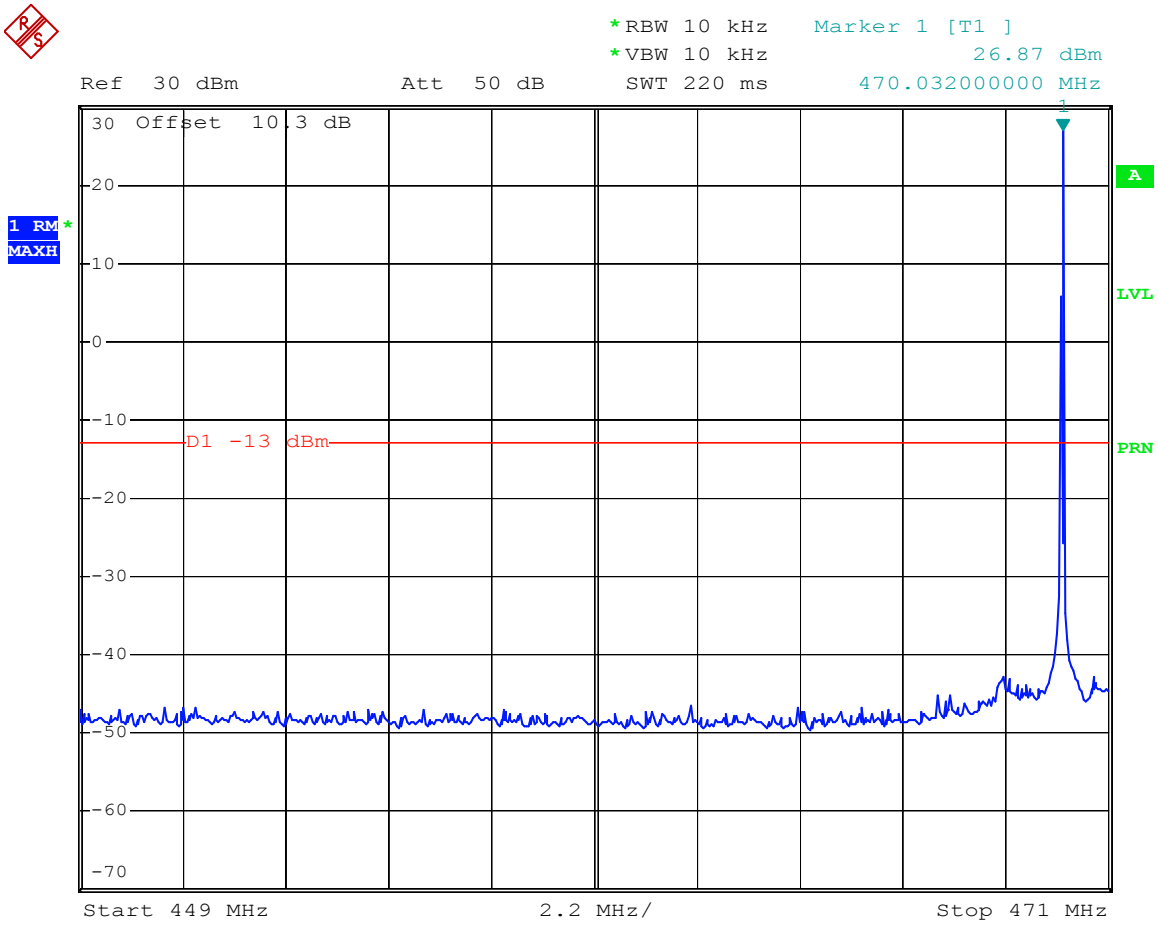
Comment: Out-of-band emissions, low channel, mod GMSK, rate 4800
Date: 7.APR.2005 16:05:17

Plot 6.2



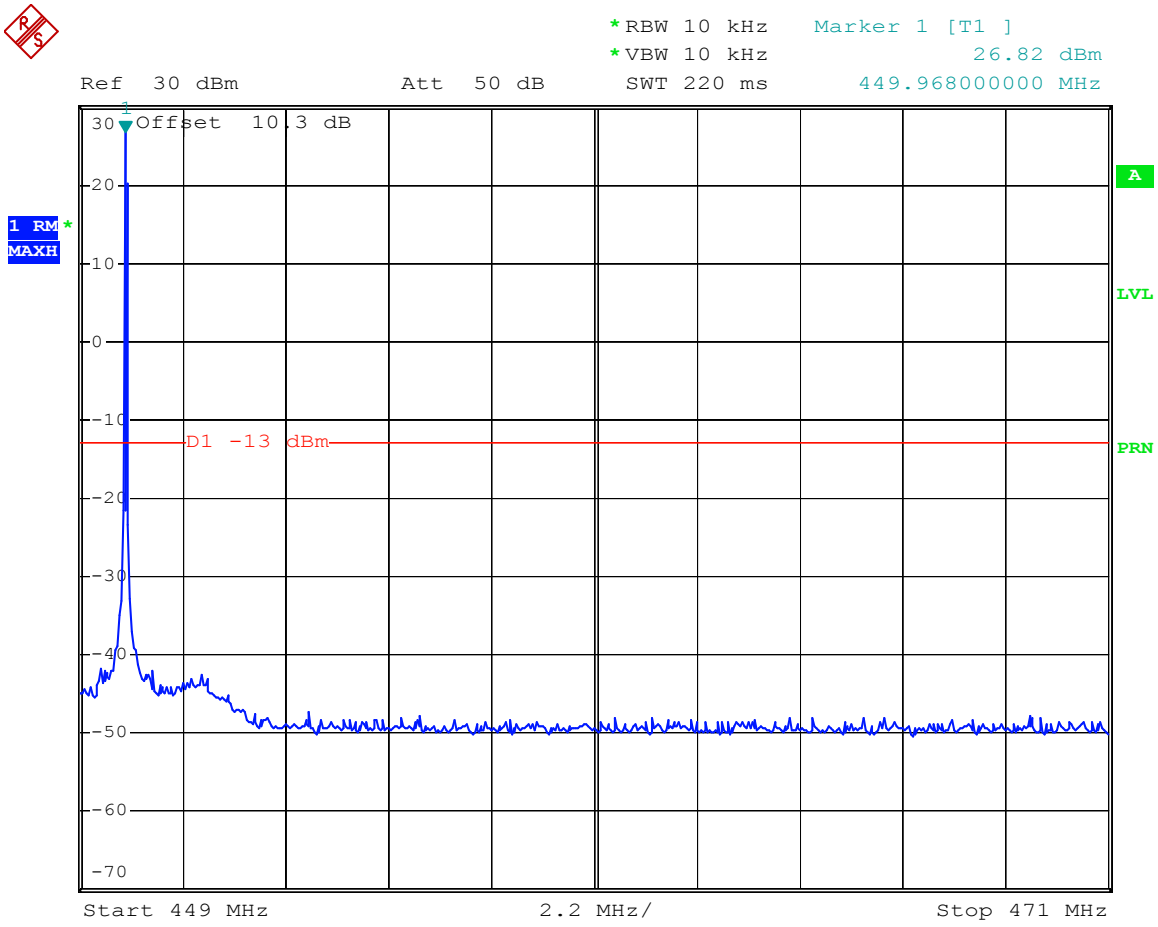
Comment: Out-of-band emissions, middle channel, mod GMSK, rate 4800
Date: 7.APR.2005 16:13:52

