HERMON LABORATORIES

ELECTROMAGNETIC EMISSIONS TEST REPORT

ACCORDING TO FCC CFR 47 PART 90 SUBPART I

for

Kavicomm Communications (PTY) Ltd.

EQUIPMENT UNDER TEST:

Alarm Radio,
model KLT-45

Hermon Laboratories Ltd.
P.O.Box 23
Binyamina 30550, Israel
Tel.+972-6628-8001
Fax.+972-6628-8277
Email: Mail@hermonlabs.com

ACCREDITED 839.01
Electrical

Description of equipment under test

Test items	Alarm radio
Manufacturer	Kavicomm Communications (PTY) Ltd.
Types (Models)	**KLT-45**
Receipt date	December 29, 1998

Applicant information

Applicant's representative & Responsible person	Mr. Itzhak Katz, managing director
Company	Kavicomm Communications (PTY) Ltd.
Address	14 Simba Street
P.O.Box	
Postal code	
City	Kfar Saba
Country	Israel
Telephone number	+972 9 7423 975
Telefax number	+972 9 7423 974

Test performance

Project Number:	13229
Location	Hermon Laboratories
Test started	December 29, 1999
Test completed	February 10, 2000
Purpose of test	Apparatus verification in accordance with emissions requirements
Test specification(s)	Part 90 subpart I, part 2

Table of Contents

1 Summary and signatures

The EUT, Alarm radio KLT-45, was tested according to part 90 subpart I, part 2 and found to comply with the standard requirements.

Test description	Specification reference	Test report paragraph	Test performed by	Signature	Pass / Fail
RF output power	90.205, 2.1046	4.1	Test engineer M. Nikishin		Pass
Occupied bandwidth	90.209 2.1049	4.2	Test engineer M. Nikishin		Pass
Emission mask	90.210	4.3	Test engineer M. Nikishin		Pass
Conducted spurious emissions	90.210 2.1051	4.3	Test engineer M. Nikishin		Pass
Radiated spurious emissions	90.210 2.1053	4.3	Test technician M. Feldman		Pass
Frequency stability vs temperature	90.213 2.1055	4.4	Test engineer M. Nikishin		Pass
Frequency stability vs voltage	2.1055	4.4	Test engineer Yu. Loparev		Pass
Modulation characteristics	2.1047	4.5	Test engineer M. Nikishin		Pass

Test report prepared by:

Mrs. Valeria Mednikov, certification engineer

Test report approved by:

Mr. Michael Nikishin, EMC group leader

Mr. Alex Usoskin, QA manager

The A2LA logo endorsement applies only to the test methods and the standards that are listed in the scope of Hermon Laboratories accreditation by A2LA.
Through this report a point is used as the decimal separator, while thousands are counted with a comma.
This report is in conformity with EN 45001 and ISO GUIDE 25.
The test results relate only to the items tested.
This test report must not be reproduced in any form except in full with the approval of Hermon Laboratories Ltd.

2 General information

2.1 Abbreviations and acronyms

The following abbreviations and acronyms are applicable to this test report:

AC	alternating current
cm	centimeter
CE	conducted emissions
dB	decibel
dBm	decibel referred to one milliwatt
dB(μV)	decibel referred to one microvolt
dB(μV/m)	decibel referred to one microvolt per meter
DC	direct current
EMC	electromagnetic compatibility
EUT	equipment under test
GHz	gigahertz
H	height
Hz	hertz
kHz	kilohertz
kV	kilovolt
L	length
LISN	line impedance stabilization network
m	meter
MHz	megahertz
NA	not applicable
NARTE	National Association of Radio and Telecommunications Engineers, Inc.
PC	personal computer
QP	quasi-peak (detector)
RE	radiated emission
RMS	root-mean-square
sec	second
V	volt
W	width

2.2 Specification references

CFR 47 part 15 subpart B: 10/1998	Radio Frequency Devices, Subpart B.
CFR 47 part 90 subpart I: 10/1998	Private land mobile radio services, Subpart I
ANSI C63.2:06/1996	American National Standard for Instrumentation-Electromagnetic Noise and Field Strength, 10 kHz to 40 GHz-Specifications.
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.

2.3 EUT description

The EUT, KLT-45, is a KLT radio, which is also referred to as FRM (Fleet management radio), designed for alarm purposes, vehicle location (and tracking) and fleet management.
Data is transmitted by analogue tone FM modulation.

The EUT operates in 450-470 MHz frequency range.
The EUT is energized from 13.6 V DC (6 A) power source such as a standard automotive "12 V" negative Gnd electrical system.

The unit is a multipurpose one. The main purpose is raising alarm signals once activated by input at the micro-controller connector. The alarm data is transmitted using FSK signals which are decoded at a central control room or other similar means.
In addition the unit could be used as a radio link repeating signals which are received by its receiver.

2.3.1 Changes made in EUT

To withstand the FCC part 15 paragraph 209 requirements for radiated spurious emissions the shield of cage was improved with a gasket inserted around D-type connector.

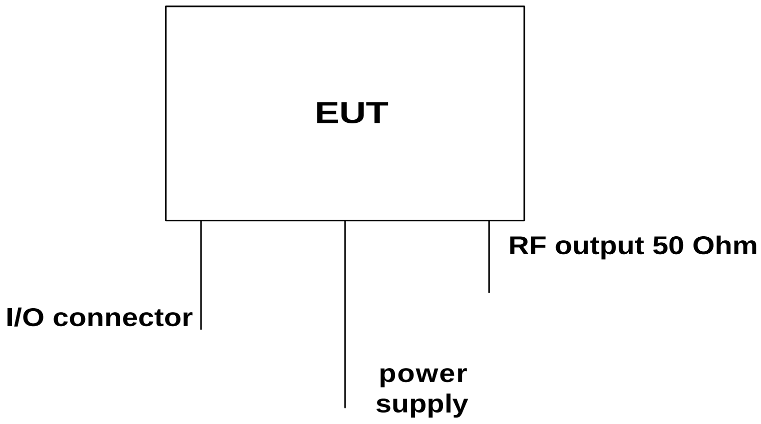
2.4 EUT test configuration

The EUT ports and lines description is given in Table 2.4.1, test configuration in Figure 2.4.1.

Table 2.4.1
EUT ports and lines

Port type	Port description	Cable type description	Cable length, m	Connected to
Power	13.6 V DC	unshielded	1	13.6 V DC power supply
Signal	RF output	Coax	0.15	Antenna/ Load
Signal	Signal	unshielded	0.5	Control switches

Figure 2.4.1
EUT test configuration



3 Test facility description

3.1 General

Tests were performed at Hermon Laboratories, which is a fully independent, private EMC, Safety and Telecommunication testing facility. Hermon Laboratories is listed by the Federal Communications Commission (USA) for all parts of Code of Federal Regulations 47 (CFR 47) and by Industry Canada for radiated measurements (file numbers IC 2186-1 for OATS and IC 2186-2 for anechoic chamber), certified by VCCI, Japan (the registration numbers are R-808 for OATS, R-809 for anechoic chamber, C-845 for conducted emissions site), assessed by NMi Certin B.V. (Netherlands) for a number of EMC, Telecommunications and Safety standards, and Accredited by AMTAC (UK) for safety of Medical Devices. The laboratory is accredited by American Association for Laboratory Accreditation (USA) according to ISO GUIDE 25/EN 45001 for EMC, Telecommunications and Product Safety Information Technology Equipment (Certificate No. 839.01). At the end of 1999, Hermon Laboratories signed an agreement with Intertek Testing Services NA. INC. concerning mutual recognition of the test results for EMC and Safety. According to this agreement Hermon Laboratories customers can bear ETL safety mark after successful testing in Hermon Laboratories. Also the laboratory performs various follow-up services.

Address: PO Box 23, Binyamina 30550, Israel
Telephone: +972 6628 8001
Fax: +972 6628 8277

Person for contact: Mr. Alex Usoskin, testing and QA manager.

3.2 Equipment calibration

The test equipment has been calibrated according to its recommended procedures and is within the manufacturer's published limit of error. The standards and instruments used in the calibration system conform to the present requirements of MIL-STD-45662A.
The laboratory standards are calibrated by the third party (traceable to NIST, USA) on a regular basis according to equipment manufacturer requirements.

3.2.1 Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Radiated emissions in the open field test site at 10 m measuring distance	Biconilog antenna: ±3.2 dB Log periodic antenna: ±3 dB Biconical antenna: ±4 dB Double ridged guide antenna: ± 2.36 dB
Radiated emissions in the anechoic chamber at 3 m measuring distance	Biconilog antenna: ±3.2 dB

3.3 Statement of qualification

The test measurement data supplied in this test measurement report having been received by me, is hereby duly certified. The following is a statement of my qualifications.
I am a technician, have obtained 30 years experience in electronics and measurements.
I have been with Hermon Laboratories since 1995.

Name: Mr. Michael Feldman	Signature:		
Position: test technician	Date:	August 15, 2000	

The test measurement data supplied in this test measurement report having been received by me, is hereby duly certified. The following is a statement of my qualifications:
I am an engineer, graduated from university in 1996 with an M. Sc. EE degree and certified by NARTE as an EMC Accredited Test Laboratory engineer, the certificate No. is ATL–0005–E.
I have obtained 2 years experience in EMC measurements and have been with Hermon Laboratories since 1998.

Name: Mr. Michael Nikishin	Signature:		
Position: test engineer	Date:	August 15, 2000	

The test measurement data supplied in this test measurement report having been received by me, is hereby duly certified. The following is a statement of my qualifications.
I am an engineer, graduated from university in 1992 with an MScEE degree, have obtained 7 years experience in research and development of electronic devices.

I have been with Hermon Laboratories since January 2000.

Name: Mr. Yuri Loparev	Signature:		
Position: test engineer	Date:	August 15, 2000	

I hereby certify that this test measurement report was prepared by me and is hereby duly certified. The following is a statement of my qualifications.
I have a university degree and more than 10 years experience in document processing.
I have been with Hermon Laboratories since May 1999.

Name: Mrs. Valeria Mednikov	Signature:		
Position: certification engineer	Date:	August 15, 2000	

4 Emissions measurements

4.1 Effective radiated power measurements according to FCC part 90 paragraph 205g

4.1.1 General

This test was performed to determine maximal effective radiated power.
The standard specification limit is 100 W ERP for service area radius up to 8 km.

4.1.2 Test procedure

The measurements were made with power meter, connected to RF output connector of the EUT via attenuator 30 dB. The measurements were performed at 3 frequencies: one close to the lower edge of the frequency range, one in the middle and one close to the upper edge of the frequency range.

The RF output power was calculated according to formula

$$\mathbf{P = P_M + Att_{ext},}$$

where

P_M is power meter reading,

Att_{ext} is external attenuation.

The test results are shown in Table 4.1.1.

Reference numbers of test equipment used

HL 0051	HL 0190	HL 0611

Full description is in Appendix A.

Table 4.1.1
Output power measurement

Frequency, MHz	Power, dBm	Power, W	Pass / Fail
450.5502	41.6	14.5	Pass
460.0126	41.7	14.8	Pass
469.5502	41.7	14.8	Pass

4.2 Occupied bandwidth measurements according to FCC part 90 paragraph 209

4.2.1 General

According to paragraph 90.209 (5) the maximum authorized bandwidth shall be 11.25 kHz in the 421.00 – 512.00 MHz band.

4.2.2 Test procedure

The EUT was set up as shown in Photograph 4.2.1.
The measurements were performed using spectrum analyzer.

The occupied bandwidth was measured as a frequency band between points where power envelope of carrier, modulated with normal signal, drops 23 dB below unmodulated carrier.

The test results are recorded in Table 4.2 and shown in Plots 4.2.1 to 4.2.3.

Reference numbers of test equipment used

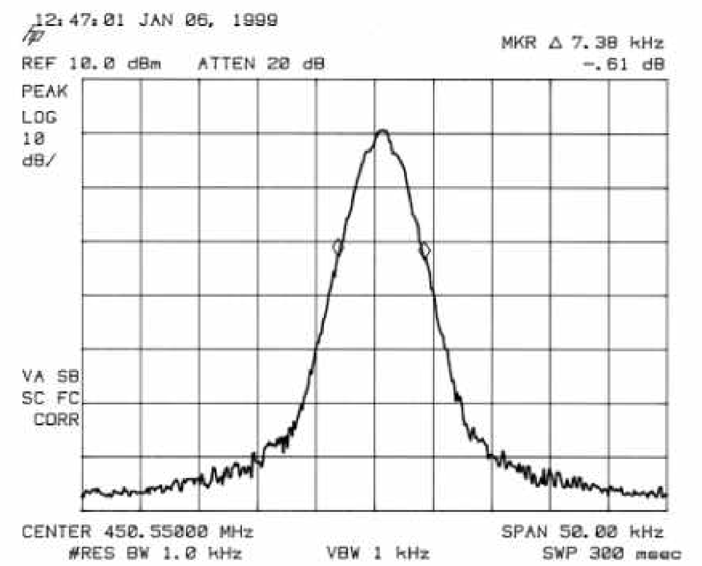
HL 0051	HL 0052	HL 0507

Full description is in Appendix A.

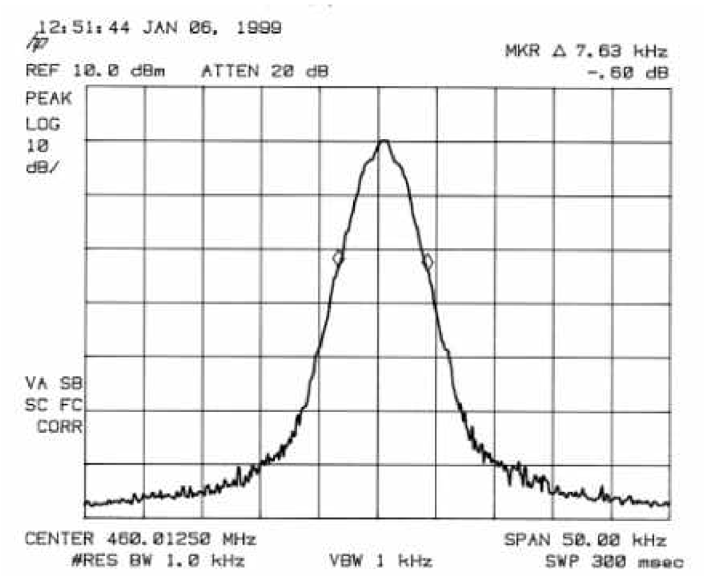
Table 4.2
Occupied bandwidth measurements