Plot 6.3



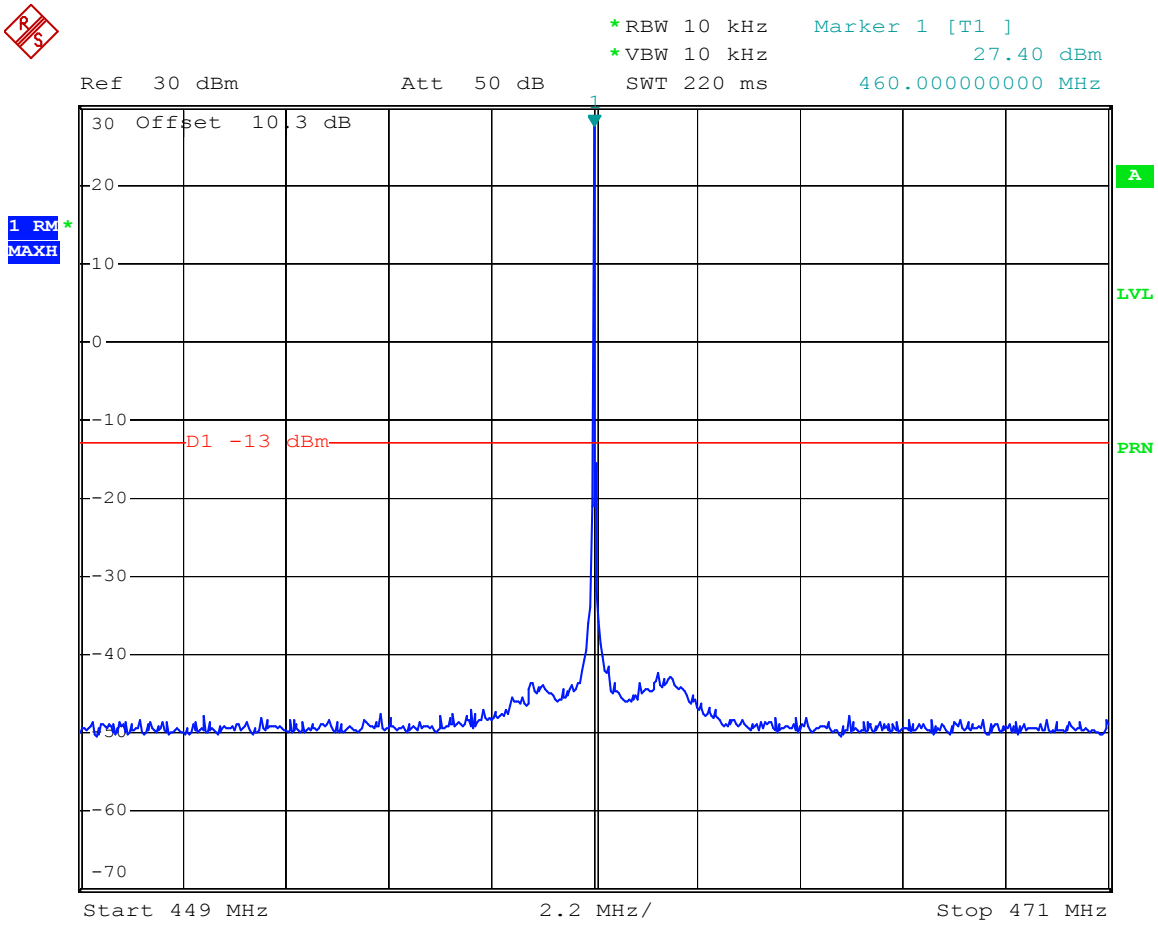
Comment: Out-of-band emissions, high channel, mod GMSK, rate 4800
Date: 7.APR.2005 16:06:55

Plot 6.4



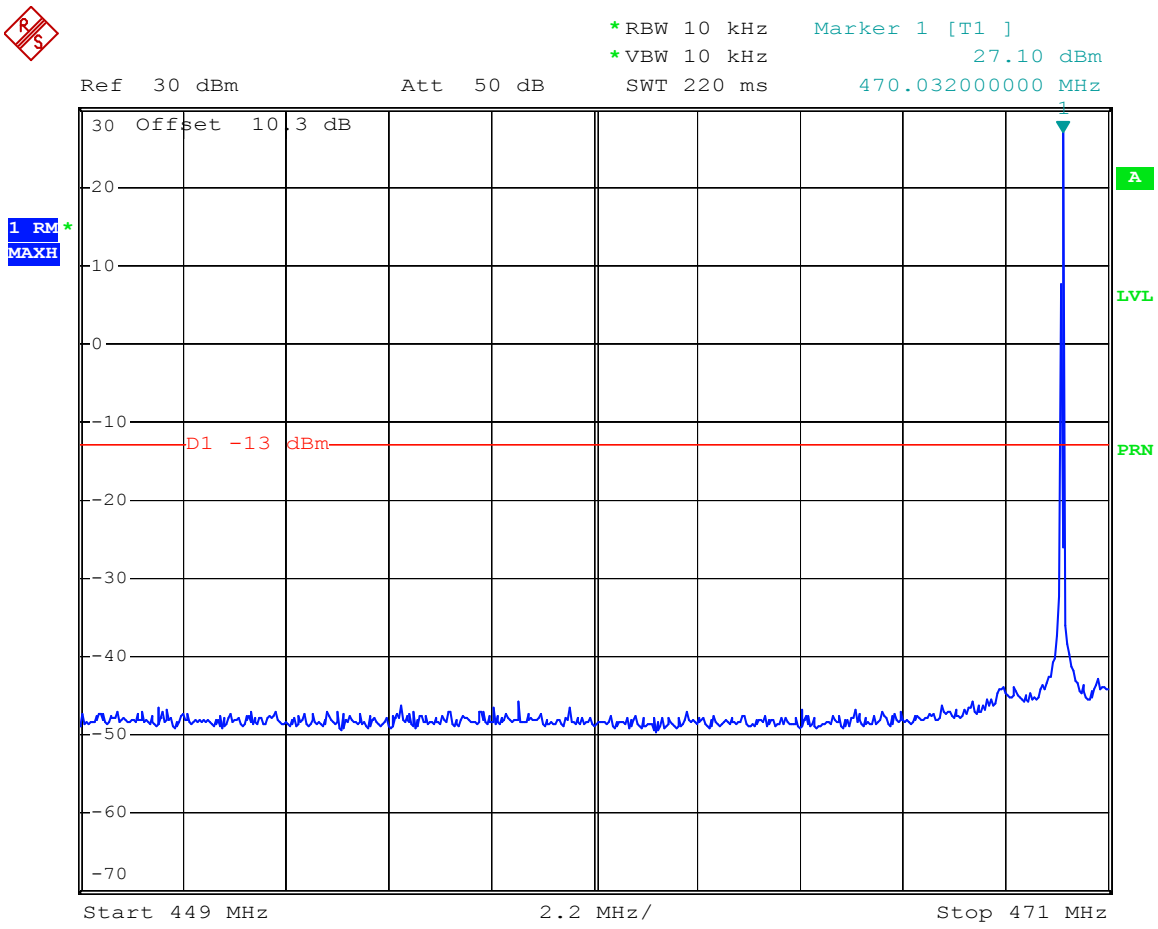
Comment: Out-of-band emissions, low channel, mod FM-4, rate 9600
Date: 8.APR.2005 09:48:45

Plot 6.5



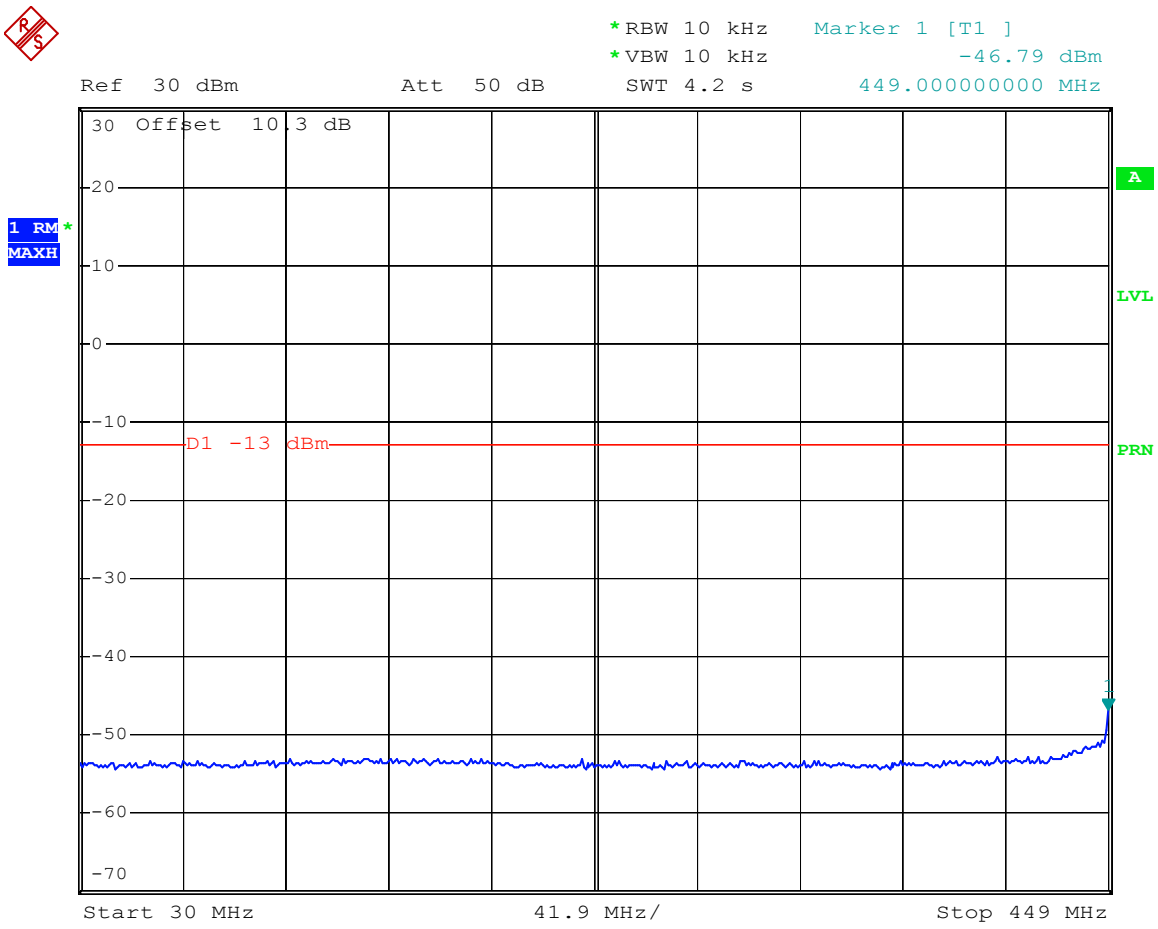
Comment: Out-of-band emissions, middle channel, mod FM-4, rate 9600
Date: 7.APR.2005 16:11:26