Frequency, MHz	OBW, kHz	Pass / Fail
450.5502	7.38	Pass
460.0126	7.63	Pass
469.5502	7.63	Pass

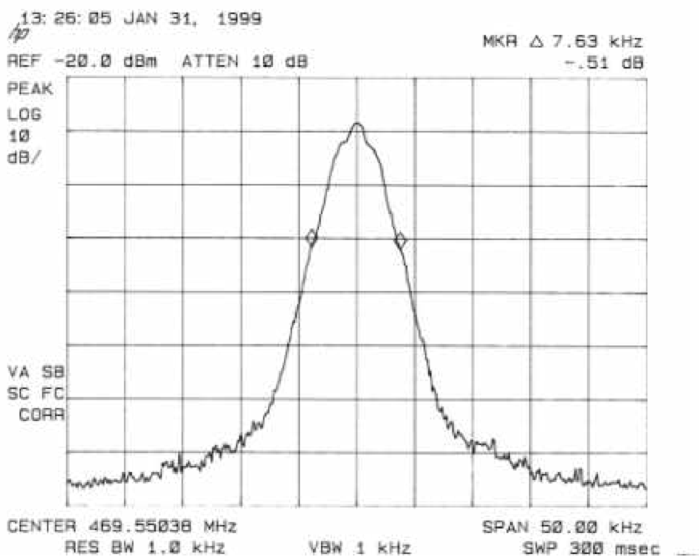
Plot 4.2.1
Occupied bandwidth measurements test result
Frequency 450.550 MHz



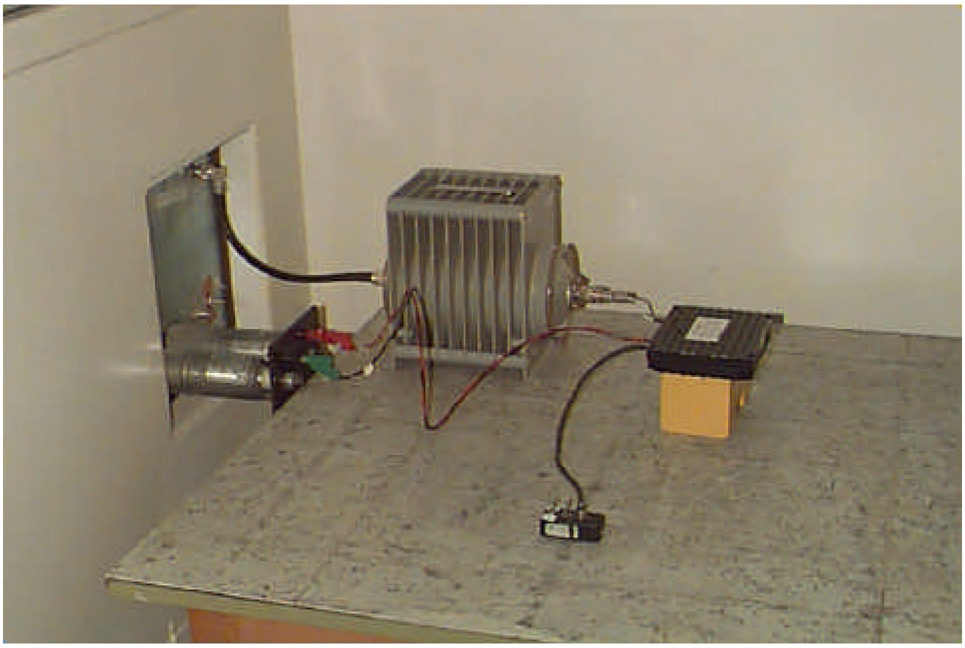
Plot 4.2.2
Occupied bandwidth measurements test result
Frequency 460.0125 MHz



Plot 4.2.3
Occupied bandwidth measurements test result
Frequency 469.550 MHz



Photograph 4.2.1
Occupied bandwidth measurements test result



4.3 Emission mask according to FCC part 90 paragraph 210

4.3.1 General

Any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

(1) On any frequency from the center of the authorized bandwidth f_0 to 5.625 kHz removed from f_0: Zero dB.
(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least 7.27(f_d – 2.88 kHz) dB.
(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: At least 50 + 10 log(P) dB or 70 dB, whichever is the lesser attenuation.

4.3.2 Test procedure

For test setup refer to Photograph 4.3.1.

The emission mask, calculated according to formulas (1) – (3) is shown in Figure 4.3.1, refer to Plots 4.3.2, 4.3.17, 4.3.32.

Conducted spurious emissions were measured in the frequency range 9 kHz to 4.7 GHz for three operating frequencies (450.550 MHz, 460.030 MHz, 469.559 MHz). Outside the specified bandwidth (f_0 – 12.5 kHz, f_0 + 12.5 kHz) they were compared with the limit, expressed as follows:

$$Att_{min} = 50 + 10 \log(P).$$

Test results are shown in Table 4.3.1 and in Plots 4.3.3 to 4.3.15, 4.3.18 to 4.3.30, 4.3.33 to 4.3.46.

Radiated spurious emissions were measured in the anechoic chamber at 3-m test distance: with loop antenna in the range 9 kHz – 30 MHz, biconilog antenna in the range 30 – 1000 MHz and double ridged guide antenna in the range 1GHz – 4.7 GHz.

The specified limit expressed in attenuation vs carrier 50 + 10 logP was converted in EIRP units – 20 dBm and in field strength units as follows:

E = sqrt(30P) /r, where P = –20 dBm = 0.01 mW = 10^{-5} W.

E [dBμV/m] = 20 log {10^6 x sqrt (30x10^{-5})/3} = 75.2 dBμV/m.

The EUT was set up on the wooden table, as shown in Figure 4.3.2.
To find maximum radiation the turntable was rotated 360°, the measuring antenna height varied from 1 to 4 m and the antennas polarization was changed from vertical to horizontal.

The received values were compared with calculated field strength limit E = 75.2 dBμV/m and the results, which were found closer than 10 dB to the limit, were investigated by means of substitution method and emissions were compared with the limit expressed in attenuation below the power of carrier.

The worst test results are recorded in Table 4.3.2 and shown in Plots 4.3.47 to 4.3.50.

The EUT was found to comply with standard requirements.

Reference numbers of test equipment used

HL 0025	HL 0041	HL 0052	HL 0120	HL 0205	HL 0446	HL 0507	HL 0521	HL 0554
HL 0557	HL 0604	HL 0614	HL 0661	HL 0872	HL 0887	HL 0940		

Full description is in Appendix A.

Table 4.3.1
Conducted spurious emissions test results

TEST SPECIFICATION: FCC part 15, subpart C
DATE: January 8, 2000
RELATIVE HUMIDITY: 58%
AMBIENT TEMPERATURE: 21°C

Harmonic	Carrier frequency 450.550 MHz Att.min = 62.89 dBc		Carrier frequency 460.030 MHz Att.min = 63.16 dBc		Carrier frequency 469.559 MHz Att.min = 62.23 dBc	
	Att. vs carrier, dBc	**Margin, dB**	**Att. vs carrier, dBc**	**Margin, dB**	**Att. vs carrier, dBc**	**Margin, dB**
2	69.41	6.52	71.24	8.08	70.98	8.75
3	67.91	5.02	66.24	3.08	79.37	17.14
4	71.21	8.32	70.24	7.08	81.57	19.34
5	77.79	14.9	76.26	13.1	69.23	7
6	72.69	9.8	70.76	7.6	79.23	17
7	81.49	18.6	79.56	16.4	78.43	16.2
8	79.89	17	72.66	9.5	71.53	9.3
9	78.99	16.1	71.56	8.4	75.83	13.6
10	79.39	16.5	83.96	20.8	80.93	18.7

Table 4.3.2
Radiated spurious emissions test results

TEST SPECIFICATION:	FCC part 15, subpart C
DATE:	January 24, 2000
RELATIVE HUMIDITY:	59%
AMBIENT TEMPERATURE:	19°C

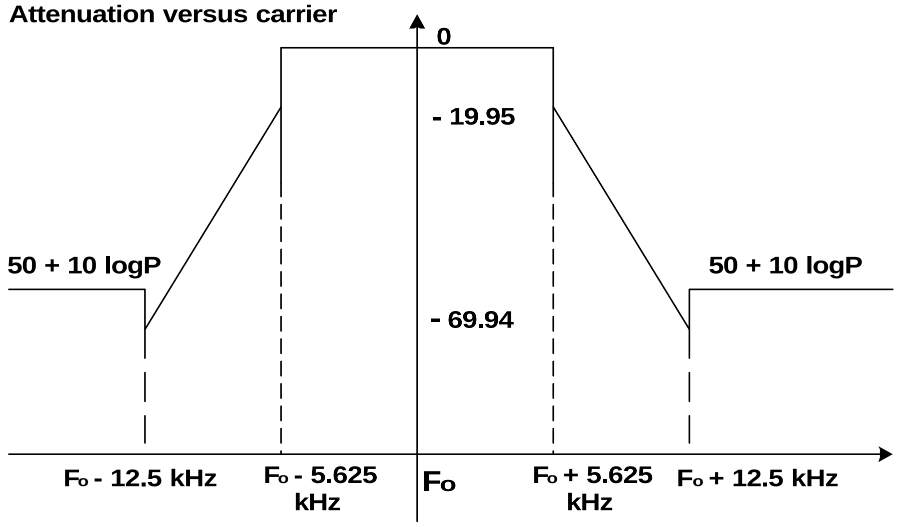
MEASUREMENTS PERFORMED AT 3-METER DISTANCE

Frequency MHz	Ant. type	Measured result dB(μV/m)	Antenna gain dB	Cable loss dB	Gen. P out dBm	ERP dBm	Limit dBm	Margin dB	Pass/ Fail
901.1	TD	75.2	1.7	0.5	-24.2	-23.0	-20	3.0	Pass
920	TD	73.1	1.8	0.5	-27.3	-26.0	-20	6.0	Pass
1380	RGA	57.4	7.8	0.7	-45.3	-38.2	-20	18.2	Pass

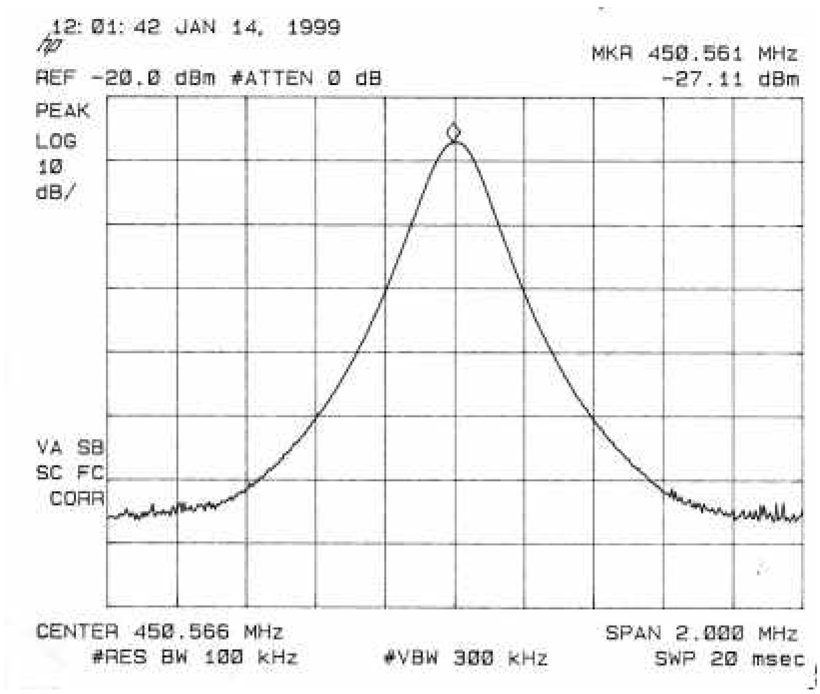
Test parameters:
Detector type = Peak.
Resolution bandwidth = 120 kHz below 1000 MHz and 1 MHz above 1000 MHz.

Table calculations and abbreviations:
ERP (dBm) = P out gen. (dBm) – Cable loss (dB) + Antenna gain (dB).
Ant. type = antenna type (TD – tunable dipole, RGA – double ridged guide).
Margin = dB below (negative if above) limit.

Figure 4.3.1
Emission mask



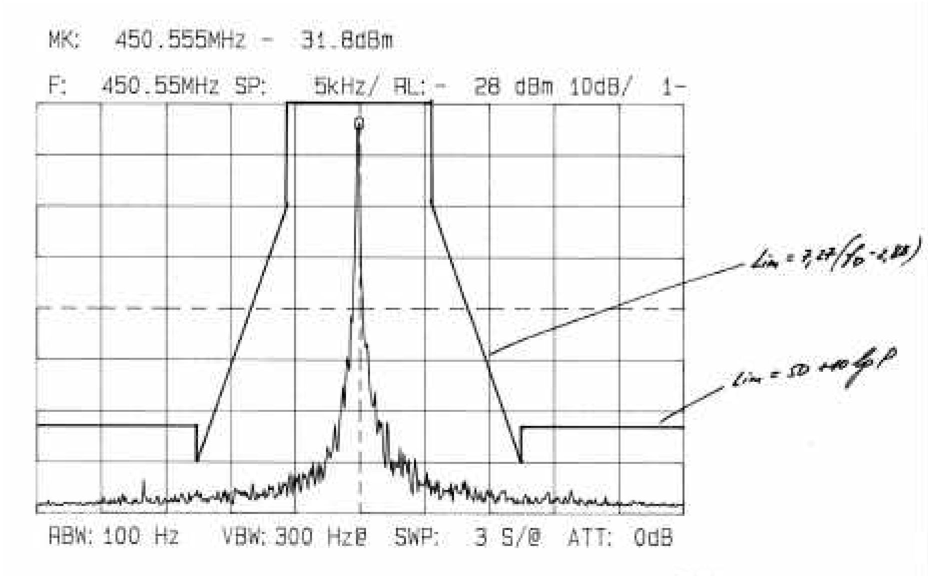
Plot 4.3.1
Frequency 450.550
Carrier



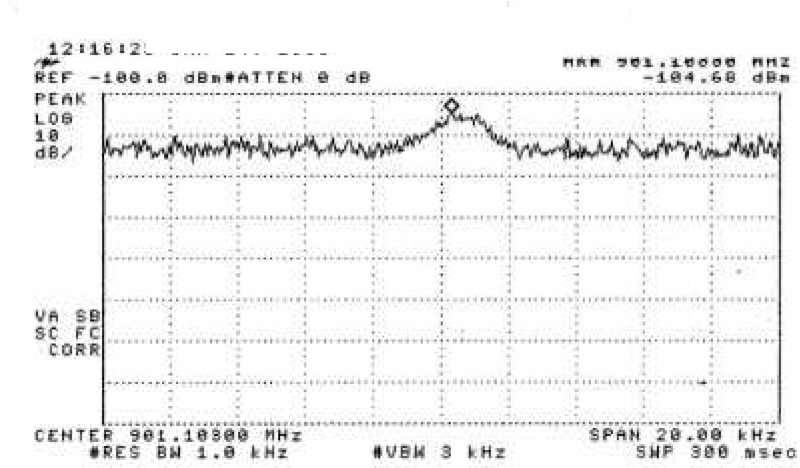
External attenuation = 70 dB.