Plot 6.6



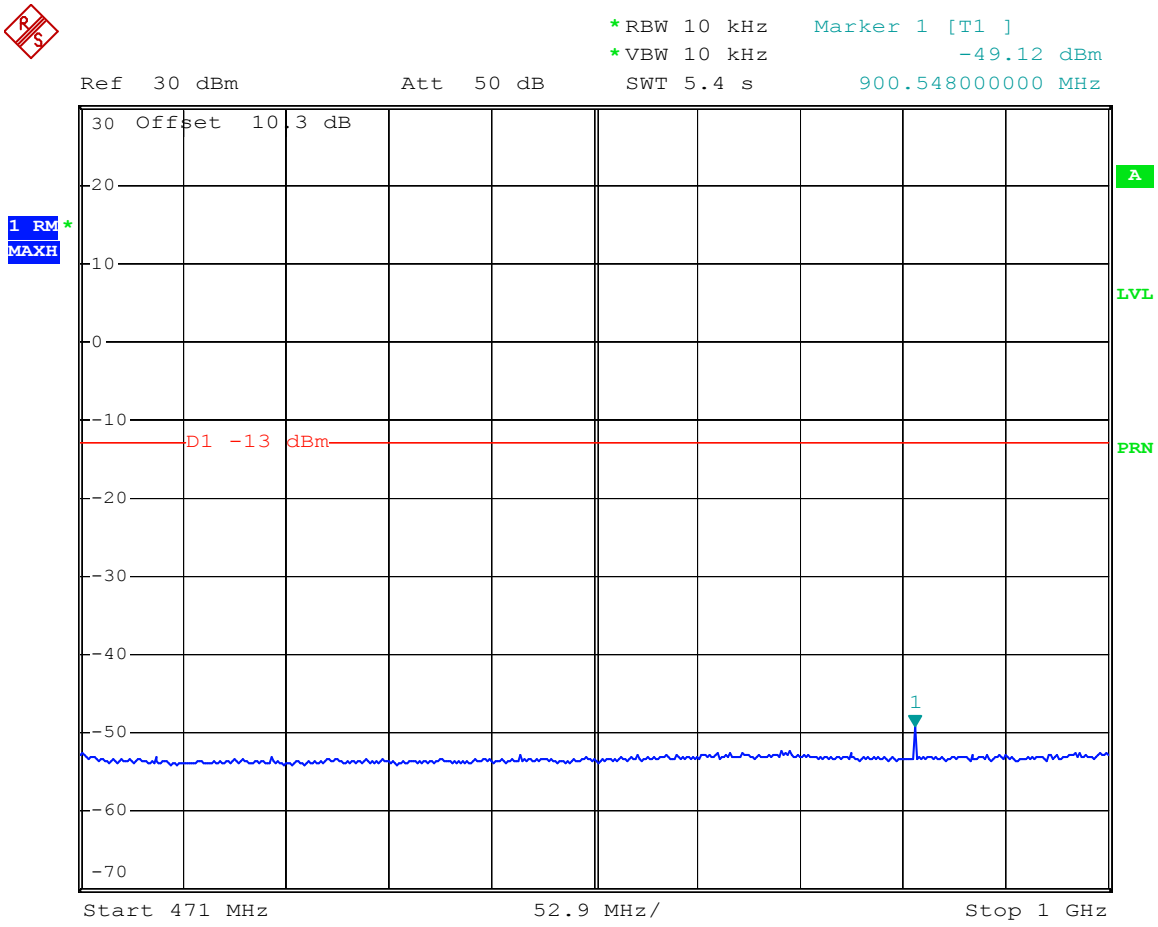
Comment: Out-of-band emissions, high channel, mod FM-4, rate 9600
Date: 7.APR.2005 16:08:37

Plot 6.7



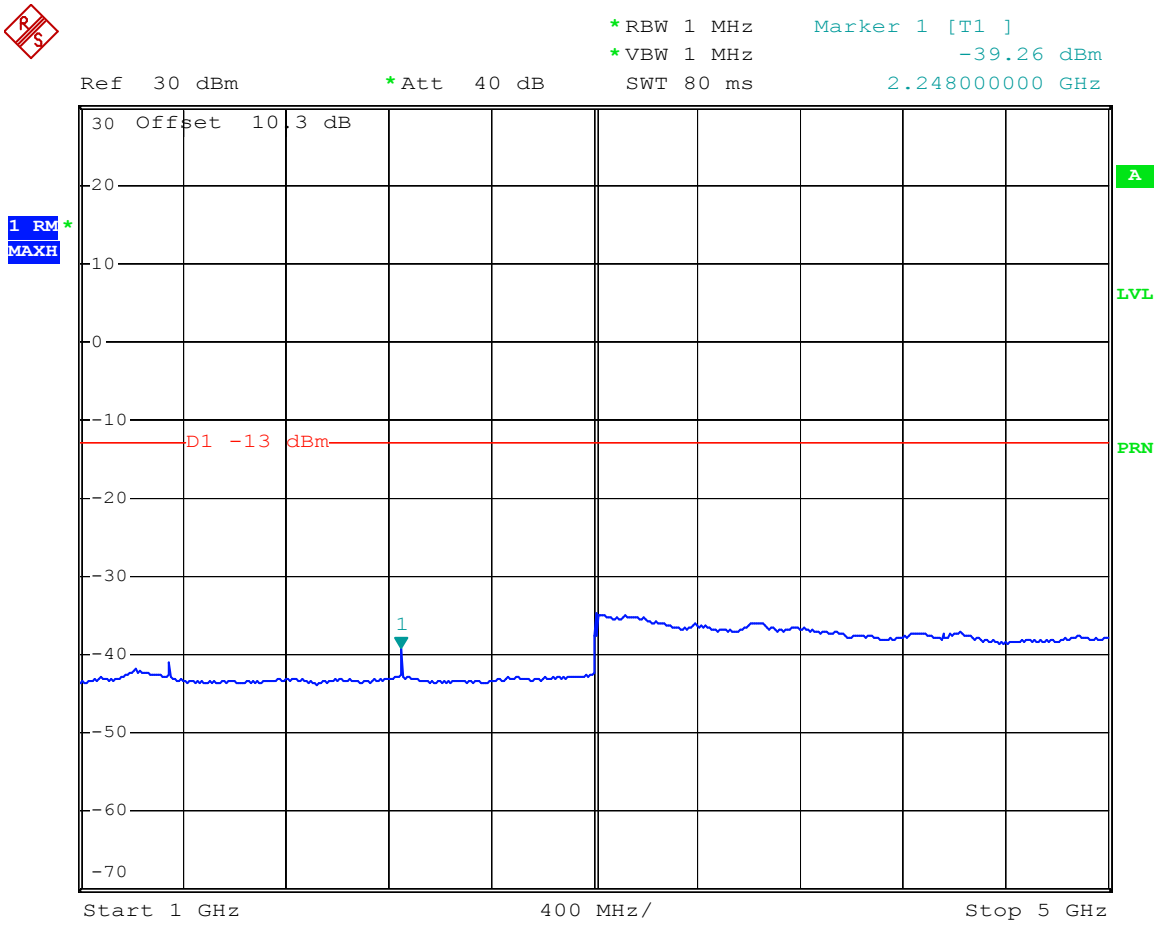
Comment: Out-of-band emissions, low channel, mod FM-4, rate 9600
Date: 7.APR.2005 16:17:39