P = –27.11 + 70 = 42.89 dBm

Plot 4.3.2
Frequency 450.550
Emission mask

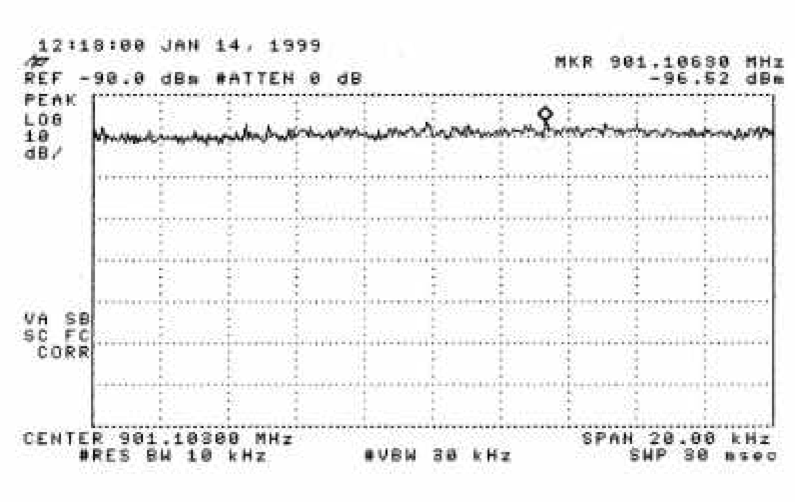


Plot 4.3.3
Conducted spurious emissions
Frequency 450.550
2nd harmonic



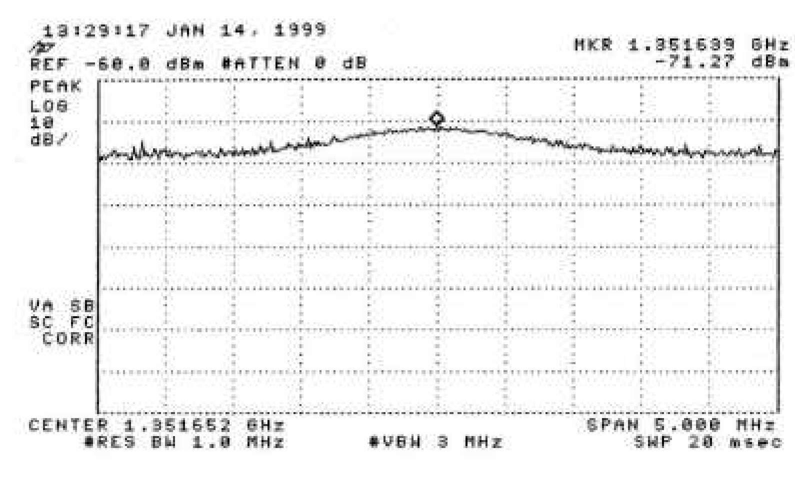
Ext. attenuation 70 dB.
Att (vs Pc) = – 27.11 – (– 104.68) = 77.57 dBc
Lim = 50 + 10 log P = 62.89 dBc

Plot 4.3.4
Conducted spurious emissions
Frequency 450.550
2nd harmonic



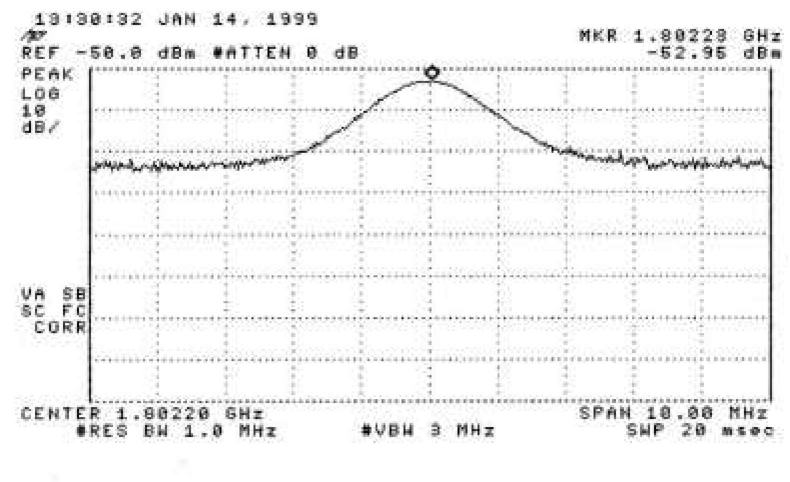
Ext. attenuation 70 dB.
Att (vs Pc) = – 27.11 – (– 96.52) = 69.41 dBc
Lim = 50 + 10 log P = 62.89 dBc

Plot 4.3.5
Conducted spurious emissions
Frequency 450.550
3d harmonic



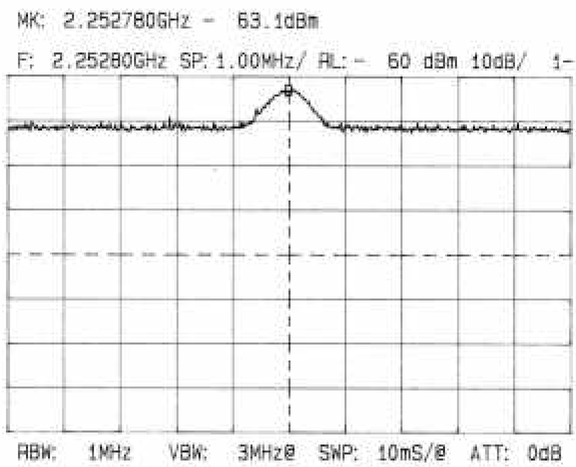
Ext. attenuation 46.25 dB.
Ps = – 71.27 +46.25 = – 25.02 dBm
Att (vs Pc) = 42.89 – (– 25.02) = 67.91 dBc
Lim = 50 + 10 log P = 62.89 dBc

Plot 4.3.6
Conducted spurious emissions
Frequency 450.550
4th harmonic



Ext. attenuation 24.63 dB.
Ps = – 52.95 +24.63 = – 28.32 dBm
Att (vs Pc) = 42.89 – (– 28.32) = 71.21 dBc
Lim = 50 + 10 log P = 62.89 dBc

Plot 4.3.7
Conducted spurious emissions
Frequency 450.550
5th harmonic



Ext. attenuation 28.2 dB.
Ps = – 63.1 +28.2 = – 34.9 dBm
Att (vs Pc) = 42.89 – (– 34.9) = 77.79 dBc
Lim = 50 + 10 log P = 62.89 dBc

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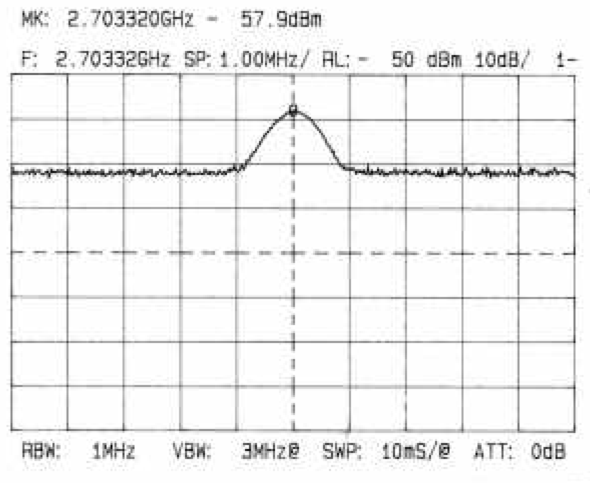
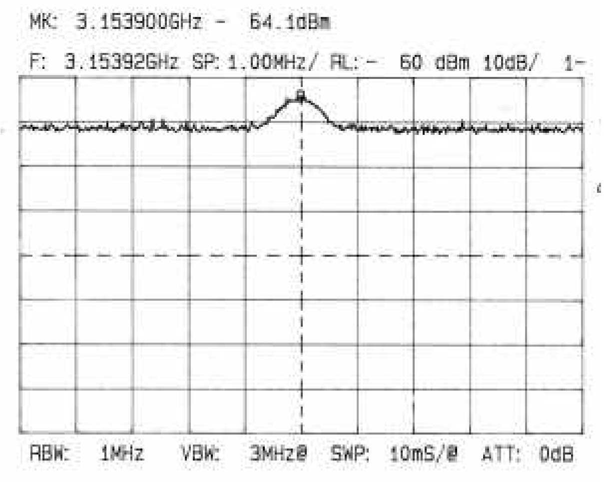
Plot 4.3.8
Conducted spurious emissions
Frequency 450.550
6th harmonic



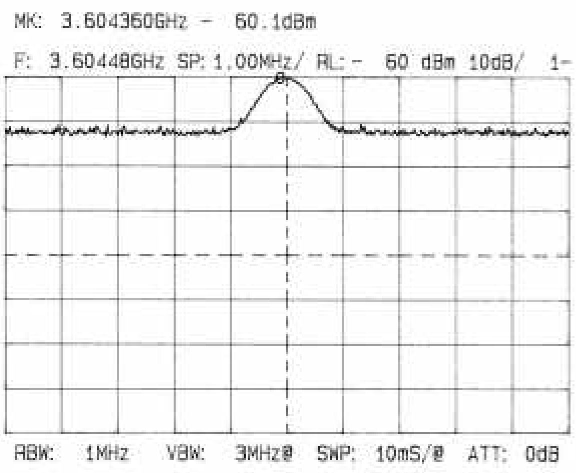
Ext. attenuation 28.1 dB.
Ps = – 57.9 +28.1 = – 29.8 dBm
Att (vs Pc) = 42.89 – (– 29.8) = 72.69 dBc
Lim = 50 + 10 log P = 62.89 dBc

Plot 4.3.9
Conducted spurious emissions
Frequency 450.550
7th harmonic



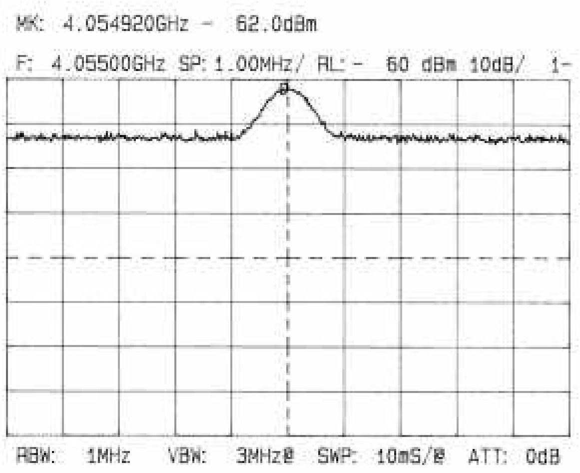
Ext. attenuation 25.5 dB.
Ps = – 64.1 +25.5 = – 38.6 dBm
Att (vs Pc) = 42.89 – (– 38.6) = 81.49 dBc
Lim = 50 + 10 log P = 62.89 dBc

Plot 4.3.10
Conducted spurious emissions
Frequency 450.550
8th harmonic



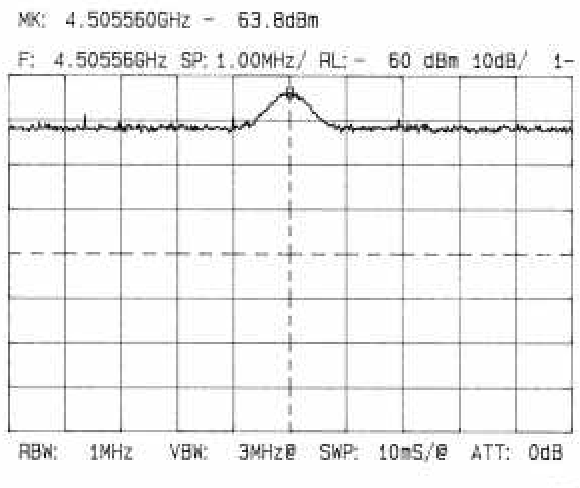
Ext. attenuation 23.1 dB.
Ps = – 60.1 +23.1 = – 37.0 dBm
Att (vs Pc) = 42.89 – (– 37.0) = 79.89 dBc
Lim = 50 + 10 log P = 62.89 dBc

Plot 4.3.11
Conducted spurious emissions
Frequency 450.550
9th harmonic



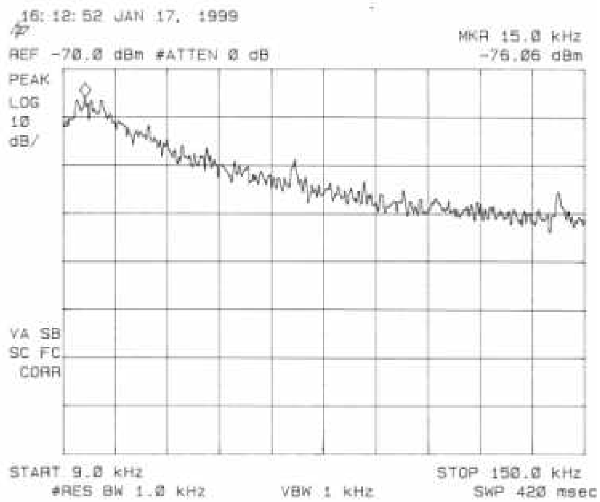
Ext. attenuation 25.9 dB.
Ps = – 62.0 +25.9 = – 36.1 dBm
Att (vs Pc) = 42.89 – (– 36.1) = 78.99 dBc
Lim = 50 + 10 log P = 62.89 dBc