Plot 6.8



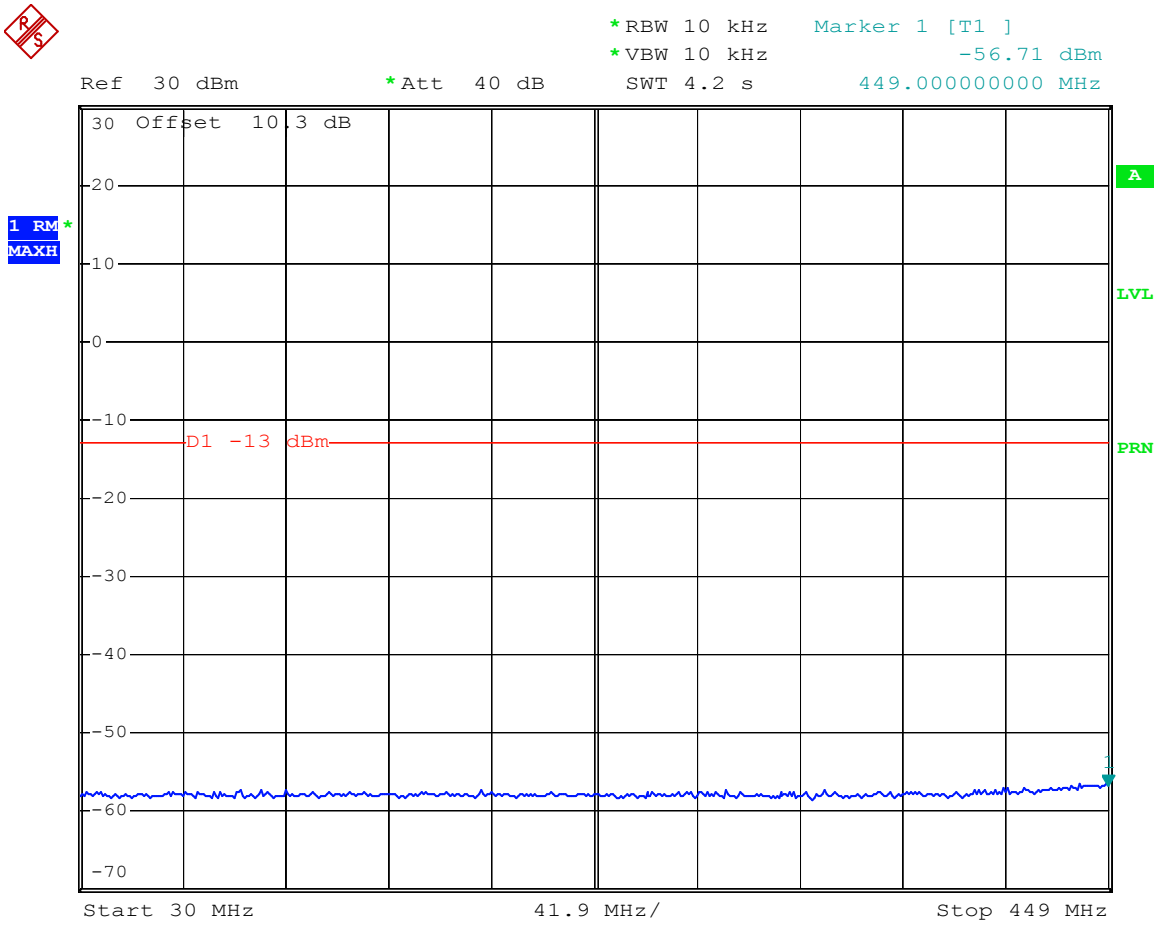
Comment: Out-of-band emissions, low channel, mod FM-4, rate 9600
Date: 7.APR.2005 16:19:50

Plot 6.9



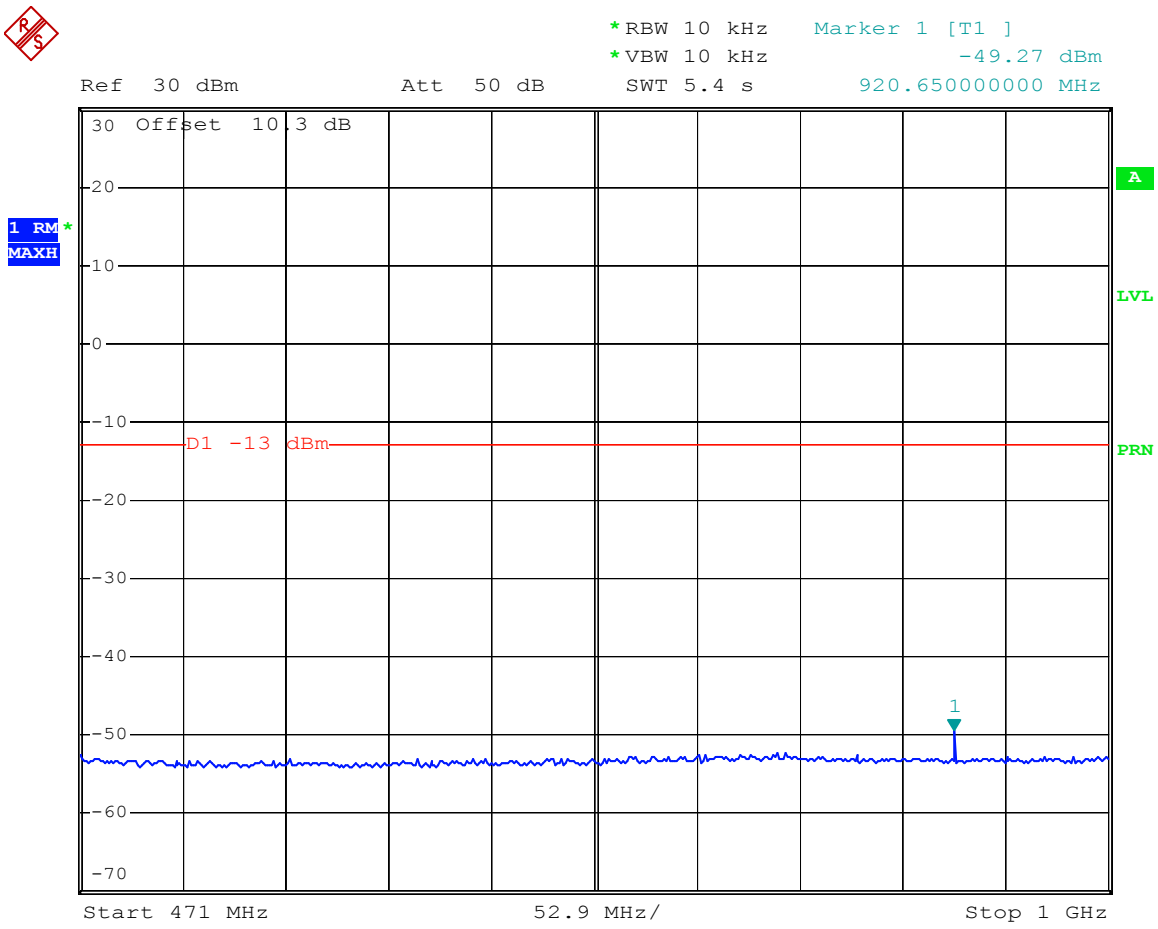
Comment: Out-of-band emissions, low channel, mod FM-4, rate 9600
Date: 7.APR.2005 16:21:50

Plot 6.10



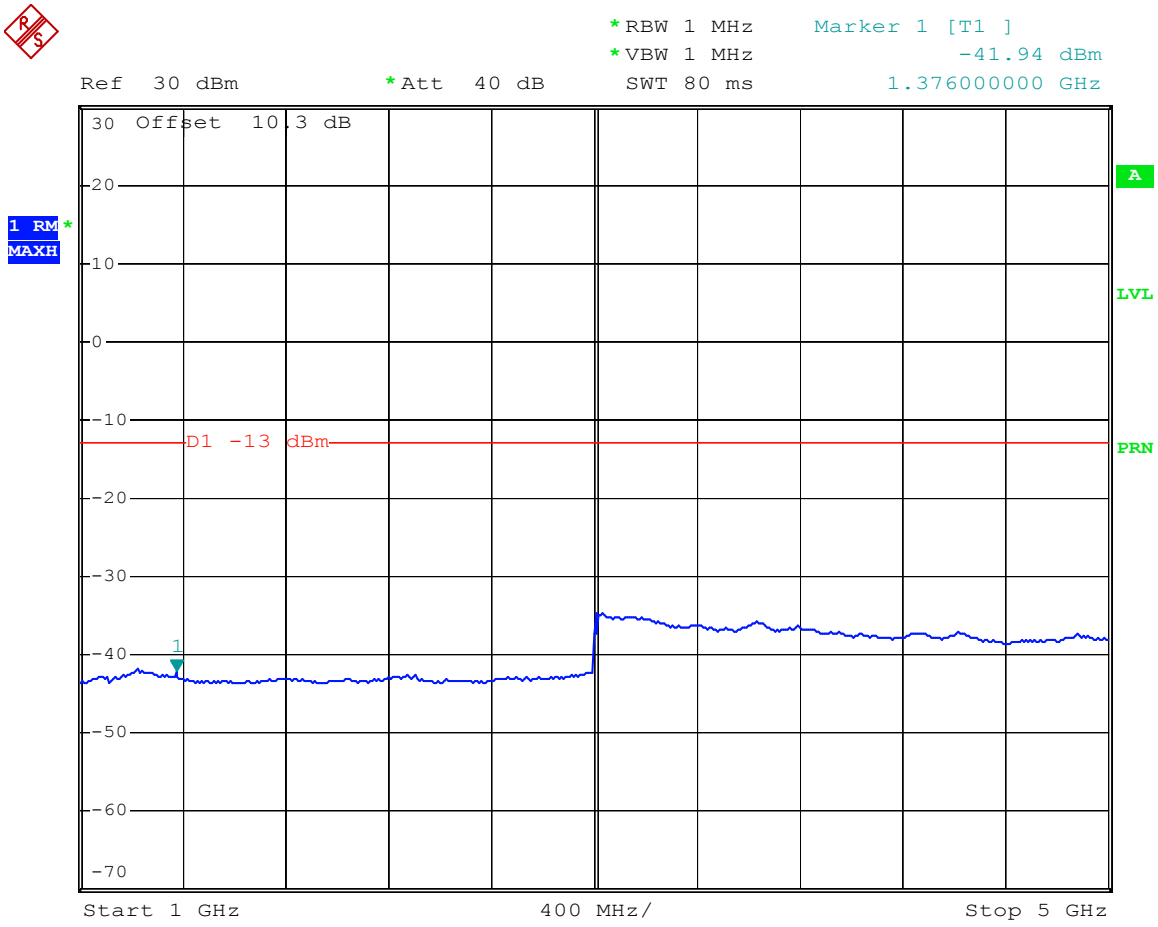
Comment: Out-of-band emissions, middle channel, mod FM-4, rate 9600
Date: 7.APR.2005 16:25:32