Plot 4.3.12
Conducted spurious emissions
Frequency 450.550
10th harmonic



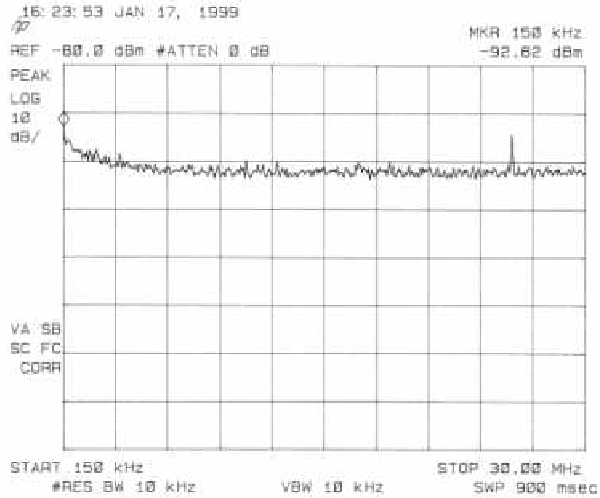
Ext. attenuation 27.3 dB.
Ps = – 63.8 +27.3 = – 36.5 dBm
Att (vs Pc) = 42.89 – (– 36.5) = 79.39 dBc
Lim = 50 + 10 log P = 62.89 dBc

Plot 4.3.13
Conducted spurious emissions
Frequency 450.550
9-150 kHz



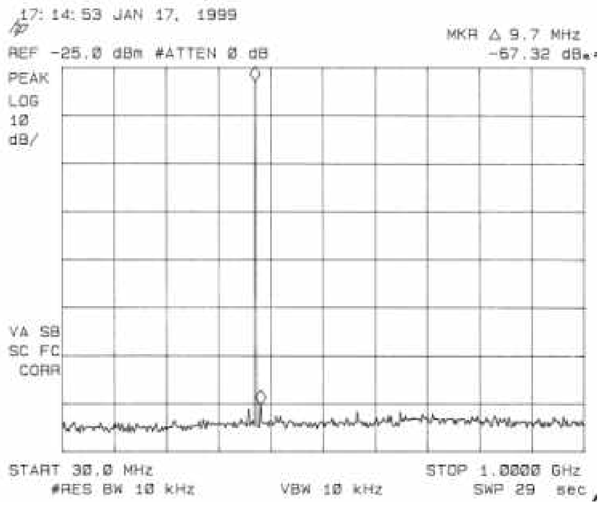
Ext. attenuation 40 dB.
Ps = – 76.06 +10 log (10 kHz/1 kHz) + 40 = – 26.06 dBm
Att (vs Pc) = 42.89 – (– 26.06) = 68.95 dBc
Lim = 50 + 10 log P = 62.89 dBc

Plot 4.3.14
Conducted spurious emissions
Frequency 450.550
150 kHz – 30 MHz



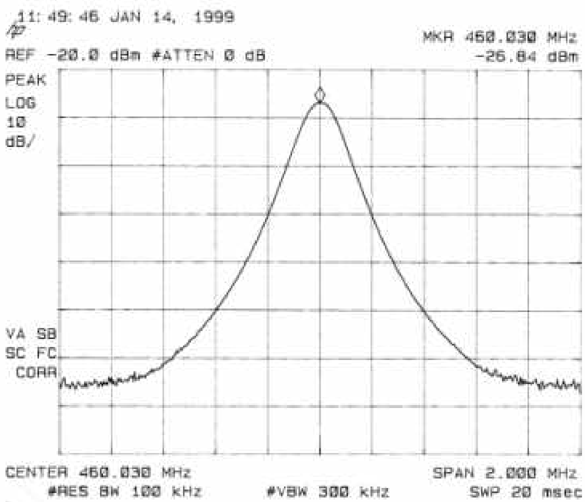
Ext. attenuation 40 dB.
Ps = – 92.82 + 40 = – 52.82 dBm
Att (vs Pc) = 42.89 – (– 52.82) = 95.71 dBc
Lim = 50 + 10 log P = 62.89 dBc

Plot 4.3.15
Conducted spurious emissions
Frequency 450.550
30 - 1000 MHz



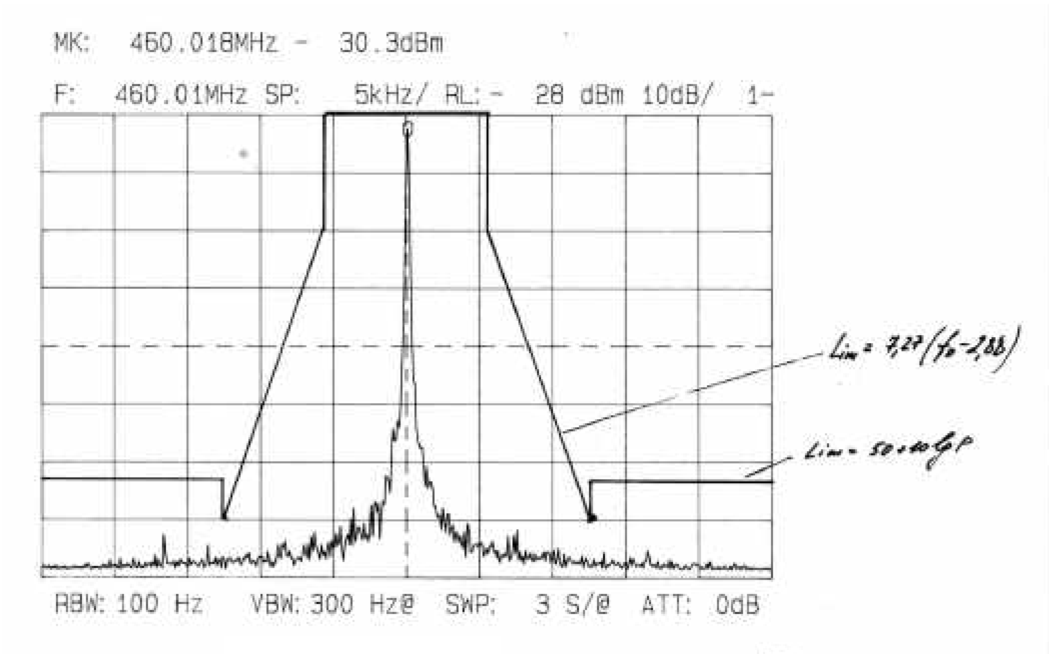
Ext. attenuation 70 dB.
Att (vs Pc) = 67.32 dBc
Lim = 50 + 10 log P = 62.89 dBc

Plot 4.3.16
Frequency 460.030
Carrier

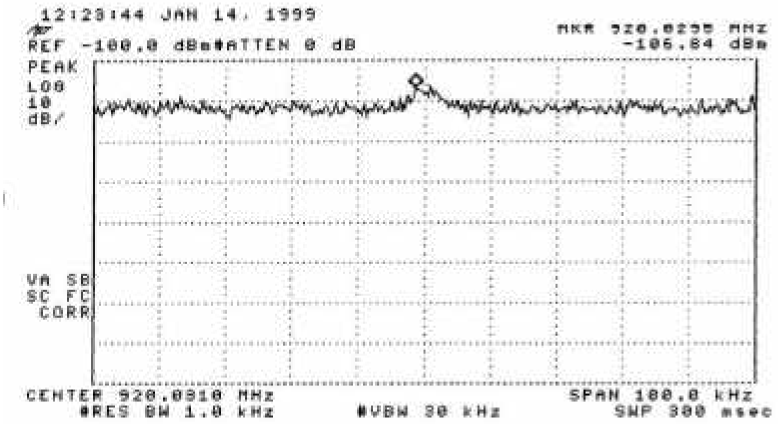


External attenuation = 70 dB.
P = –26.84 + 70 = 43.16 dBm

Plot 4.3.17
Frequency 460.030
Emission mask

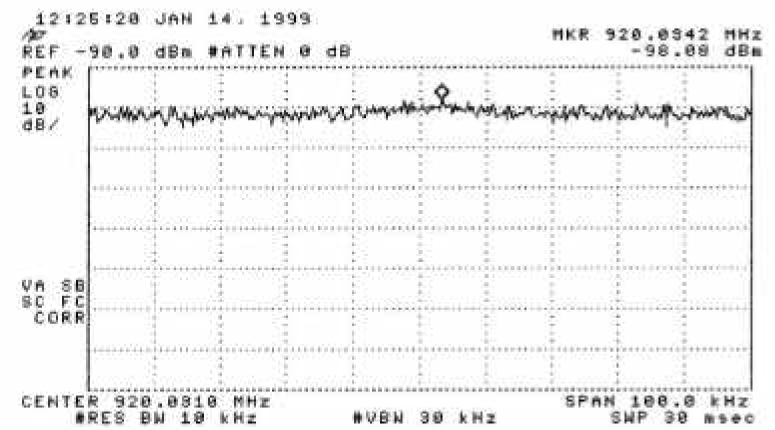


Plot 4.3.18
Conducted spurious emissions
Frequency 460.030
2nd harmonic



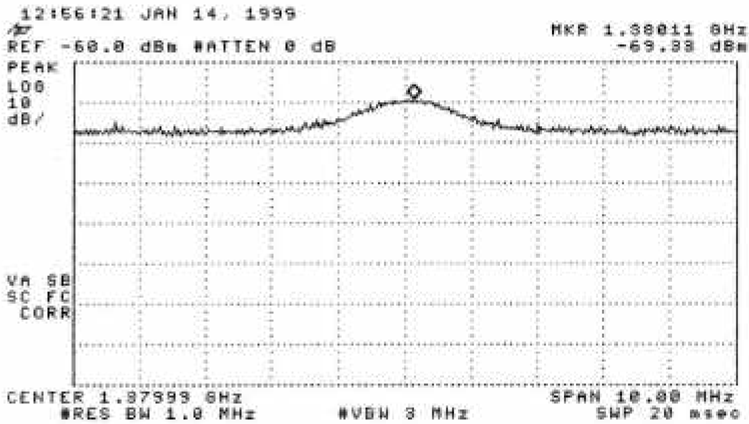
Ext. attenuation 70 dB.
Att (vs Pc) = 106.84 – 26.84 = 80.0 dBc
Lim = 50 + 10 log P = 63.16 dBc

Plot 4.3.19
Conducted spurious emissions
Frequency 460.030
2nd harmonic



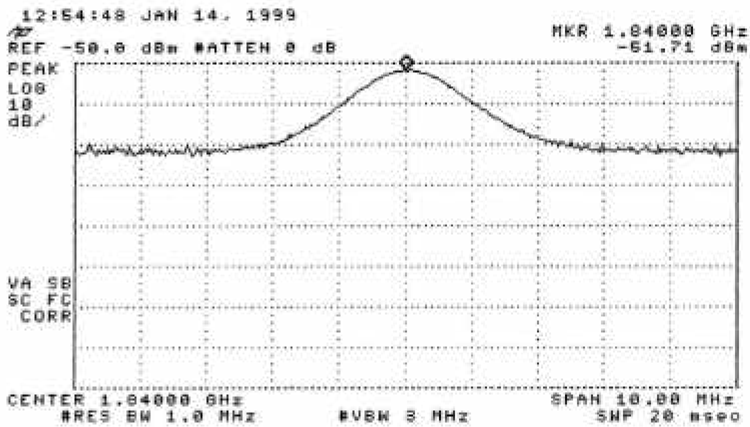
Ext. attenuation 70 dB.
Att (vs Pc) = 98.08 – 26.84 = 71.24 dBc
Lim = 50 + 10 log P = 63.16 dBc

Plot 4.3.20
Conducted spurious emissions
Frequency 460.030
3[d] harmonic



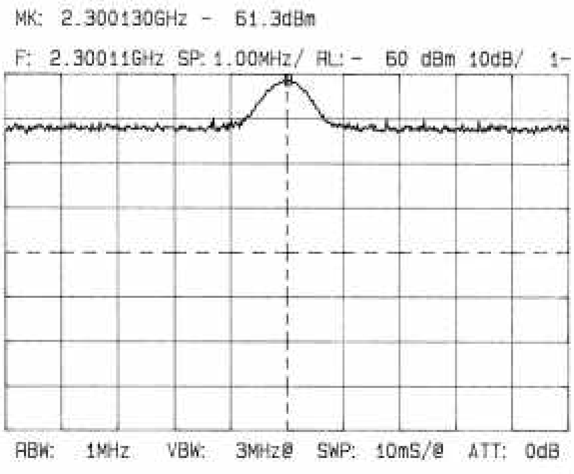
Ext. attenuation 46.25 dB.
Ps = – 69.33 +46.25 = – 23.08 dBm
Att (vs Pc) = 43.16 – (– 23.08) = 66.24 dBc
Lim = 50 + 10 log P = 63.16 dBc

Plot 4.3.21
Conducted spurious emissions
Frequency 460.030
4[th] harmonic



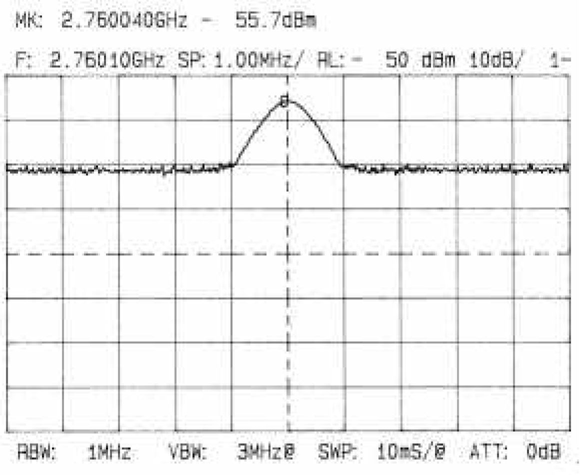
Ext. attenuation 24.63 dB.
Ps = – 51.71 +24.63 = – 27.08 dBm
Att (vs Pc) = 43.16 – (– 27.08) = 70.24 dBc
Lim = 50 + 10 log P = 63.16 dBc

Plot 4.3.22
Conducted spurious emissions
Frequency 460.030
5th harmonic



Ext. attenuation 28.2 dB.
Ps = – 61.3 +28.2 = – 33.1 dBm
Att (vs Pc) = 43.16 – (– 33.1) = 76.26 dBc
Lim = 50 + 10 log P = 63.16 dBc

Plot 4.3.23
Conducted spurious emissions
Frequency 460.030
6th harmonic



Ext. attenuation 28.1 dB.
Ps = – 55.7 +28.1 = – 27.6 dBm
Att (vs Pc) = 43.16 – (– 27.6) = 70.76 dBc
Lim = 50 + 10 log P = 63.16 dBc