Plot 6.11



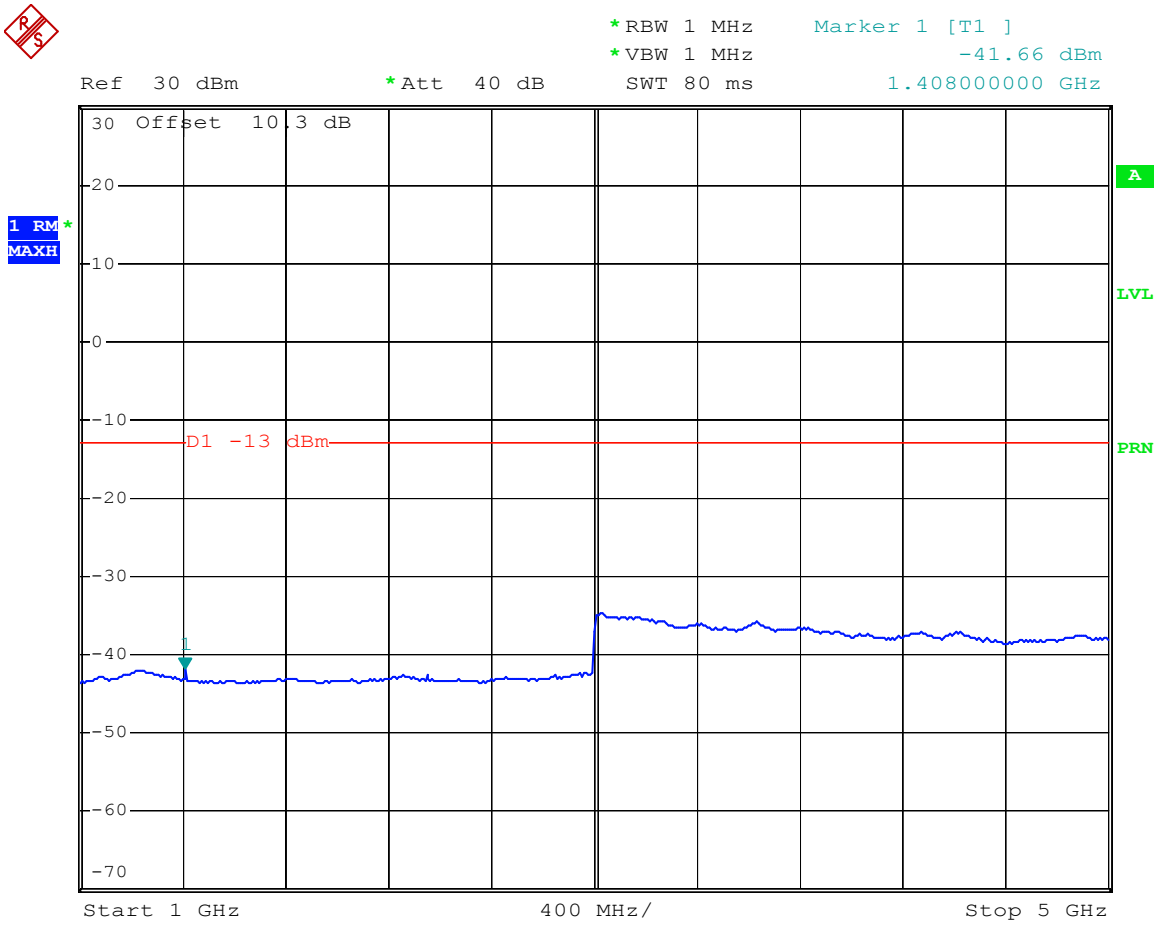
Comment: Out-of-band emissions, middle channel, mod FM-4, rate 9600
Date: 7.APR.2005 16:27:23

Plot 6.12



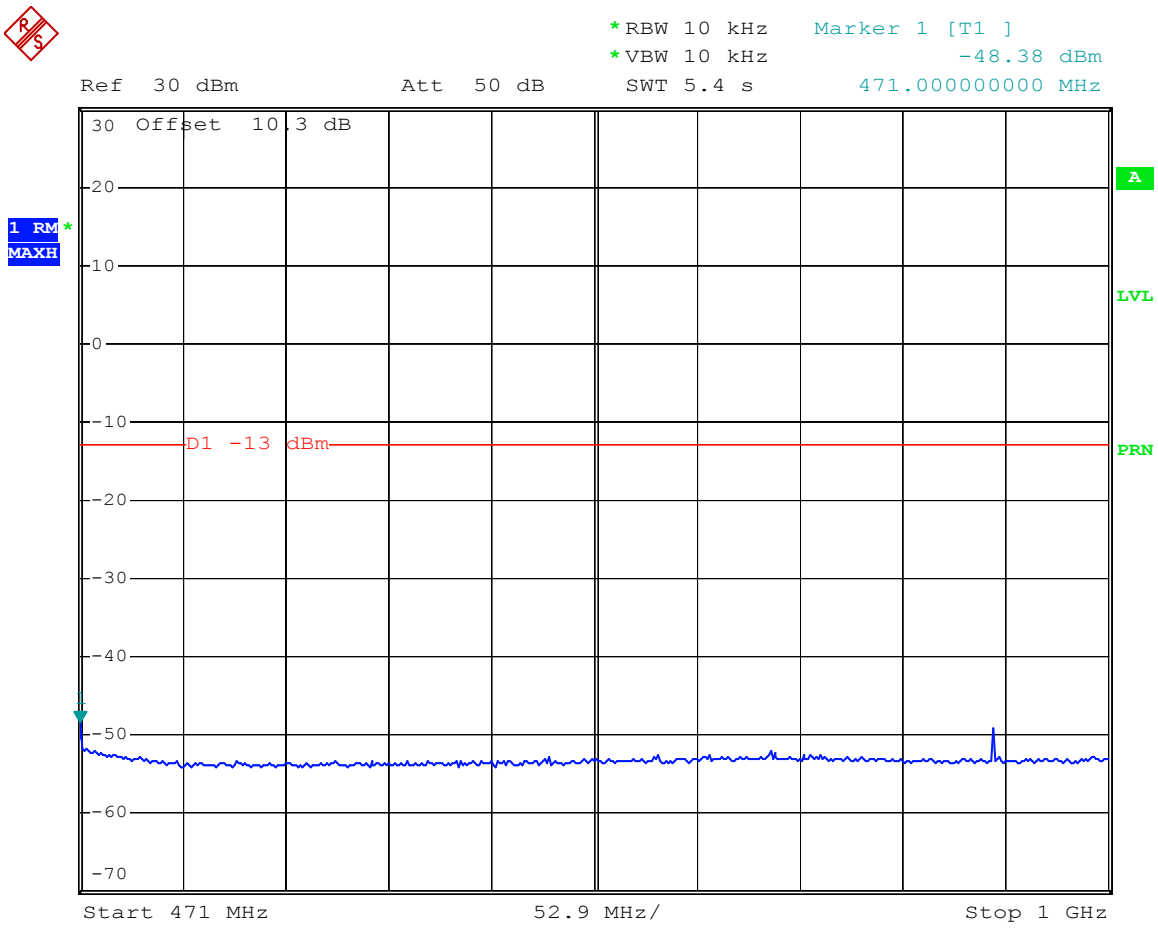
Comment: Out-of-band emissions, middle channel, mod FM-4, rate 9600
Date: 7.APR.2005 16:29:31

Plot 6.13



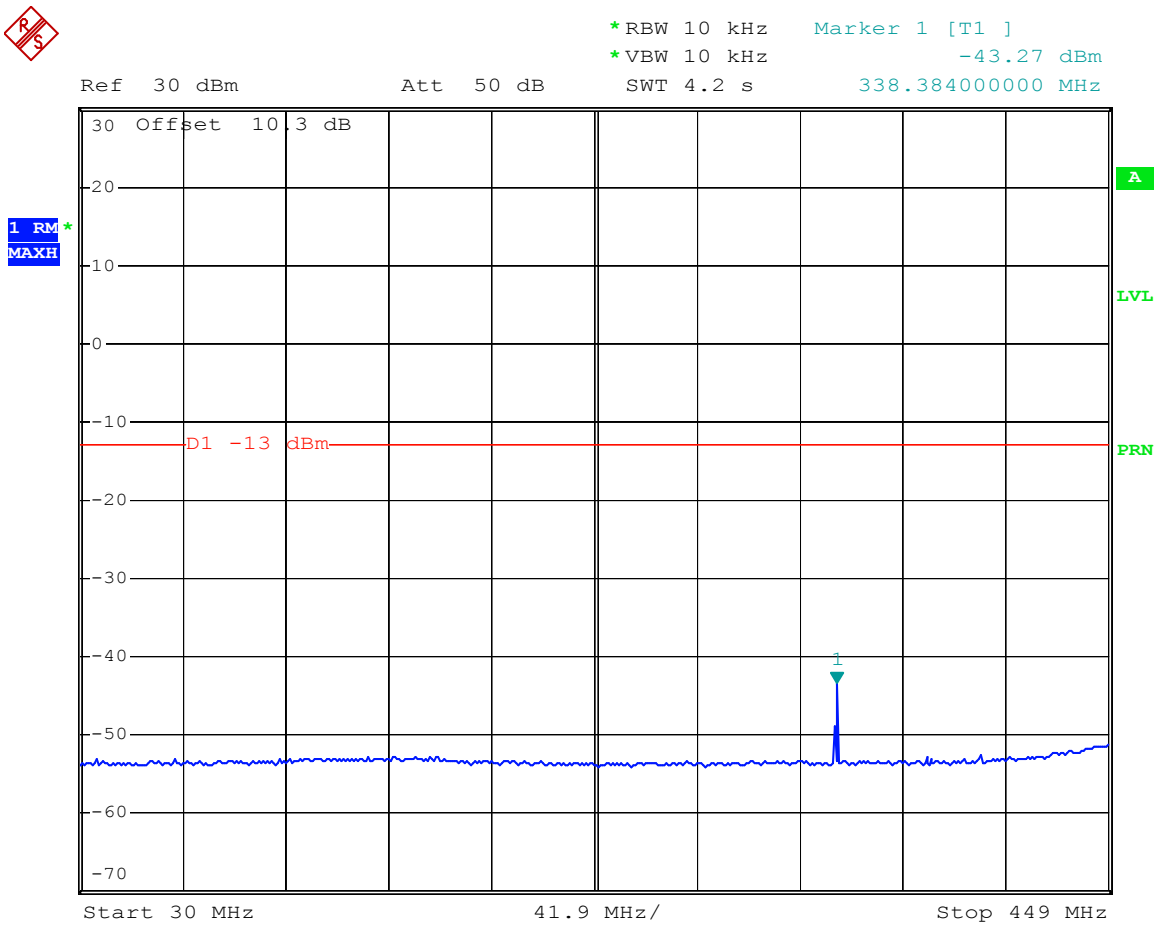
Comment: Out-of-band emissions, high channel, mod FM-4, rate 9600
Date: 7.APR.2005 16:31:41

Plot 6.14



Comment: Out-of-band emissions, high channel, mod FM-4, rate 9600
Date: 7.APR.2005 16:33:58

Plot 6.15



Comment: Out-of-band emissions, high channel, mod FM-4, rate 9600
Date: 7.APR.2005 16:39:19

7.0 Spurious Radiation

FCC 2.1053, 90.210

7.1 Requirement

The mean power of emissions must be attenuated below the mean power of the unmodulated carrier (P) on any frequency outside the frequency band by at least (50 + 10 log P) dB.

Note: That corresponds to the level of -20 dBm for any out-of-band and spurious emissions.

7.2 Test Procedure

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT.

The frequency range up to 10th harmonic of each of the three fundamental frequency (low, middle, and high channels) was investigated. The worst case of emissions was reported.

For spurious emissions attenuation, the substitution method was used. The EUT was substituted by a reference antenna (half-wave dipole - below 1 GHz, or Horn antenna - above 1GHz), connected to a signal generator. The signal generator output level ($\mathbf{V_g}$ in dBm) was adjusted to obtain the same reading as from EUT. The ERP at the spurious emissions frequency was calculated as follows.

$$ERP_{(dBm)} = \mathbf{V_g} + \mathbf{G}_{(dBd)}$$

The spurious emissions attenuation is the difference between ERP at the fundamental frequency (see section 3) and at the spurious emissions frequency.

7.3 Test Equipment

Roberts Antenna
EMCO 3115 Horn Antennas
Rohde & Schwarz FSP40 Spectrum Analyzer
Low Pass Filter
Preamplifiers

7.4 Test Results

Spurious Radiated Emissions

Frequency	SA Reading (from EUT)	Signal Generator Output required to have the same SA Reading as from EUT	ERP*	ERP Limit	ERP Margin
MHz	**dB(µV)**	**V_g dBm**	**dBm**	**dBm**	**dB**
Tx 450 MHz					
900.0	61.2	-30.6	-30.6	-20	-10.6
1350.0	45.9	-54.9	-50.9	-20	-30.9
2250.0	44.0	-53.0	-46.7	-20	-26.7
Tx 460 MHz					
920.0	61.2	-30.8	-30.8	-20	-10.8
1380.0	44.4	-56.6	-51.9	-20	-31.9
1840.0	43.7	-54.6	-49.0	-20	-29.0
2300.0	41.7	-54.7	-48.7	-20	-28.7
3680.0	40.0	-52.0	-44.5	-20	-24.5
Tx 470 MHz					
940.0	63.4	-28.8	-28.8	-20	-8.8
1410.0	47.0	-54.5	-49.7	-20	-29.7
1880.0	41.5	-56.2	-50.7	-20	-30.7
2820.0	41.0	-53.0	-45.8	-20	-25.8

* ERP is calculated as: $ERP_{(dBm)} = V_{g(dBm)} + G_{(dBd)}$

All other emissions not reported are more than 20 dB below the limit.

Result	Complies by 8.8 dB

8.0 Transient Frequency behavior

FCC 90.214

8.1 Requirement

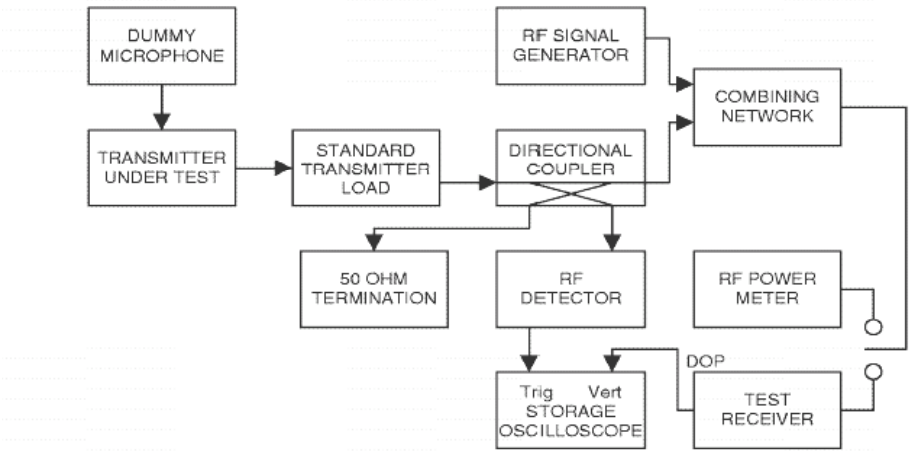
Time interval	Maximum frequency difference	Time
Transient Frequency Behavior for equipment designed to operate on 25 kHz channels		
t1 *	±25 kHz	10 ms
t2	±12.5 kHz	25 ms
t3 *	±25 kHz	10 ms
Transient Frequency Behavior for equipment designed to operate on 12.5 kHz channels		
t1 *	±12.5 kHz	10 ms
t2	±6.25 kHz	25 ms
t3 *	±12.5 kHz	10 ms

ton is the instant when a 1 kHz test signal is completely suppressed
t1 is time period immediately following **t**on
t2 is time period immediately following **t**1
t3 is time period from the instant when the transmitter is turned off until **t**off
toff is the instant when the 1 kHz test signal start to rise

* If the transmitter carrier output power rating is 6 Watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

8.2 Procedure

Test was performed according to the block diagram below.



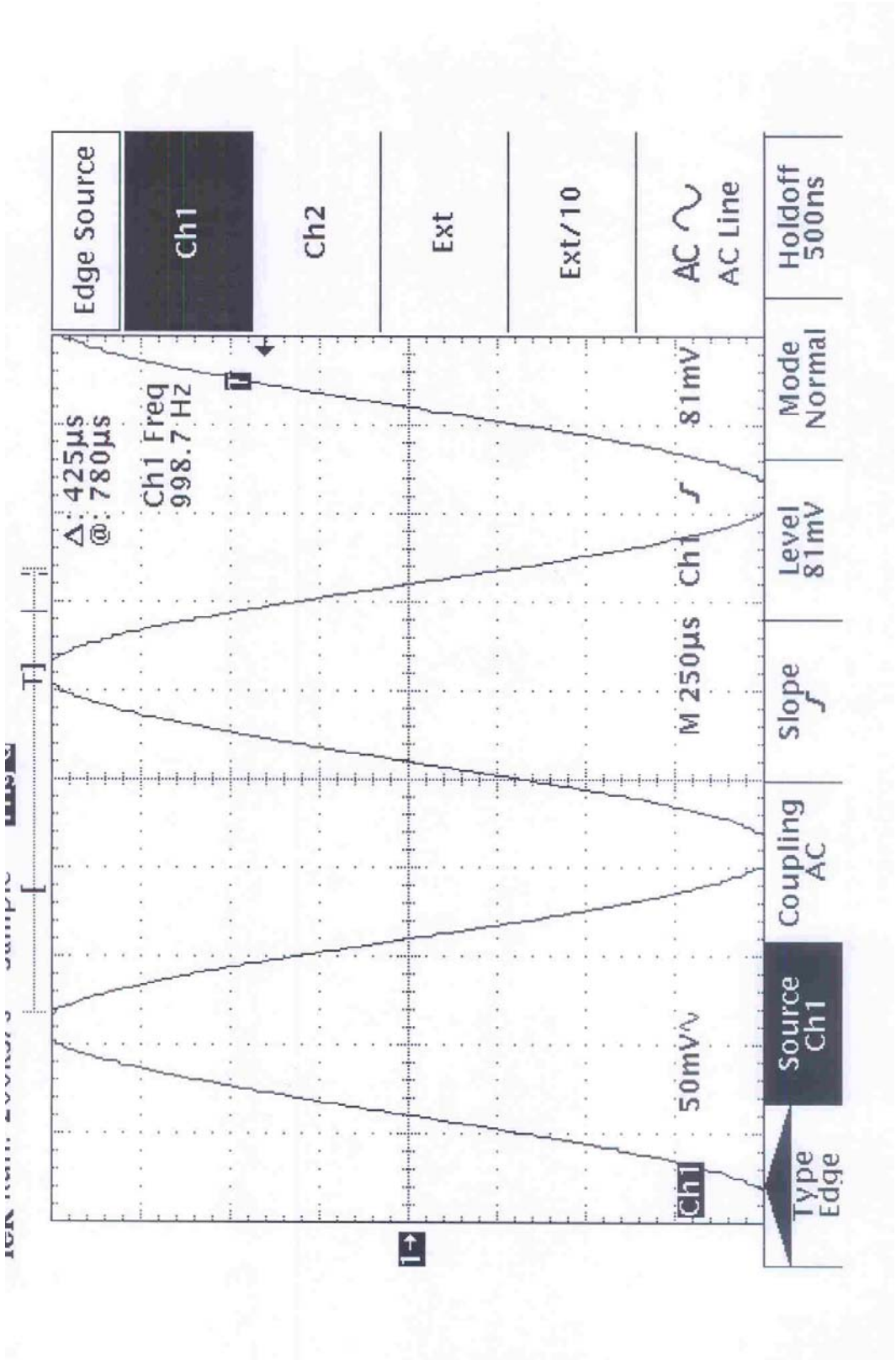
8.3 Test results

For more details refer to the attached plots:

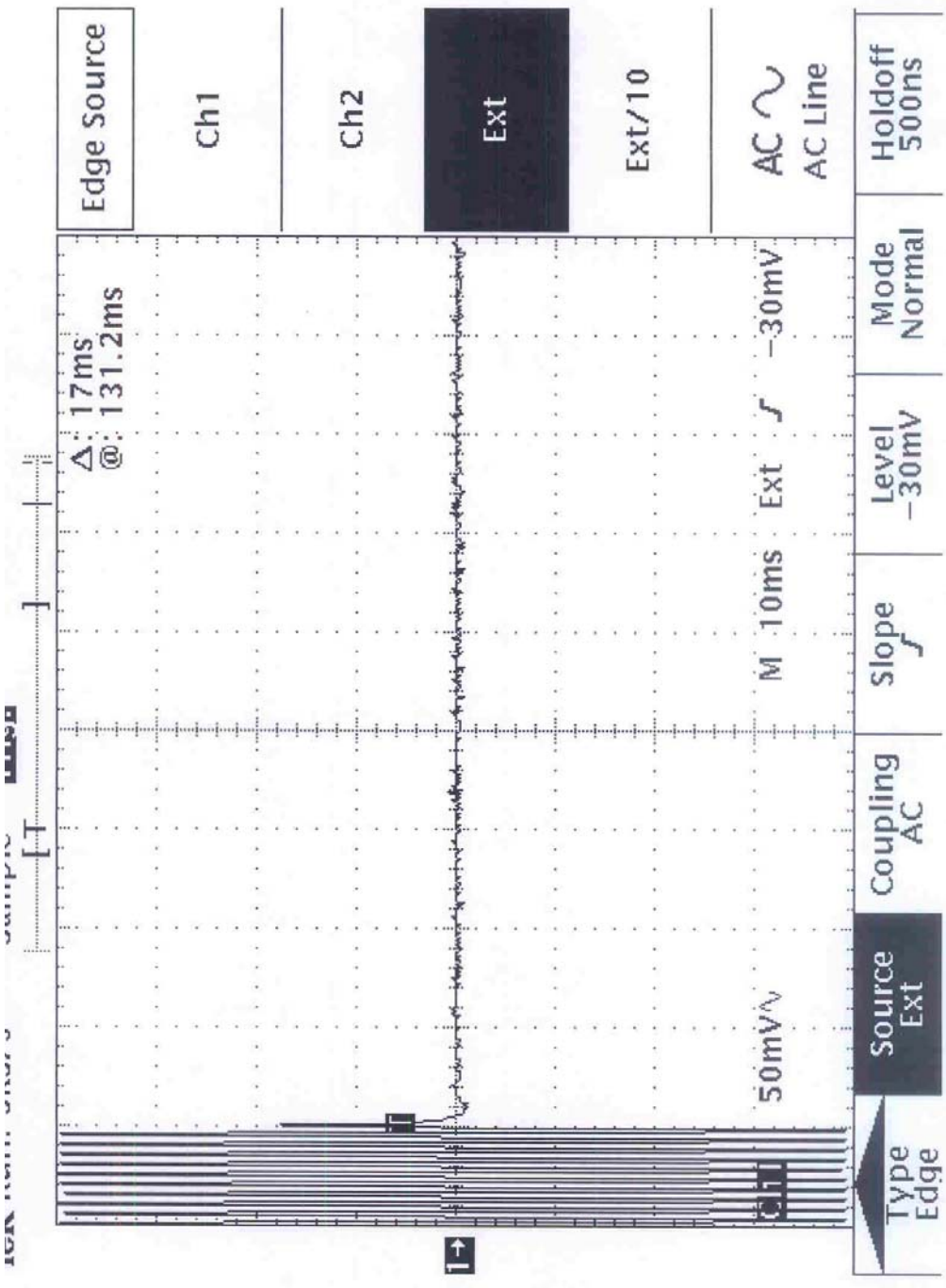
Plot 8.1 – 1 kHz signal applied from the Signal Generator (FM signal with 25 kHz deviation)
Plot 8.2 – Transient behavior when transmitter was turned ON
Plot 8.3 – Transient behavior when transmitter was turned OFF

Result	Complies

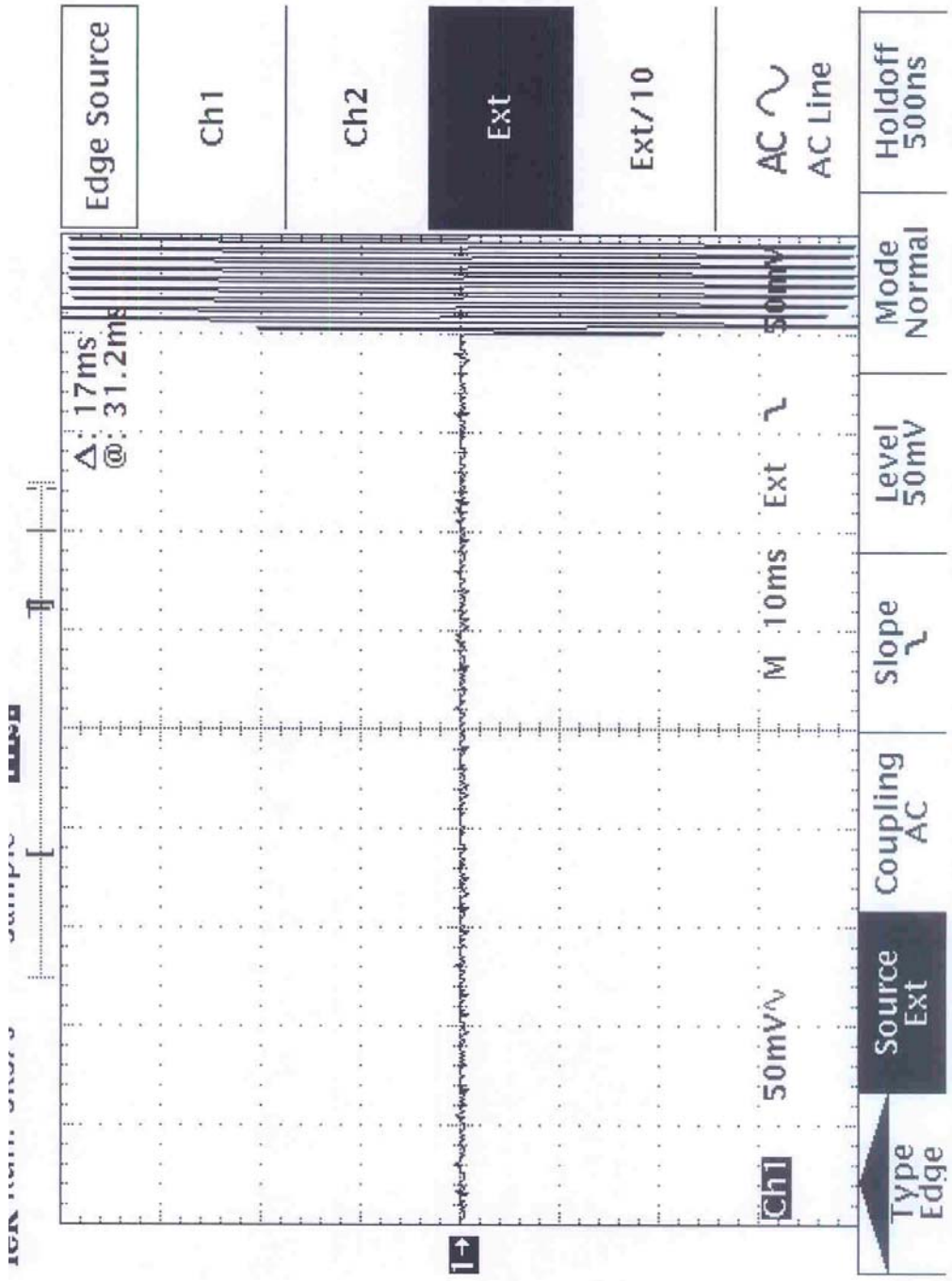
Plot 8.1


Edge Source
Ch1
Ch2
Ext
Ext/10
AC
AC Line
Holdoff
500ns
Mode
Normal
Level
81mV
Slope
Coupling
AC
Source
Ch1
Type
Edge
Δ: 425µs
@: 780µs
Ch1 Freq
998.7 Hz
M 250µs Ch1
81mV
50mV
Ch1

Plot 8.2


Edge Source
Ch1
Ch2
Ext
Ext/10
AC
AC Line
Holdoff
500ns
Mode
Normal
Level
−30mV
Slope
Coupling
AC
Source
Ext
Type
Edge
Δ: 17ms
@: 131.2ms
50mV
M 10ms
Ext
−30mV
Ch1

Plot 8,3


Edge Source
Ch1
Ch2
Ext
Ext/10
AC
AC Line
Holdoff
500ns
Mode
Normal
Level
50mV
Slope
Coupling
AC
Source
Ext
Type
Edge
Ch1
50mV
M 10ms
Ext
Δ: 17ms
@: 31.2ms

9.0 Frequency Stability vs Temperature and Voltage

FCC 2.1055, 90.213

9.1 Requirement

Mobile stations designed to operate with a 25 kHz channel bandwidth must have a frequency stability of 5.0 ppm.
Mobile stations designed to operate with a 12.5 kHz channel bandwidth must have a frequency stability of 2.5 ppm.

9.2 Test Procedure

The EUT was placed inside the temperature chamber. The RF power output was connected to frequency counter. The EUT was setup to transmit the maximum power.

After the temperature stabilized for approximately 20 minutes, the transmitting frequency was measured by the frequency counter and recorded.

At the room temperature, the frequency was measured when the EUT was powered with the nominal voltage and with 85% and 115% of the nominal voltage.

9.3 Test Equipment

Temperature Chamber
Frequency counter

9.4 Test Results

Nominal frequency: 460 MHz

Temperature (°C)	Measured frequency, MHz	Maximum deviation from nominal, Hz	Maximum deviation from nominal, ppm
-30	459.999996	4	<0.1
-20	459.999870	130	0.3
-10	459.999840	160	0.3
0	459.999830	170	0.4
10	459.999800	200	0.4
20	459.999760	240	0.5
30	459.999750	250	0.5
40	459.999770	230	0.5
50	459.999800	200	0.4

AC Voltage, V	Measured frequency, MHz	Maximum deviation from nominal, Hz	Maximum deviation from nominal, ppm
138	459.999750	250	0.5
120	459.999760	240	0.5
102	459.999760	240	0.5

Result	Complies

10.0 RF Exposure evaluation

FCC 2.1091

The EUT is a wireless device used in a mobile application, at least 20 cm from any body part of the user or nearby persons.

The maximum calculated peak EIRP is 3.8 W, and the maximum calculated peak ERP is 2.3 W.

As declared by the Applicant, in normal operation the EUT transmit the signal with a worst-case Duty Cycle of 49% (see Operational description for Duty Cycle calculation). Therefore, the average radiated power is not to exceed: EIRP = 1.90 W; ERP= 1.13 W.

Using the formula for the Power Density $S = EIRP/ 4\pi D^2$, the distance D, where the Maximum Permissible Exposure (MPE) satisfies the FCC 1.1310 limit for General Population/Uncontrolled Exposure, can be calculated as:

$$D \geq \sqrt{(EIRP/ 4\pi S)}$$

The MPE Limit at 450 MHz is 3 W/m^2, therefore $D \geq 0.22$ m

The Statement that a minimum separation distance of 25 cm between the antenna and persons must be maintained is included in the User's manual.

Note, that since the ERP is less than 1.5 W, the device is excluded from routine environmental evaluation for RF exposure, according to FCC 2.1091.

11.0 List of Test Equipment

Measurement equipment used for compliance testing utilized the equipment on the following list:

Equipment	Manufacturer	Model/Type	Serial #	Cal Int	Cal Due
BI-Log Antenna	EMCO	3143	9509-1164	12	4/26/05
Double-ridged Horn Antenna	EMCO	3115	9170-3712	12	6/18/05
Dipole Antenna	CDI	Roberts	331	12	5/09/05
Double-ridged Horn Antenna	EMCO	3115	8812-3049	12	4/14/05
RF Filter Section	Hewlett Packard	85460A	3448A00267	12	9/10/05
EMI Receiver	Hewlett Packard	8546A	3710A00373	12	9/10/05
Spectrum Analyzer	Rohde & Schwarz	FSP40	036612004	12	9/15/05
Signal Generator	Hewlett Packard	83732A	322A00119	12	3/21/06
Signal Generator	Hewlett Packard	8663A	2537A00214	12	7/16/05
Power Meter	Booton	4300	21402DC	12	8/26/05
Pre-Amplifier	Sonoma Inst.	310	185634	12	4/25/05
Pre-Amplifier	Miteq	AMF-4D-001180-24-10P	799159	12	4/25/05
Oscilloscope	Tektronix	TDS 380	BI05549	12	2/18/06
Digital Counter	Leader	LDC-825	1010046	12	8/30/05
Directional Coupler	Krytar	101020020	70798	12	3/22/05

12.0 Document History

Revision/ Job Number	Writer Initials	Date	Change
1.0 / 3074887	DC	April 29, 2005	Original document